INEQUALITIES IN EFFECTIVE PROPERTY TAX RATES: A STATISTICAL STUDY OF THE CITY OF BOSTON

by

David E. Black

B.A., Lawrence College

(1963)

SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE

DEGREE OF DOCTOR OF

PHILOSOPHY

at the

MASSACHUSETTS INSTITUTE OF

TECHNOLOGY

September, 1969

Signature of Author ________________________
Department of Economics, Sept. 1, 1969

Certified by ________________________
Thesis Supervisor

Accepted by ________________________
Chairman, Departmental Committee
on Graduate Students

Abstract

Title: Inequalities in Effective Property Tax Rates: A Statistical Study of the City of Boston

Author: David E. Black

Submitted to the Department of Economics on September 1, 1969, in partial fulfillment of the requirement for the degree of Doctor of Philosophy

This dissertation describes the systematic portion of the total variation in effective residential property tax rates (ratios of assessed valuation to market variation) within the City of Boston, and it attempts to identify the causes of the systematic variation. A model of the assessment process is developed in order to empirically test several general hypotheses about assessment behavior. In addition to the U. S. Census Bureau data on population and housing characteristics by census tract, a sample of about 20,000 residential property transactions, gathered especially for this dissertation, provides estimates of effective property tax rates by census tract on different property types in 1950 and 1960.

Empirical analysis reveals many different types of significant effective tax rate variations. In all areas of the city effective tax rates increase continuously with increases in the number of families per structure. Also, for properties of any given type, it appears that with respect to characteristics of the neighborhood in which the property is located, there is a positive partial correlation between effective property tax rates and the density of housing units in poor physical condition and the density of Negro residents, and that there is a negative partial correlation between effective tax rates and median family income or average market value of properties. Estimates of partial correlation coefficients are obtained by regressing observations of mean neighborhood effective tax rates on variables representing relevant characteristics of neighborhoods.

The failure to adjust assessments to changing market values seems to be one important cause of effective tax rate inequalities. It is also possible that the assessor's estimates of market values are systematically in error because important neighborhood characteristics are not taken into account. Finally, the results suggest that some part of the systematic variation in effective tax rates is created by deliberate use of effective tax rate inequalities for the purpose of achieving certain policy goals.

Thesis Supervisor: E. Cary Brown

Title: Professor of Economics

ACKNOWLEDGEMENTS

I want to express my gratitude for the many constructive comments and suggestions from my thesis advisors, Professors E. Cary Brown, Edwin Kuh, and Jerome Rothenberg. Their constant availability, especially at times when problems were encountered, was very helpful and is greatly appreciated. Fellow graduate students, in particular Dwight Jaffee and William Vaughn, also provided invaluable assistance in the initial stages of development and in interpreting statistical results. I take full responsibility, however, for any errors which still remain.

I am indebted for financial assistance received during the academic year 1967 - 1968 from two sources. A fellowship from the Gerard Swope Foundation allowed me to devote full time to thesis work, and a grant from the Harvard - M.I.T. Joint Center for Urban Studies covered the substantial cost of collecting data.

This study has also benefited from the generous help and cooperation of private organizations and agencies of city government. The Boston Metropolitan Mortgage Bureau allowed me to have free access to their records of property transactions. Moreover, the staff of the Mortgage Bureau was both patient and helpful during the several months which were spent examining their records. John Culp of the Metropolitan Area Planning Council supplied a computer tape containing useful Boston land use data.

My greatest debt is to my wife, Georgia. Her contributions were all too many. She typed several rough drafts, worked valiantly to improve the overall clarity of presentation, and was a steady source of encouragement without which this dissertation would still be only 20 boxes of IBM punch cards.

Finally, this thesis owes much to the efforts of Mary Kirkland, who cheerfully and efficiently typed the final copy.

D. E. B.

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CHAPTER I

Introduction

The property tax is one of the primary sources of tax revenue in the United States. In the fiscal year ending in 1967, it accounted for over $26 billion of tax revenue. Thus, the property tax collected only a few billion dollars less than the federal corporation income tax.[1] Moreover, it was the most important single source of total state and local tax revenue. For local governments alone, the property tax is even more important. In fact, the property tax produced over 87% of all local government tax revenue in fiscal 1967.[2]

Among the major sources of tax revenue, the property tax is unique with respect to the process by which effective tax rates are established. Effective personal income tax rates and corporation income tax rates are products of the legislative process, and thus, for these two taxes the various exemptions, deductions, and rate

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[1]The federal corporation income tax collected $31 billion in the fiscal year ending in 1967. Economic Report of the President, Transmitted to the Congress January, 1969, Tables B-63 and B-69.

[2]In Massachusetts, property tax collections are 99% of all local government tax revenues. U. S. Bureau of Census, Census of Governments: 1967, Vol. 2, "Taxable Property Values," Table 1.

schedules are more or less openly determined and explicitly written into tax laws. Such is not the case, however, with respect to the establishment of effective property tax rates. Effective property tax rates are a function of both the nominal tax rate and the relationship between assessment levels and market value.[1] Although the nominal tax rate, which is the tax as a per cent of assessed value, is usually decided upon openly by local governmental units, property tax assessment administrators are typically allowed considerable leeway in establishing assessment-to-market value relationships. Thus, even though the same nominal tax rate may apply to all properties within a given tax jurisdiction, the same effective rate will not apply to all properties if there is a lack of uniformity in ratios of assessed value to market value. In effect then, the two decision making units, one for the nominal tax rate and one for the

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[1]The definition of the term "effective tax rate" is

$$t = t_n (A/P),$$

where A is assessed value, P is market value, t_n is the nominal tax rate as a percent of $1,000 assessed value, and t is the effective tax rate as a percent of market value. Since most of this investigation involves cross-sectional comparisons in which t_n is the same in all areas, the term "assessment-to-sale value ratio" is used interchangeably with the term "effective tax rate."

assessment-to-market value ratios, decide different aspects of the property tax burden. Nominal tax rate decisions establish the aggregate tax burdens, and assessment ratio decisions determine the distribution of the tax burden among property owners.

Thus, unlike any other important source of tax revenue, a considerable degree of power over effective property tax rate determination is placed in the hands of authorities, assessment administrators, whose decisions are not well publicized and who are usually not directly accountable to the electorate. Admittedly, there is some public control over assessment administration through statewide tax-equilization boards which exist in some places, e.g., California. However, in most areas public control is weak, especially with respect to the administration of assessments within local property tax jurisdictions. This situation is clearly true in the city of Boston, where this study is undertaken.

Given this process of effective rate determination, it is not surprising that the property tax is frequently criticized from the standpoint of horizontal equity.[1] If market value is the standard of equity, then variations in effective property tax rates obviously violate the

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[1]Dick Netzer, Economics of the Property Tax, (Washington, D.C.: The Brookings Institution, 1966), p. 165.

principle of horizontal equity. On the other hand, if income is the standard of equity, then even if effective tax rates were the same for all members of the community, equals would not be taxed equally. The correlation between income and property market value is far from perfect.[1] Moreover, with respect to renters there is the additional question of tax shifting. In fact, it is possible that variations in effective tax rates actually improve horizontal income equity. Nevertheless, regardless of the particular standard of equity, the property tax is unique in that there exists such loose control over factors which have important effects on tax equity.

Several empirical studies of effective property tax rates have shown that extensive variation does in fact exist. Frederick L. Bird analyzed assessment ratio data from the 1957 Census of Governments and concluded that within selected tax jurisdictions the situation "...is one of an almost incredibly wide range of administrative performance."[2] By examining the dispersion in assessment-to-market value ratios around the median ratio, Bird judged that only 1/5 of the areas selected displayed at least "good" quality assessment practices. The assess-

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[1] U. S. Bureau of Census, Census of Housing: 1960, Vol. 11, "Metropolitan Housing," Part 1, Table 13-4.

[2] Frederick L. Bird, The General Property Tax: Findings of the 1957 Census of Governments, (Public Administration Service, 1960), p. 55.

ment quality in another 1/5 of the areas was considered to be "unbelievably poor." The 1967 Census of Governments indicates that the data on which Bird based his conclusions has not changed substantially since 1957.[1]

Charles W. Meyer also examined variations in effective tax rates.[2] However, because Meyer compared effective tax rates between different tax jurisdictions, counties, his findings do not bear on matters related to intra-jurisdictional assessment administration. In Meyer's study effective tax rate variations are caused by differences between counties with respect to the relationship of local public expenditures to the total market value of property.

Perhaps the most detailed study of variations in effective tax rates within a given tax jurisdiction is that by Oliver Oldman and Henry Aaron.[3] By grouping a large sample of properties from the city of Boston according to property type, location, and market value, Aaron and Oldman were able to examine the variation in assessment-to-market value ratios in each grouping. They

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[1]U. S. Bureau of Census, Census of Governments: 1967, Vol. 2, "Taxable Property Values," Table 19.

[2]C. W. Meyer, "Geographic Inequalities in Property Taxes in Iowa, 1962," National Tax Journal, Dec. 1965, p. 388.

[3]O. Oldman and H. Aaron, "Assessment-Sales Ratios under the Boston Property Tax," National Tax Journal, March 1965, Vol. XVIII, pp. 36-49.

described their general findings as follows: "How much and what kinds of unequal treatment exist in Boston? 'Plenty' and 'many' are the answers indicated by the study, though the reasons are not always apparent."[1]

The present study examines assessment-to-market value ratios within the city of Boston in even greater detail than did Oldman and Aaron. One of two objectives of this study is to attempt to explain why variations in effective tax rates occur. Oldman and Aaron's results indicate that in Boston there are "...systematic inconsistencies in property tax assessments...."[2] But at the same time they admit that "...explanations for this pattern [the observed pattern of effective tax rates] are obscure."[3] Actually, an attempt to explain the causes of variation constitutes an attempt to describe the behavior of assessment administrators. The approach taken in this study is to test hypotheses about assessment behavior against the observed pattern of effective rate variations. The results help to identify the considerations of assessment administrators which can possibly explain the observed pattern. Also, the results have some bearing on the question of the extent to which variation is a product of an intentional assessment policy as opposed to an inadvertent policy.

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[1]*Ibid.*, p. 36.

[2]*Ibid.*, p. 48.

[3]*Ibid.*, p. 48.

A second objective of this study is to improve on Oldman's and Aaron's description of the pattern of effective rate variation in Boston. Even though the reasons for effective rate variation may not be entirely clear, it is important to identify how and to what extent rates vary with respect to location and general housing and population characteristics. Since the pattern of effective rate variation will become apparent in the course of the above mentioned search for possible explanations of variation in effective tax rates, the study focuses on this first objective.

Although this study is designed for an examination of the Boston situation given the available Boston data, the approach is believed to be sufficiently general to be useful for performing similar studies of other tax jurisdictions. Moreover, conclusions of a study based on Boston data alone are probably not unique to the city of Boston. Data published in the <u>Census of Governments</u> suggest that most major cities have assessment systems which impose widely variable effective tax rates. On the other hand, only careful examination of each individual situation can reveal to what extent tax rate variation in other tax jurisdictions is similar to Boston's and to what extent the causes of the variation are the same.

More specifically, in Chapter II general aspects of assessment behavior are discussed, and several hypotheses of assessment objectives are developed. After a description of the sources of data in Chapter III, a model of assessment behavior is specified in Chapter IV. Results of empirical tests of this model are presented in Chapters V and VI.

CHAPTER II

Assessment Behavior

Throughout this study it is assumed that assessment behavior is a function of certain objectives of assessment policy. These objectives are constrained by the limitations imposed by the assessment mechanism, which is the process by which assessment policy decisions are effectively translated into the desired pattern of effective tax rates. There are several possible methods of identifying assessment policy objectives and of describing the assessment mechanism. One way is to examine the entire assessment process directly by interviewing city officials. Such an approach is, however, far from satisfactory. Almost any subject connected with property taxation in Boston is a fairly sensitive political issue, and, as a result, there is a general reluctance on the part of city officials to discuss most of the interesting subjects. Nevertheless, some informal interviews were conducted. As expected, officials were rather guarded in their responses, and no conclusive information was obtained. However, the interviews did provide a better understanding of the assessment mechanism and helped to shape some of the following hypotheses on assessment behavior.

Another method of determining assessment behavior is to infer assessment behavior from the performance of the assessment system. The general pattern of observable effective tax rates can be used to test hypotheses on assessment behavior. Unfortunately, this procedure also has its shortcoming. Given the available data, it may not be possible to distinguish clearly between alternative hypotheses. Nevertheless, the second procedure is the one employed in this study.

Three basically different assessment behavior hypotheses are discussed in the following pages. Each hypothesis attempts to explain how cross-sectional variation in effective tax rates can occur. To summarize briefly, the first hypothesis is that assessment policy is intentionally discriminatory with respect to certain cross-sectional variables. The second hypothesis holds that the assessor's only goal is to estimate the market value of properties and thus to assess all properties in an equal proportion to their market value. Under these conditions effective tax rate variation is inadvertent and is attributed to systematic and random errors in market value estimation. The third hypothesis is that because of time lags in the assessment mechanism, desired assessment policies, whatever they may be, cannot be immediately instituted.

A. Assessment Discrimination

The first of several explanations given in this study for the existence of cross-sectional variation in effective tax rates is that the variation is a deliberate result of a discriminatory assessment policy. This hypothesis holds that it is by no means a mistake that properties are assessed nonuniformly with respect to the ratio of assessed value to market value. The general pattern of effective tax rates which exists within the city is designed by the assessment administration according to certain policy objectives. The following discussion suggests three possible objectives of a discriminatory assessment policy.

Benefit Principle

With respect to the property tax, property value itself is the most obvious standard of equity. Moreover, property value is the legally established norm in Massachusetts.[1] Nevertheless, there is a general tendency on the part of policy-makers to compromise the importance of property value as a standard of equity. The strong possibility exists that, instead of following a property value standard, the assessor resorts to a benefit principle of

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[1]Bettigole v. Assessors of Springfield, 343 Mass. 223, 178 N.E. 2d 10 (1961); and see Part II, Ch. 1, sec. 1, art. 4 of the Constitution of the Commonwealth of Massachusetts, as well as Mass. G.L. (Ter. Ed.), Ch. 59, Sec. 38.

taxation. These two standards are, of course, usually at odds because of the fact that property value is not generally a good indicator of benefits received.[1] Public service benefits accrue in large part to individuals and not to property.

Given that the assessor does consider the property tax to be at least in part a benefit tax, what objective criteria might he use for distributing the tax burden on this basis? First of all, the level of public expenditures is a frequently used measure of benefits received, and there is intra-jurisdictional variation in public expenditures for services such as education, welfare, and police and fire protection. Educational expenditures vary largely according to population density. Welfare costs and police protection are both usually higher in slum neighborhoods.[2] Although no explicit accounting of the distribution of these expenditures exists, there is a prevailing consensus among city officials as to the general distribution of city expenditures.

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[1]Dick Netzer, Economics of the Property Tax, p. 5.

[2]The distribution of fire protection expenditures is not clear. The probability of fire is greater in crowded neighborhoods. But in less crowded areas where fires are less likely to occur, the buildings are more spread out tending to increase the cost of fire protection per capita.

Another type of benefit criteria may be based on property type.[1] Population density per $1,000 of property value usually increases with the number of families living in a single structure. Thus, effective tax rates may be positively related to the number of families per structure because of an effort to maintain a constant absolute tax bill on a per family or per capita basis.

A final type of benefit criteria may influence intra-neighborhood assessment decisions among properties of the same type. Whereas public service benefits may vary substantially across the city, they probably vary much less within small subdivisions of the city. And, even though they do vary somewhat within small areas, it is unlikely that the assessor attempts to discriminate between individual properties within the same neighborhood on the basis of benefits received. In fact, he probably assumes that, with respect to neighboring properties of the same type, potential public service benefits are equal. As a result, one of his goals may be to establish within each property class a pattern of effective tax rates which yield relatively uniform tax burdens in terms of annual tax bills. (Of course, given variations in property value, effective tax rates which yield uniform tax bills will not themselves be uniform.)

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[1]Property types are distinguished by the number of families per structure, e.g., single-family, two-family, etc..

The assessor's application of this last benefit criterion is probably motivated not so much by devotion to benefit principles *per se* but rather by more practical considerations. Taxpayers are likely to be more aware of and concerned about absolute tax bills on neighboring properties than they are about tax bills on properties in other neighborhoods or effective tax rates in general. According to officials in the assessment department, the motivation of most property tax abatement requests is not alleged inequities with respect to properties in distant areas of the city but rather alleged inequities with respect to properties in the immediate vicinity of the person making the abatement request. Thus, by striving for uniform absolute tax bills on neighboring properties, the assessor reduces taxpayer discontent.

Social Goals

Facing the City of Boston are several interrelated long-run problems which conceivably motivate the assessment administration to pursue a discriminatory effective tax rate policy. These problems are not peculiar to Boston; they exist in many large cities.

Since the War many middle-to-upper income central city families have been attracted to suburbia. Although there are several explanations for this middle-to-upper income population movement, differential tax rates between the city and the suburbs must be considered a principal factor. Another important incentive is created by the urban-suburban difference in the quantity and quality of public services.

Out-migration of middle-to-upper income families has caused a downward conversion of the central city housing stock. Because downward conversion usually involves an increase in the number of occupants per structure, the net effect of out-migration and in-migration will be to tend to increase the total central city population and therefore also its population density. Moreover, the incoming population will be composed primarily of low income families because low income families typically are demanders of low quality housing. Thus, with an increase in its population density, a decrease in the quality of its housing stock, and an increase in the proportion of low income families, the central city's cost of providing a constant level of public services increases as middle-to-upper income people leave the central city.

Given this situation, the city is forced to cut back on public service quality and/or raise property tax rates. Unfortunately, both means of adjustment only further aggravate the initial problem. By increasing the urban-suburban property tax differential and/or the urban-suburban public service quality differential, middle-to-upper income families are provided with an even greater incentive to leave the city. In effect, a vicious circle develops. Location decisions are based on several factors which are themselves a function of the location decisions.

In addition, the only stable equilibrium of such a system would appear to be at the limit where all middle-to-upper income people have finally left the city, and the city itself is left with hugh per capita public expenditure requirements.

Although the discussion to this point has focused on what is essentially a fiscal problem, there are also several other problems created by the transformations which have taken place within the city. For one thing, the decline in housing quality which has taken place is not localized in those areas vacated by middle-to-upper income people. Instead, the decline has been more general, and therefore the housing conditions in some areas reach a point where significant neighborhood externalities develop which are characteristic of a slum situation. Thus, in addition to a general downward quality conversion of the central city housing stock, the middle-to-upper income out-migration also tends to encourage the spread of slum conditions.

Not to be overlooked is the fact that many of the city's newer residents are Negroes. Thus, the city's racial mix has also been changing over the past two decades as middle-to-upper income families have left the central city.

In view of the problems of the city, which have been only briefly described above, there are several rational social goals which may influence assessment policy. First, a central city policy of effective tax rate competition with the suburbs for middle-to-upper income families must be a tempting means of halting the exodus of middle-to-upper income people. It is clear from discussions with city officials that they are not only distressed by the continuing exodus of upper and middle income families from the central city to the suburbs, but that they also believe that assessment policy decisions can affect family location. Evidence that this is the case is found when officials are asked why some of the obvious assessment ratio inconsistencies between high and low income neighborhoods have been allowed to develop. The responses inevitably refer to a desire not to encourage any further movement of upper income families out of the city.

A slightly different goal from that of trying to stem the middle-to-upper income migration is that of promoting stability in any "nice" neighborhood regardless of its average income level. "Nice" neighborhoods are those characterized by the absence of any of the undesirable social costs related to slum conditions. In "nice" neighborhoods housing conditions are good, crime rates are low, and health standards are high. Although the emphasis of this particular assessment goal is essentially the prevention of slums, the actual pattern of effective tax rates which is called for probably substantially overlaps that of the previously discussed goal.

Given the changing racial mixture of the city, the assessment administration may also desire to discourage the exodus of white citizens from the city. This particular goal is not necessarily motivated by racial prejudice. The maintenance of a racially heterogeneous population may be a desirable goal in itself, although it is difficult to argue that Boston's less than 10% Negro population represents a proportion which is greater than that desired for a health racial balance.

Political Pressures

The administration of the property tax in Boston is not performed in a politically isolated atmosphere. Many of the appointments to the assessment department are political appointments, and much of assessment policy is worked out between the head of the assessment department and the Mayor's office. The opportunity for political pressures to influence assessment policy decisions most certainly exists.

The specific nature of possible political pressures is difficult to identify without a thorough political analysis. However, it is possible to suggest several potential sources of political influence. Although voter densities appear to be one such source, a large majority of the residents in densely populated areas are tenants as opposed to owner occupants, and tenants, as a group, are not as likely to seek favorable assessments through political action as are home owners, as a group. Many tenants are likely to reason that since the property tax is paid by the landlord, he is the one who is bearing most of the burden. Thus, one would expect political pressures to be greatest in areas of predominantly owner occupied residences.

Other potential sources of political influence exist in the several areas of Boston which are rather homogeneous with respect to either race or nationality. Most parts of Roxbury exhibit Negro densities of well over 50%. Much of East Boston is about 30% occupied by citizens of Italian nationality. There is also a strong Irish community in Boston although it is not as concentrated as either of the other two groups.

The actual effect of these ethnic and racial groups on effective tax rates is likely to vary considerably. From casual observation of Boston politics, it is clear that both the Italian and the Irish communities are effective political forces. On the other hand, the Negro community appears to have had little voice in the political process until recently.

B. Mis-estimation of Market Value

The previous hypothesis argued that effective tax rate variation is the intentional result of discriminatory assessment behavior. An opposing hypothesis is that discrimination is inadvertent; the only objective of assessment policy is to assess according to market value, an objective which would seem to be consistent with Massachusetts law.[1] A further aspect of this hypothesis is that the assessor possesses imperfect knowledge of property market value and therefore must estimate market value. In fact, under this hypothesis, the errors in the estimation of market value are the key to the pattern of effective tax rates.

Assessment errors resulting from the mis-estimation of market value can be of two general types -- random or systematic. However, if the errors were only of the first type, it is impossible to explain by this hypothesis the obvious systematic pattern of effective tax rates which are revealed by a preliminary study of the data. Although it is inevitable that random errors do occur, it is clear that the present hypothesis must be based on the supposition that systematic errors are made in the estimation of market value. Thus, the discussion turns to a brief examination of the determinants of residential property market value.

Property value depends on at least two distinguishable factors: the characteristics of the specific piece of property and the characteristics of the neighborhood in which the property is located. With respect to

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[1]See footnote 1, p. 20.

the specific piece of property, various physical characteristics are, of course, important, e.g., the size of the structure, the age and state of repair of the structure, and the size of the lot. The location of the dwelling with respect to centers of employment opportunities and retail activity also influences the value of the specific property.

Neighborhood characteristics are also a determinant of property value because of the many important externalities which are inherent in the provision of housing services. The quality of one housing unit is a function not only of the quality of that particular housing unit but also of certain characteristics of neighboring housing units, such as their state of repair. In addition to other residential buildings, a neighborhood consists of many potential sources of neighborhood amenities such as commercial establishments, parks, schools, and police and fire protection. Some neighborhood amenities may also be related to intangible factors involving general neighborhood social conditions.

Thus, a correct estimation of market value requires the consideration of many factors, some of which may be rather difficult to evaluate, especially the influence of neighborhood externalities. In fact, the assessor may choose to largely ignore neighborhood externalities and base his assessment only on the characteristics of the property itself. It is probably much easier to defend assessments which are founded on objective rules of thumb pertaining to obvious physical characteristics of properties than it is to defend subjective evaluations of neighborhood amenities.

If the assessor does confine his estimation to a consideration of only the objective characteristics of properties, it is clear that errors in estimation will be made. However, unlike random errors, these errors are very likely to be systematic. For example, market value will tend to be overestimated in all areas where significant negative neighborhood externalities exist, and, therefore, effective tax rates will tend to be higher in these areas. This type of assessment error would create a pattern of differential effective tax rates which would be a function of the distribution of various neighborhood externalities.

It is possible that in addition to neighborhood externality errors, assessors may also make systematic errors in the evaluation of individual property characteristics. Given that a strictly objective approach is followed, the rules of thumb which are used in the calculations may be biased. For example, for each property land may be weighted too heavily in the estimation process. As a result, properties with large lots would tend to be assessed higher than those with smaller lots, and a definite pattern of effective tax rates would exist among areas of the city which are dominated by properties with different lot sizes. This example, however, is only a conjecture used for illustrative purposes. The probable nature of this type of assessment error cannot be determined *a priori*; it can only be argued that the possibility for this type of error exists and that it may cause systematic effective tax rate biases.

C. Assessment Lags

Any pattern of effective tax rates which is determined by assessment policy goals may not be perfectly consistent with the actual pattern of effective tax rates. In order to maintain any given pattern of effective tax rates, it is necessary to adjust continuously assessments to changing market values. However, continuous assessment adjustment, or anything close to it, is very unlikely given a limited assessment budget. Thus, it is reasonable to suppose that, regardless of what the assessment objectives may be, a time lag in the assessment process causes the observed pattern of effective tax rates to be different from that which is determined by the assessment objectives. A more precise specification of this hypothesis immediately follows.

It is assumed that for any property the discrepancy between the actual effective tax rate and the desired effective tax rate is some function of the percentage change in market value, $\Delta P/P$.[1] This relationship can be written as

$$(A_t/P_t) - (A_t/P_t)^d = \beta(\Delta P/P).$$

The left-hand side of this expression represents the difference between actual and desired assessment-to-market value ratios, where these ratios are directly proportional to corresponding effective tax rates.[2] The superscript "d" identifies the desired assessment-to-market value ratio. On the right-hand side of the above equation, $\Delta P/P$ is the percentage change in market value or price.[3] Also, on the right-hand side the term β is the ratio of the difference between actual and desired assessment ratios to the percentage change in prices. Furthermore, $\beta \leq 0$. A situation where $\beta = 0$ implies that there is perfect adjustment of actual to desired effective tax rates. The minimum value of β, which indicates a complete lack of adjustment of assessments to changing prices, depends on the size of the stationary assessment and on the level of

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[1]"Desired effective tax rate" means the effective tax rate which is determined by assessment policy. Strictly speaking, if this tax rate is a result of assessment errors, it is not intentional, and therefore "desired" is not a very accurate description of it. However, for simplicity the expression "desired" will be used with the above qualification.

[2]See footnote 1, page 11.

[3]The exact definition of $\Delta P/P$ which will be used is $(P_t-P_{t-1})/((P_t+P_{t-1})/2)$.

prices before and after the price change.[1]

By adding $(A_t/P_t)^d$ to both sides of the above equation, it is clear that A_t/P_t is a function of a change in market price and the desired assessment-to-market value ratio, i.e.,

$$\text{(II.1)} \qquad (A_t/P_t) = \beta \Delta P/P + (A_t/P_t)^d .$$

In equation (II.1) notice that $\beta = 0$ implies $(A_t/P_t) = (A_t/P_t)^d$. Also, $\beta < 0$ and $(\Delta P/P) > 0$ implies $(A_t/P_t) < (A_t/P_t)^d$, and $\beta < 0$, $(\Delta P/P) < 0$ implies $(A_t/P_t) > (A_t/P_t)^d$.

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[1]At time $t = 0$ let prices and assessments equal P_0 and A_0, respectively. At a later time, $t = 1$, let prices and assessments equal P_1 and A_1, respectively. The minimum value of β occurs when there is no adjustment of assessment, i.e., when $A_0 = A_1$. Also, if it is assumed that the desired assessment ratio equals the actual assessment ratio at $t = 0$, i.e., $(A_0/P_0)^d = (A_0/P_1)$, then

$$\beta_{min} = \frac{(A_0/P_1) - (A_0/P_0)}{(P_1-P_0)/((P_1+P_0)/2)} .$$

Simplifying, the above yields

$$\beta_{min} = - \frac{A_0(P_1+P_0)}{2P_1P_0}$$

The assessment lag hypothesis can be refined somewhat by supposing that the assessor's speed of adjustment to changing market conditions is a function of the frequency of market transactions. One would expect the assessor to recognize price changes more quickly in areas where there is more market activity and therefore more observable sale prices. This assumption can be written as

$$\beta = f(F), \qquad \partial\beta/\partial F > 0,$$

where F is a measure of transaction frequency. Furthermore, it is also assumed that the function f is linear and that the relationship can be written as

$$\text{(II.2)} \qquad \beta = \beta_0 + \beta_1 F,$$

where $\beta_0 < 0$ and $\beta_1 > 0$, and because $\beta \leq 0$, $\beta_1 F \leq |\beta_0|$.[1] The above equation and the conditions imposed on it indicate that although the total speed of response, β, may be reduced by quicker recognition, $\beta_1 > 0$, there may still be a lag between recognition and actual assessment adjustments, $\beta_0 < 0$. Substitution of equation (II.2) into equation (II.1) yields the following:

$$\text{(II.3)} \qquad (A_t/P_t) = \beta_0(\Delta P/P) + \beta_1 F(\Delta P/P) + (A_t/P_t)^d.$$

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[1]The dimensionality of β_1 is the difference between actual and desired assessment ratios divided by percentage price change times transactions frequency units.

It is clear from (II.3) that the assessment lag hypothesis is consistent with either of the previous two hypotheses. In fact it is even consistent with the supposition that the assessor's one objective is to estimate market value and that he does so accurately. The fact that the actual effective tax rates do not appear to be consistent with such a hypothesis may simply be due to lags in the assessment mechanism.

D. Overview of Empirical Tests of Assessment Behavior Hypotheses

Empirical tests of the hypotheses presented in this chapter are complicated by the general lack of data on the various assessment objectives which are suggested. For example, quantification of the somewhat vague "social goals" is probably impossible. Useful data on the distribution of public service benefits within the city could not be collected without considerable time and effort. However, some measures of neighborhood externalities do exist, and there are also several available measures of interesting neighborhood characteristics.

Thus, because the possibility of direct testing of hypotheses is limited, this study relies on evidence which can be obtained through more or less indirect testing. Although variables which explain part of the variation in effective tax rates may not be policy objectives in themselves, their logical association with policy objectives provides useful information. Moreover, some of the clear patterns which are shown by effective tax rate data may in themselves be highly suggestive.

The primary statistical tool used in this study is ordinary least squares regression analysis. It is applied to two different models explaining effective tax rate variation. The most useful model is that which explains inter-neighborhood variations. The other model explains variations among individual properties. Both models provide a framework within which assessment behavior hypotheses can be tested. Furthermore, effective tax rate variation among property classes, including new construction, is examined by straightforward inspection of effective tax rate patterns.

The nature of the data which are available for this study imposes some limits on the development of assessment models. Therefore, before these models are discussed, a description of the data and of the nature of the data sample is presented.

CHAPTER III

The Data and the Nature of the Sample

A. Data Sources

City of Boston data were used in the study for reasons of locational convenience and data availability. In 1960 the city of Boston had a total population of 696,000; metropolitan Boston's population was 2,589,000 in 1960. Like most local governmental units, the city of Boston is heavily dependent on property tax revenue. With respect to effective property tax rates, the city of Boston has one of the highest in the U. S.. The 1967 Census of Governments indicates that among the 182 major metropolitan areas selected for study only eight had effective property tax rates on single-family properties higher than Boston's 3.01%. Ninety-two of the selected areas, including New York, Chicago, and Los Angeles, had effective tax rates of 2.0% or less.[1]

The body of data which was collected especially for this study is on individual parcels of residential

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[1] U. S. Bureau of Census, Census of Governments: 1967, Vol. 2, "Taxable Property Values," Table 21.

property. Each of the observations is of an individual property transaction and was obtained from the Boston Metropolitan Mortgage Bureau. From records of each property transaction, the following information was obtained: the sale price, the most recent assessment, the number of families or apartments in the structure, the number of stories in the structure, the size of the lot in square feet, the date of the transaction, and the street address of the property. Non-market property transfers and transactions involving properties with newly constructed buildings were also identified. The property assessment information is the total assessment of both the structure and the land.

Although the Boston Metropolitan Mortgage Bureau is the source from which the data were obtained, it is not actually the primary source of information. The Mortgage Bureau combines records obtained from the Registry of Deeds with other records in the city assessor's office. The Registry of Deeds supplies sale price information on each transaction.[1] Periodically a list of the most recent property transactions is sent to the city assessor's office. Assessment records on each of these properties provide information not only on the most recent assessment but also on

[1]Sale price is not given directly on the deeds; it must be calculated from the number of tax stamps affixed to the deed at the time of transfer.

the particular land use of the property and on the physical characteristics of the property.

A second source of data is the U. S. Bureau of Census publications on population and housing characteristics in Boston. There are several publications which provide this information by census tract for 1940, 1950, and 1960.[1]

The Metropolitan Area Planning Council also provided some data on land use in Boston.[2] For each census tract in the city, these data describe the areal distribution of all land uses. For residential land uses, they distinguish between land uses according to the number of dwelling units on the property. There is also a dwelling unit count for each of three residential land use classifications. These data are used chiefly to describe some of the land use characteristics of the sampled portions of the city. Unfortunately, on a census tract level most of this data is not considered to be accurate enough to be useful in the regression analysis.

B. Sampling Method

The goal of the data collection process was to sample as much of residential Boston as possible. Two

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[1]U. S. Bureau of Census, Census of Population and Housing, census tract statistics for Boston, Mass., 1940, 1950, 1960.

[2]The actual source of this data is a computer tape which contains land use data for all of Eastern Massachusetts.

cross sections were needed: one in 1950 and one in 1960. The principal constraint on the size of the sample was the cost of collecting observations of residential property transactions.[1] A primary unit of observation in this study is a small geographically defined area called a census tract.[2] In order to include a census tract in the sample, there had to be a minimum number of observations of individual property transactions within the tract. Thus, the transaction sample was selected so as to maximize the number of census tracts containing a sufficient number of transaction observations.

At the Metropolitan Mortgage Bureau the records of property transactions are kept on index cards which are filed alphabetically by street address. There are index cards for any given address with information on every transaction which occurred from 1940 to present on that specific property. Furthermore, the files are divided into nine subdivisions of Boston.

A problem was created by the fact that the density of residential properties of different types is not the same in all nine of the Boston subdivisions. Given limited resources, it would have been wasteful to sample all areas

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[1]The lack of some census data in a few census tracts did impose an additional constraint. However, this limitation was minor compared to that related to the transaction data.

[2]A complete description of a "census tract" will be given in III. D.

with the same intensity. Some areas would have accumulated a greater number of observations than were necessary, and an insufficient number of observations would have been obtained in other areas. Therefore, some areas had to be sampled more intensively than others so as to assure a fairly good chance of collecting at least six observations of each property type in each census tract.[1] The sampling intensity was varied by changing the number of years which were sampled. Preliminary testing in each subdivision was undertaken so that an estimate could be made of the number of years for which data collection was necessary in each property classification. For example, in the Hyde Park subdivision every single-family property transaction in 1950 and 1960 was recorded. In East Boston, however, the density of single-family properties is lower and observations from several years around 1950 and 1960 were included.

In summary, the actual data recording process was performed by inspecting all the transaction cards in each subdivision and selecting the transactions which occurred in the appropriate years for each property classification. About 18,000 transactions were recorded in this way. Since only about one in 30 transactions was acceptable, over 500,000 transactions had to be individually examined.

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[1]Property types are determined by the number of families living in the dwelling. The relevant classifications are one-family, two-family, three-family, and four-family and over.

The only instance in which information from more than one card was used for one observation was in the case of transactions involving new construction. Many times the information on these properties was incomplete. If another transaction could be found on property with incomplete data within one year of the first, the information about this transaction was used to supplement that from the first.

C. Data Processing

Considerable clerical work was necessary to put the raw data on property transactions into usable condition. Since the data could not be moved at any time from the offices of the Mortgage Bureau, they had to be copied there by hand from the files. The coding of structure size and property use classifications was completed in the initial recording step. After the raw data were recorded, the street address of each of the 18,000 observations was coded according to its census tract location.[1] Also, the transactions were numbered consecu-

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[1]The primary source for the street address coding was: Boston House Numbers by Census Tract, published by the Research Division of the United Community Services of Metropolitan Boston, 1962, Boston, Mass.. For some of the "problem" addresses, a second street address coding source was used: Street Coding Index, prepared for the Eastern Massachusetts Regional Planning Project by Wilbur Smith and Associates, 1963-1964. In was also necessary to resort to census tract maps in some cases. The most detailed maps for this purpose accompany the U.S. Census of Housing: 1960, City Blocks, Boston, Mass., U. S. Bureau of the Census.

tively in the order of collection for identification purposes. Finally, all the information, except the street addresses, was transferred to IBM data cards.

Because of the large quantity of data, accuracy tests were somewhat limited. It was only possible to search the data for observations which were grossly out of line. The data were first sorted by census tract and by land use class. Then, within each tract the assessment-to-market value ratio was calculated for each observation, and the mean ratio of each land use class was also calculated. By comparing the assessment ratio of each observation with the mean ratio of properties of the same type within the same census tract, suspicious observations were located. These observations, about 500, were then double checked with the original records. Approximately 10% of the suspicious observations had to be dropped or corrected either because of a clerical error or because the original information was somehow incorrect.

The only question of accuracy with regard to property transaction records themselves involves the calculation of sale price from tax stamps on the deed. Since the stamps constitute a proportional tax on the sale price of the property, there is an obvious incentive to understate the sale price. However, according to the people at the Mortgage Bureau, understatement of sale price occurs rather infrequently. When it does occur, it is usually easy to spot. The Mortgage Bureau attempts to identify all "questionable" sales of this type on its records. None of these questionable sales were included in the sample.

D. Description of Samples Used

The two basically different observational units used in this study are individual property transactions and census tracts. Individual properties usually consist of land and one primary structure.[1] Census tracts are small areas within the city. The Bureau of Census establishes the boundaries of census tracts for statistical purposes. The boundaries are designed to achieve some uniformity of population characteristics, economic status, and living conditions.[2] The average census tract in Boston contains roughly 4,000 to 5,000 people. In the city of Boston there are 155 census tracts which could conceivably be used in this study.[3]

Given the two observational units, there are, of course, two different possible sources of data samples:

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[1]Transactions involving more than one structure were recorded when the property use was "apartments." For other property use classifications, transactions involving more than one structure were not recorded unless it was possible to determine the sale price and assessment of each parcel in the group.

[2]A more detailed description of a "census tract" can be found in the introduction of any census publication which presents data by census tract.

[3]Several tracts could not be included because they contain the highly transient population connected with the harbor facilities. Another tract consisting of several islands in Boston Harbor also had to be excluded.

individual properties and census tracts. These sources are related by the fact that individual property data can be aggregated by census tract and used as census tract observations. Census tract assessment levels, market prices, and structure and lot sizes are all variables which are census tract averages of individual property observations. On the other hand, all of the data which is obtained from U. S. Bureau of Census sources is only available by census tract. Moreover, the U. S. Census data differs from the aggregated transaction data in that the former is based on a 100% sample of the population and the latter on a partial sample determined by the purchases and sales of residential properties.

The answer to the question of which of these two samples is appropriate for a study of assessment behavior depends primarily on the type of assessment behavior which is to be studied. If the objective is to examine regional assessment behavior, i.e., to examine the variation in assessment-to-market value ratios among different regions within the city, then a census tract sample should be used. In this case the study compares the experience of typical properties in different census tracts. On the other hand, if one is concerned with differences in assessment practices with respect to individual properties, then the individual property sample is more appropriate. In this study the primary concern is with regional variations in effective tax rates, and, therefore, the census tract sample is the principal source of information. However, because of the fact that assessment practices which are related to individual property characteristics may create regional differences in assessment practices, the individual property sample is also examined in an attempt to discover the extent to which the observed regional data may in fact have been generated by individual property assessment phenomena.

With respect to the assessment behavior models which are developed in the next section, the observational units for the neighborhood model are census tracts and for the individual property model are individual properties. Also, in the ensuing discussion, a "neighborhood" is usually meant to be the equivalent of a census tract.

A variety of different census tract samples are used in this study. After the transaction data is coded, checked for accuracy, and sorted by property type, census tracts containing fewer than six transaction observations of a particular property type were dropped from the census tract sample of that particular property type. Obviously, with the variation in the density of different residential land uses from one part of Boston to another, the samples necessarily differ. Thus, there is a different census tract sample for each of four property types. Although eight property types are actually identified, one through eight housing unit structures, all transactions on four housing unit structures and over are aggregated into one property type. This was necessary because of the relative scarcity of transaction observations on four housing unit structures and over.

In addition to the four different property type samples, the single-family sample is separated into white and non-white census tracts. Thus, there are six different census tract samples which are used in the estimation of the neighborhood model in V.C.3. and V.C.4.. The individual property model estimation, V.D., is based on single-family transaction observations from the same geographic area defined by the single-family census tract sample. Much of the data which is examined in V.A. is generated from the entire transaction sample.

Table 1 provides a few summary statistics on each sample. Data on the city as a whole is also presented for comparison. Each column, except the last one, describes a sample which is used in this study. For example, the first column describes the sample which is used to examine effective tax rate variation on single-family properties. The first entry in column one indicates that within the geographic area of this sample, 16% of the structures are used for single-family occupancy. The last entry at the bottom of column one indicates that the total single-family sample encompasses 72% of the total land area of the city, which is 32,749 acres (last entry at bottom of last column).

On the page following Table 1 is a map of the city

Table 1. Description of Data Samples[1]

	Single-Family[2] Total	Single-Family[2] White	Single-Family[2] Non-White	Two-Family	Three-Family	Four-Family +	City
A. Per cent of samples' structures used by							
one-family	16%	17%	3%	17%	11%	4%	
two-families	21	23	12	25	22	12	
three-families	57	55	69	54	60	75	
four-families and more	6	5	16	4	7	9	
	100	100	100	100	100	100	
B. Per cent of samples' residential land used for housing							
one-family	17%	17%	5%	16%	12%	7%	13%
two-families	9	9	12	9	10	9	7
three-families	8	8	25	8	11	16	9
four-families and more	66	66	58	67	67	67	71
	100	100	100	100	100	100	100

Table 1. (continued)

	Single-Family Total	Single-Family White	Single-Family Non-White	Two-Family	Three-Family	Four-Family +	City Totals
C. Per cent of city totals included in sample							
population	72%	63%	9%	68%	66%	32%	696,197
non-white population	53	5	48	54	59	57	63,165
housing units	68	58	10	60	59	36	238,547
total land	72	69	3	75	59	18	32,746 acres

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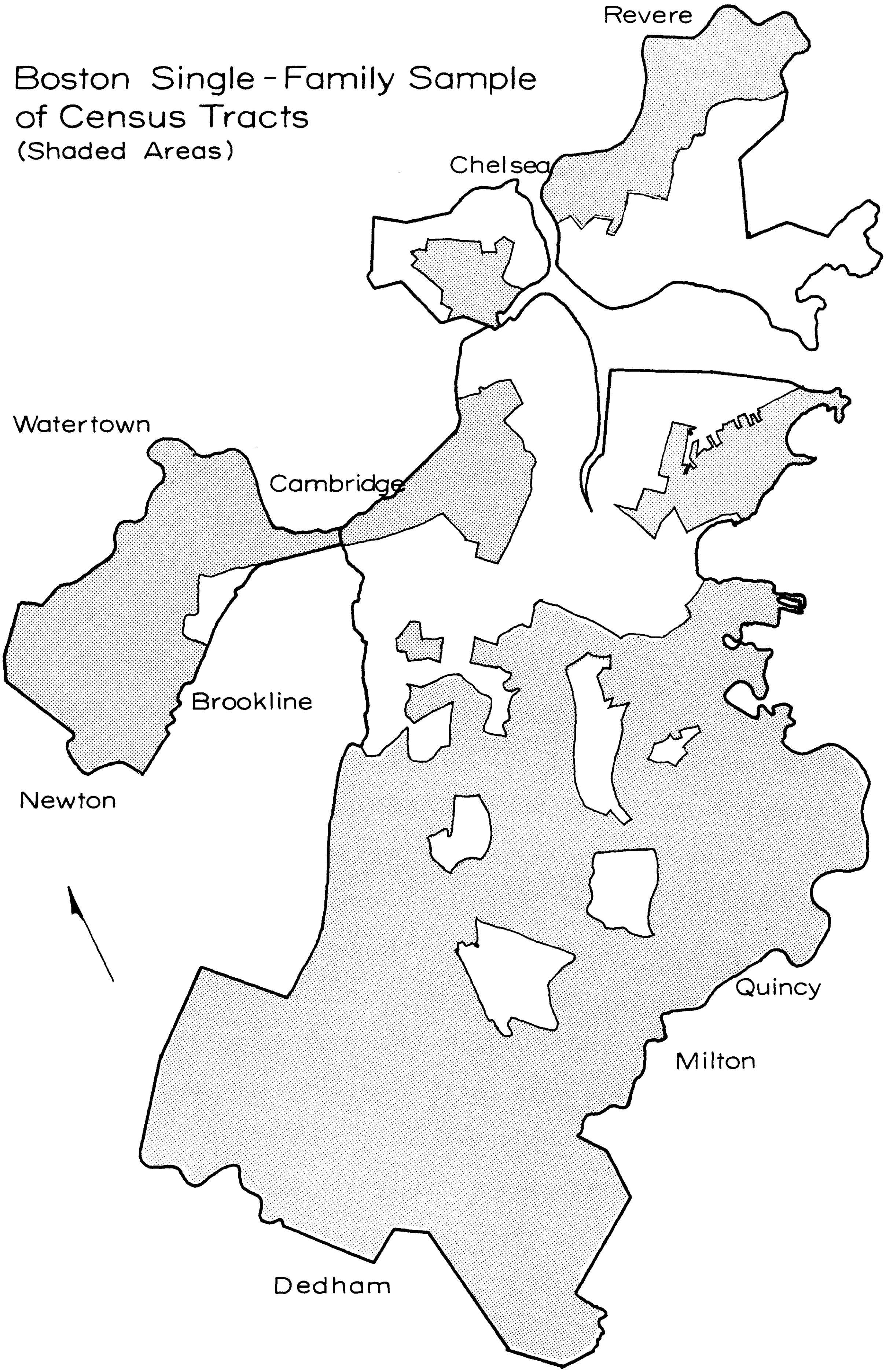
[1]All numbers are percentages except the city totals for 1960. The source of data for A, B, and "Total Land" of Part C is the land use data supplied by the Metropolitan Area Planning Commission of Boston. The other figures shown in C are from the U. S. Bureau of Census.

[2]The six samples described here are labeled according to the particular type of effective tax rate examined with the sample, e.g., single-family, white effective tax rates: column two.


Boston Single-Family Sample
of Census Tracts
(Shaded Areas)
Revere
Chelsea
Watertown
Cambridge
Brookline
Newton
Quincy
Milton
Dedham

of Boston. The shaded areas indicate the total area covered by the single-family property sample.

E. Sampling Bias

The source of sampling bias in the transaction data arises from the very nature of the data itself. The only properties which appear in the files of the Metropolitan Mortgage Bureau are those which have been sold. To the extent that these properties do not constitute a truly random sample of properties, the transaction sample is biased.

Unfortunately, it is much easier to argue that some kind of bias probably exists than it is to estimate the importance of the bias. Although the characteristics of individuals who buy and sell properties and of the properties which are bought and sold are probably different from those of the average property owner and piece of property, an examination of the housing market itself would be necessary to determine exactly what these differences are. There is, however, one bit of evidence which suggests that the transaction sample is probably not too far off the mark with respect to market value. The coefficient of correlation between census tract single-family market value based on the transaction sample and the value of owner occupied dwellings, supplied by the Bureau of Census, is .964. The census variable is based on estimates of market value made by owner occupants. Obviously this fact does not constitute conclusive evidence of the absence of extreme bias in the sample. The possibility of bias in the transaction sample must qualify all the results of this study.

CHAPTER IV

Assessment Behavior Models

A. Over-view

The two assessment behavior models which are developed in the following pages represent different aspects of assessment activity: the determination of average assessment levels by neighborhood and the determination of assessment levels for individual properties within each neighborhood. Variations in neighborhood assessment-to-market value ratios are explained by variations in relevant neighborhood characteristics; ratios on individual properties are explained by the extent to which they differ from the average property with respect to observable characteristics. Thus, the neighborhood relationship can be written as follows:

$$(IV.1) \quad (A_t/P_t)_i = f(N_{i1}, N_{i2}, \ldots) \quad (i = 1, 2, \ldots, S),$$

where $(A_t/P_t)_i$ is the average assessment-to-market value ratio at time t in the i^{th} neighborhood, and N_{i1}, N_{i2}, etc., are neighborhood characteristics. For individual properties an equation analogous to equation (IV.1) can be written:

$$(IV.2) \quad (a_t/p_t)_{ij} = \{g[(n^*_{ij})_1, (n^*_{ij})_2, \ldots]\} \quad (A_t/P_t)_i.$$

In this case the dependent variable is the assessment-to-market value ratio on the j^{th} individual property in the i^{th} neighborhood. The term, $(A_t/P_t)_i$, is the actual average ratio in the i^{th} neighborhood. The (n^*_{ij}) variables represent characteristics of the i^{th} individual property in the j^{th} neighborhood. The star superscript denotes the fact that the measurement of the variable is in terms of its relationship to the mean value of the variable in the particular neighborhood in which the property is located. For example,

$$(n^*_{ij})_1 = h[(N_i)_1, (n_{ij})_1],$$

where $(N_i)_1$ is the mean value of characteristic number one in the i^{th} neighborhood, and $(n_{ij})_1$ is the value of that characteristic for the j^{th} individual property in the i^{th} neighborhood. Notice that with respect to individual property assessments, equation (IV.2) does not imply that neighborhood characteristics are necessarily considered by the assessor. Neighborhood characteristics may or may not influence $(A_t/P_t)_i$.

In order to make these two models consistent, there are some restrictions which can be placed on the exact specification of the g function. It should be formulated so that when all the individual property characteristics are the same as the characteristics of the average property, $(a_t/p_t)_{ij} = (A_t/P_t)_i$. Both the g and h function will be discussed more explicitly in Section C of this chapter.

The fact that the assessment process is separated, as shown above, does not mean that the two activities are independent. It is certainly possible that there are assessment biases based solely on individual property characteristics which may explain variations in neighborhood ratios because of the clustering of individual properties with similar characteristics. Thus, when interpreting the results of neighborhood model tests, care must be taken not to confuse what appears to be evidence of some type of neighborhood behavior with what is in fact a reflection of assessment behavior with respect to individual property variations.

The possible simultaneity of equations (IV.1) and (IV.2) could, of course, be taken into account, and the entire system estimated simultaneously. However, from a practical point of view, in this situation the advantage of ordinary least squares estimation over simultaneous equation estimation is very important. Estimation of equation (IV.1), the more interesting of the two, can be performed with observations totaling less than 100 while estimation of equation (IV.2) requires the considerably more cumbersome use of about 2,000 observations. The difference in convenience between the two estimation processes is not small.

B. Derivation of the Neighborhood Model

A systematic derivation of the neighborhood model is undertaken in order to provide more explicit specification of equation (IV.1). A linear form is chosen to represent the relationship between assessment ratios and the independent variables. Although this form creates an estimation problem, it is still preferred over an alternative multiplicative relationship. The reason for this choice will be discussed in V.C.2.

The assessment behavior hypotheses, described in II.A. and II.B., suggest that there are certain objectives of assessment policy which determine a desired pattern of effective tax rates. Thus, the derivation of a neighborhood model begins by supposing that in each assessment period the assessor determines a particular desired level of assessment for each i^{th} neighborhood which is proportional to the average property value in that neighborhood. This can be represented as follows:

$$(A_t/P_t)^d = \alpha, \qquad \text{(IV.3)}$$

where in the i^{th} neighborhood at time t, $(A_t/P_t)^d$ is the average desired ratio of assessment, A_t, to average market value, P_t, and α is the average desired proportionality factor of assessment to market value. Next, suppose that there exists a functional relationship between α and relevant neighborhood characteristics. This relationship can be written as follows:

$$\text{(IV.4)} \qquad \alpha = f(N_t),$$

where N_t represents several relevant neighborhood characteristics. If equation (IV.4) is in fact linear, it can be written as,

$$\text{(IV.5)} \qquad \alpha = \alpha_0 + \alpha_1 N_1 + \alpha_2 N_2 + \cdots \quad .$$

By substituting (IV.5) into (IV.3) we arrive at the following equation:

$$\text{(IV.6)} \qquad (A_t/P_t)^d = \alpha_0 + \alpha_1 N_1 + \alpha_2 N_2 + \cdots \quad .$$

Given that in some sense the assessor has a target assessment ratio, the hypothesis discussed in II.C. argues that there may be a lag in the adjustment of the actual ratios to the desired ratios. In order to incorporate this hypothesis into the neighborhood model, equation (IV.6) is substituted into equation (II.3). As a result, the specification of the relationship represented by equation (IV.1) is as follows:

$$\text{(IV.7)} \qquad (A_t/P_t) = \beta_0(\Delta P/P) + \beta_1 F(\Delta P/P) + \alpha_0 + \alpha_1 N_1 + \alpha_2 N_2 + \cdots \ .$$

The variables $(\Delta P/P)$ and F are from equation (II.3) and represent price change and transaction frequency respectively. In equation (IV.7) actual neighborhood assessment ratios are seen to be a linear function of several neighborhood characteristics and a price change variable.[1] As noted earlier, it is unfortunate that variables which directly quantify assessment policy considerations are not available. They could be used instead of the N's of equation (IV.7). Strictly speaking, the price change variable also represents a neighborhood characteristic and is perhaps closely related to other characteristics. However, its special dynamic relationship with the dependent variable is more explicitly described by the model. Obviously, if time series data were available, the dynamics of the assessment process could be formulated in a more powerful model. Unfortunately, we are limited to this admittedly crude attempt to capture at least some of the dynamic flavor of the assessment process.

C. Derivation of the Individual Property Model

Compared to the neighborhood model, the derivation of the individual property model, equation (IV.2), is rather straightforward. Remember that the purpose of this model is to explain the deviation of individual property assessment-to sale value ratios from the mean ratio in each neighborhood. The independent variables are deviations in individual property characteristics from the mean value of the characteristic in each neighborhood.

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[1]See footnote 3, page 33 for exact definition of $(\Delta P/P)$.

The specification of equation (IV.2) which is chosen describes the deviations from the mean as the ratio of the individual property characteristics to the mean value of the characteristics. The dependent variable is also defined in this way. Thus, the relationship can be written as

$$\text{(IV.8)} \quad \frac{(a_t/p_t)_{ij}}{(A_t/P_t)_i} = \gamma_0 + \gamma_1 \left(\frac{n_{ij}}{N_i}\right)_1 + \gamma_2 \left(\frac{n_{ij}}{N_i}\right)_2 + \cdots .$$

All of the lower case letters in the above refer to individual property variables; all of the capitalized letters refer to neighborhood variables.[1]

Notice that in equation (IV.8) the ratio variables have unique values for each property in the sample even though these values are jointly determined by a unique

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[1]A second specification of equation (IV.2) is also possible. In this case the deviations from the mean are described as differences between the value of individual property characteristics and the mean value of the characteristics. Thus, equation (IV.2) can be written as follows:

$$[(a_t/p_t)_{ij} - (A_t/P_t)_i] = \gamma_0 + \gamma_1(n_{ij}-N_i)_1 + \gamma_2(n_{ij}-N_i)_2+\cdots,$$

where the notation is the same as for equation (IV.8).

Since there is no theoretical basis for preferring either of these two specifications of equation (IV.2), both were estimated. However, only the results of the estimation of equation (IV.8) are reported. This choice is made because equation (IV.8) performed somewhat better than the alternative formulation in terms of the proportion of variance explained and the significance levels of the regression coefficients. Moreover, the results of the two estimationsare highly consistent in terms of signs and relative magnitudes of coefficients.

individual property value and a neighborhood average. The latter is, of course, the same for each property within the same neighborhood.

CHAPTER V

Empirical Tests of Hypotheses

In this chapter a variety of empirical tests are performed on the assessment behavior hypotheses which were developed earlier in Chapter II. Most of the results are obtained from ordinary least squares regression analysis of assessment behavior models. However, some interesting evidence can be found from direct examination of effective rate patterns.

A. Effective Tax Rate Variation Among Property Types

As indicated in Chapter III, it is possible to classify each property transaction and therefore each assessment-to-market value ratio according to the number of dwelling units for which the structure is designed. Table 2, page 63, represents citywide averages of assessment ratios for each property type for 1950 and for 1960. In parentheses below each mean is the standard deviation of the distribution and immediately below it the number of observations for each year-type group.

The evidence of Table 2 is quite clear; different property types are treated differently. Mean assessment-to-market value ratios increase steadily with increases in

Table 2: 1950 and 1960 Assessment-to-Market Value Ratios, Standard Deviations, and Number of Observations by Property Type

Property Types	1950	1960
Single-family	.5625 (.2176) 2352	.3840 (.1786) 2133
Two-family	.6058 (.1813) 1976	.4296 (.1601) 2102
Three-family	.7320 (.2133) 2426	.5322 (.2029) 2150
Four-family	.8836 (.3168) 251	.5998 (.2286) 167
Five-family	.8793 (.3054) 56	.6094 (.2369) 69
Six-family	.9108 (.2838) 140	.6709 (.2240) 243
Seven-family	.9375 (.3035) 243	.7008 (.3193) 245
Eight-families or more	.9448 (.2567) 290	.5917 (.2090) 419

the number of families per structure. In 1960 the lowest mean ratio is that for single-family properties, .3840. The highest ratio is for seven-family properties, .7008. The only significant exception to this pattern in 1960 is the mean ratio on structures with eight-families or more. This particular ratio is less than the mean ratios of property types four through seven. One explanation for this deviation from the pattern is that the eight-family or more property type includes many large apartment buildings. Perhaps special tax treatment was afforded these structures beginning some time after 1950. The only other exception to the general pattern of increasing ratios is in the 1950, five-family group. However, this deviation is well within the margin of statistical error.

Table 2 also shows that assessment ratios declined in every property class between 1950 and 1960. Moreover, the decline is about the same magnitude for each property type.

Although there are several possible explanations for the assessment ratio pattern shown by Table 2, an assessment behavior hypothesis based on the application of a benefit principle appears to be the one most consistent with the results. Given that the population density per dollar of property value rises with the number of families per structure, rising assessment ratios tend to equalize per family tax burdens among various property types. Even though there may be taxpayer pressure for intra-neighborhood uniformity, assessment ratio differentiation based on property types is probably an acceptable form of assessment discrimination.

The fact that single-family properties are the most favorably treated is consistent with an argument made earlier that single-family property owners are perhaps the most politically effective group of residential property owners. However, this hypothesis does not explain why there is a progressive gradation among the other property types. The existence of a satisfactory political explanation for the entire inter-property type pattern would appear to be unlikely.

Another explanation for the results of Table 2 is that inter-neighborhood assessment ratio variation is the underlying reason for the inter-property type variation. The fact that different property types are concentrated in different neighborhoods makes this explanation a distinct possibility. For example, single-family properties may not be receiving preferential treatment because of their property type but because most of these properties are located in areas of the city which have low assessment ratios for all property types. However, close examination of assessment ratios by neighborhood does not support this explanation. In 1960 there are 53 neighborhood observations with at least six assessment ratio observations for each of the first three property types. In 40 of these neighborhoods, the order of assessment ratio magnitudes by property type is exactly the same as that displayed by Table 2. Moreover, only two of the order inversions are caused by a difference in assessment ratios of more than 5%. Evidently, the general pattern of Table 2 is indicative of what one could expect to observe in almost any area of Boston.

It is also possible that the rate of price increase falls with increases in the number of families per structure. Given a lag in the assessment mechanism a differential rate of price increase of this type would yield the observed pattern of assessment-to-market value ratios if the differences in the rates were large enough. Although the actual price increases of the different property types show a general tendency to decline with increases in the number of families per structure, the price increases are all within three percentage points of one another. Such small differences could account for only insignificant differences in assessment-to-market value ratios.

One final explanation for the positive relationship between families per structure and assessment ratios is that structure size also tends to increase with families per structure. If assessors weight the size of a structure too heavily in their estimation of total property value, then perhaps it is this error which is the real cause of the observed pattern of assessment ratios. However, it is hard to believe that assessment errors of this type would cause very large variations in assessment ratios. The highest ratios are almost twice the size of the smallest.

B. New Construction

There are several reasons to expect assessment ratios on properties with newly constructed buildings to be higher than on older properties. The assessment lag hypothesis argues that assessments tend to lag by neighborhoods. The updating of assessments is not performed randomly on individual properties throughout the city. Instead, one area at a time is reassessed. However, when a new structure is built on a vacant lot, reassessment of that individual property is unavoidable. Given a trend of generally rising prices, assessments are usually lower than what the assessor would like them to be. Therefore, there probably is a tendency to assess newly constructed properties at somewhat higher ratios than others in the same neighborhood. Moreover, since newly constructed properties either have been very recently sold or are about to be sold, market value is well-known. Thus, the assessor has no reason to underassess because he is uncertain of the exact size of the assessment-to-market value ratio which he is establishing.

Unfortunately, data on new construction are not very satisfactory. To begin with, there is only a limited amount of new residential construction in Boston, which is a city where over 90% of all residential properties were built before 1939. Thus, the sample of newly constructed properties is small. Another problem is created because the property transaction records do not reliably identify transactions involving new construction. The data on some new construction transactions were incomplete, thus excluding these observations from the sample. Also, not all new construction transactions were identified as such, and, as a result, they were recorded as normal transactions. Nevertheless, based on the data which does exist, it appears that new construction tends to be assessed at a higher proportion of market value than other properties of the same type.

In neighborhoods where new construction is observed, the mean assessment ratios for the new construction are compared to the means of properties of similar types. Comparisons are made by neighborhood so that other factors can be held reasonably constant in each case. There are 35 of these intra-neighborhood comparisons between new construction and older properties of similar types. In 20 cases the assessment-to-market value ratios on the new construction are higher, and in 13 cases they are lower. The ratios are equal in two cases. The average difference between the ratios is about 5%.

Additional evidence consistent with the above was obtained from a citywide sample of transactions which were identified only as "houses." Supposedly, this property description is frequently given to newly constructed single-family dwellings. There were 235 of these transactions in 1960 with an average assessment ratio of .4406. This is significantly higher than the .3840 ratio on older single-family properties in 1960.

Another test of the hypothesis that the assessor discriminates against new construction would be to include a variable representing the neighborhood density of new construction in the assessment behavior model which is tested in the next section. However, because of the very small number of census tracts with any new single-family construction in 1960, this would not be very informative.

C. Neighborhood Model

The assessment behavior hypotheses of Chapter II suggest numerous reasons for variations in effective tax rates by neighborhood. In order to test these hypotheses, an assessment behavior model is developed in IV.B. The final formulation of this neighborhood assessment behavior model is reproduced below:

$$\text{(IV.7)} \quad (A_t/P_t) = \beta_0(\Delta P/P) + \beta_1 F(\Delta P/P) + \alpha_0 + \alpha_1 N_1 + \alpha_2 N_2 + \cdots .$$

Testing of equation (IV.7) will be performed by use of ordinary least squares regression analysis.

The empirical tests are based primarily on a 1960 sample of single-family properties. Although some tests are performed on other 1960 samples, namely, two-family, three-family, and multiple-family properties, the single-family sample is preferred for several reasons. First, single-family properties possess relatively more homogeneous characteristics. Thus, this class of property lends itself more readily than do other classes of property to the establishment of uniform assessment standards. Second, the relatively large number of observable sales of single-family properties allows the broadest possible cross-section of the city to be studied. The use of any other property classifications considerably restricts the sample. The results based on samples other than that of single-family properties are examined as a group at the end of Chapter V. after a detailed discussion of the single-family results. A description of each of these samples can be found in III.D..

1. Variables of the Model

The following discussion specifically defines each variable which is tested in equation (IV.7). In addition, the relevance of each independent variable with respect to the various assessment behavior hypotheses is discussed. Since the model attempts to explain variations in 1960 assessment-to-market value ratios, all of the variables, except the price change variable, are based on a 1960 cross-section. Price change is derived from a 1950 and 1960 cross-section.

a. Dependent Variables

As described in III.D., neighborhood assessment and market value, A_t and P_t respectively, are averages of assessments and sale prices by neighborhood. Unless otherwise indicated, the assessment-to-market value ratios are those of single-family properties. The "t" subscript is, of course, equal to 1960.

b. Independent Variables

Price Change and Transaction Frequency

Price change and transaction frequency are both already explicitly included in equation (IV.7). The price change variable tests the effect of assessment lags on assessment-to-market value ratios, and the transaction frequency variable, which enters multiplicatively with price change, tests the effect of transaction frequency on the length of the assessment lag.

Price change is defined as $(P_t - P_{t-1})/(P_t + P_{t-1})/2)$, where P_t is the 1960 average price and P_{t-1} is the 1950 average price. The average prices are obtained from the sample of individual property transactions.

Transaction frequency is defined as the percentage of single-family properties which are sold per year. Because the number of sales can only be measured for the period of time in which transactions were recorded, 1960 is the only year within the 1959-1961 data collection period in which single-family transactions were recorded in every section of the city. Information on transactions for the entire period 1958-1960 would be much more desirable. Data on the total number of single-family properties in each neighborhood are taken from the U.S. Census of Housing.

Housing Conditions

There are three available measures of general neighborhood housing conditions, and each one may reflect slightly different aspects of assessment behavior.

First, there is an index of the physical condition of residential structures. It is defined as the percentage of dwelling units classified as dilapidated or deteriorated by the U.S. Census of Housing. In connection with this variable, the assumption is made that the general physical condition of structures within a neighborhood is associated with important housing market externalities. To the extent that assessors do not consider the effect of negative housing market externalities, they will overestimate market value, and assessment-to-market value ratios will tend to increase with the degree of deterioration. However, there are at least two other hypotheses which are also consistent with a positive relation between deteriorated and dilapidated housing and assessment-to-market value ratios: an assessment policy based on a benefit principle of taxation and an assessment policy which, because of the several possible social goals discussed in II.A., tends to favor "nice" neighborhoods. Deteriorated neighborhoods not only require higher per capita public service expenditures but also are not likely to be considered "nice" neighborhoods.

A second measure of housing quality is the degree of overcrowding in terms of persons per room. Like physical deterioration, overcrowding is also associated with negative housing market externalities. Moreover, it is positively correlated with physical deterioration. Thus, all the reasons given above for expecting a positive relationship between percentage of deteriorated housing and assessment-to-market value ratios also suggest a positive relationship between the degree of overcrowding and assessment-to-market value ratios. The only reason for the assessment process to differentiate between deterioration and overcrowding is the possibility that crowded neighborhoods exert relatively more political pressure on assessment decisions. However, this possibility is unlikely because any potentially greater political power of overcrowded areas is probably nullified by their relative lack of political sophistication.

The measure of overcrowding which is used is the percentage of housing units with 1.01 or more persons per room. The data source is the U.S. Census of Housing.

The age of structures is a third housing condition variable which may be related to assessment behavior. Presumably, some concept of depreciation is involved in the estimation of market value. If depreciation schedules are incorrect and are consistently applied, there will be systematic variation in assessment ratios according to age. The particular pattern of variation will be a function of the type of error connected with the estimated depreciation schedule. It is also possible that the value of older properties is simply more difficult to estimate accurately and that, realizing this, the assessor tends to undervalue older properties relative to newer properties. Relative undervaluation errors are less likely to create taxpayer discontent than relative overvaluation errors.

The positive relationship between age and physical deterioration suggests that the age variable may reflect some of the physical deterioration effect. However, the importance of this possibility cannot be too great because age is not a very reliable indicator of negative externalities in the housing market. For instance, in Boston the structures in neighborhoods with low quality housing are generally older than those in the outlying sections of the city, like Hyde Park, where housing quality is much higher. On the other hand, some of the very oldest sections of Boston, like Beacon Hill, consist of predominantly high quality structures.

The only available measure of structure age is based on all of the structures in a given neighborhood. The structure age variable is obtained from the *U.S. Census of Housing* and is defined as the percentage of structures built before 1939. It would, of course, be much more desirable to know the age of the structures which were sampled by transactions.

Racial and Ethnic Composition

Three variables representing racial and ethnic composition by neighborhood are tested in equation (IV.7). They are measured as population percentages of Irish, Italians, and Negroes. The data are obtained from the *U.S. Census of Population*. The racial and ethnic variables test the importance of political factors in the assessment process. It is expected that political considerations tend to favor the politically influential Italian and Irish neighborhoods and to discriminate against Negro areas. However, differentially high effective tax rates in Negro neighborhoods may also reflect the influence of other factors in the assessment process. First of all, there may be a desire to maintain a certain racial mixture within the city by using lower effective tax rates to counteract the outward migration of white citizens. Secondly, Negro population density is associated with negative housing market externalities which can also be imperfectly captured by other variables in the model. Thus, the particular causal relationship between Negro density and effective tax rates may be difficult to determine.

Income and Market Value

Median family income data is obtained from the *U.S. Census of Housing*. Market value data specifically defined as the "average value of owner occupied dwellings" are also taken from the *U.S. Census of Housing*.[1] Another measure of single-family market value is based on the sample

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[1]Value data are restricted to owner occupied units having only one housing unit in the structure and no business associated with the property, i.e., single-family properties.

of property transactions. The two market value measures are very highly correlated. However, since the purpose of this independent variable is to capture neighborhood characteristics as opposed to the specific characteristics of the sampled properties, the census measure is preferred. Moreover, in IV.C.2, it will be argued that, because of a possible estimation problem, there is an additional reason for preferring the census measure of market value over the transaction sample estimate.[1]

Market value and family income are, of course, very closely related. In fact, they are perhaps too closely related for regression analysis to reveal any differences between them which may exist in their relationships with assessment ratios. However, this collinearity problem is more appropriately discussed when the estimation of the model is presented.

The assessment behavior hypotheses suggest several reasons to expect a negative relationship between assessment ratios and the market value and income variables. An application of the benefit principle and/or an effort to differentially favor "nice" neighborhoods would be consistent with a negative relationship. Moreover, although it is possible that market value and income capture somewhat different dimensions of a wide variety of neighborhood

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[1]Since regression results are about the same using both market value measures, this is not a crucial decision.

characteristics, both variables are probably related to externalities in much the same way. To the extent that the assessment process fails to take externalities into consideration, there will be a tendency to underestimate market value in areas with positive externalities and to overestimate value in areas with negative externalities.

The only real difference between these variables exists because market value is directly observable by the assessor whereas family income is not. Nevertheless, the assessor certainly has some general notion of what are high and low income neighborhoods.

Lot Size and Structure Size

The hypothesis of Chapter II part B holds that the market value of residential property is a function of two important factors: the characteristics of the specific property and the general character of the neighborhood in which the property is located. It is the assessor's estimation of the first factor's contribution to market value which is directly related to the two variables, lot size and structure size. The lot size variable is defined as the land area of a lot, and the structure size variable measures only one dimension of structure size, the height of a structure in terms of stories.

Although the hypothesis of II.B. stresses the possible importance of assessment errors caused by failure to consider the influence of neighborhood factors on market value, it is also possible that there are systematic errors in the estimation of the specific property component of total value. Objective appraisals of individual properties must rely on certain "rules of thumb" which take into account many readily observable physical characteristics. Lot size and structure size are two obvious factors which are considered. However, to the extent that the "rules of thumb" are incorrect, assessment ratios will tend to be biased. For instance, if lot size is weighted too heavily, then properties with larger lots will be assessed at higher ratios than properties with smaller lots.

This suggested relationship between structure and lot sizes and assessment ratios is based essentially on individual property assessment decisions. If such a relationship does in fact exist, the reason that it may account for some of the variation in neighborhood assessment-to-market value ratios is that there are concentrations within the city of properties with similar physical characteristics. A further test of this hypothesis is provided by the estimation of the individual property model.

In addition to their possible relationship to individual property assessment decisions, these two variables are probably associated with several aspects of general neighborhood character. For example, taller single-family buildings tend to be older and more deteriorated. Larger lots are characteristic of the newer, higher income neighborhoods. Thus, both variables may also explain some assessment-to-market value ratio variation which is associated with variations in neighborhood characteristics.

Perhaps an even more important neighborhood characteristic which may be reflected by the average structure size of single-family dwellings is suggested by the results shown in V.A. There, it is clearly demonstrated that multiple family structures have generally higher assessment ratios than single-family structures. In view of this situation, it is possible that assessment ratios on single-family dwellings tend to be higher in neighborhoods which have a relatively higher concentration of multiple family dwellings than in neighborhoods with relatively low concentrations of multiple family dwellings. Since taller single-family buildings are more likely to be located in neighborhoods with relatively high multiple family density, single-family structure size would tend to be positively related to assessment ratios. The influence of multiple family density on single-family assessment ratios in predominantly multiple family neighborhoods may be due to the existence of less single-family taxpayer resistance to higher assessments. In such neighborhoods the single-family owner is surrounded by many properties which have higher assessments than his own, and therefore, he is likely to be less inclined to complain about his own high ratio.

The fact that structure size and lot size may pick up certain neighborhood characteristics which are not well accounted for by other variables may somewhat complicate the interpretation of the results. This possibility will be further analyzed in the discussion of regression results.

Single-Family Structure Density

Data on single-family structure density are obtained from the *U.S. Census of Housing*. The exact definition of this variable is the fraction of total housing units contained in single-family structures.

With respect to assessment behavior hypotheses, single-family density may indicate several relevant neighborhood characteristics. First, single-family occupants are usually owner occupants, and owner occupants, as a group, are likely to exert greater political pressure on assessment decisions. Secondly, a predominantly single-family neighborhood is likely to be a well-maintained neighborhood. Single-family occupancy is a characteristic of high quality housing while in areas of low quality housing, single-family structures are relatively scarce. Thirdly, the density of multiple family structures is, of course, inversely related to single-family density. Thus, this variable may represent the effect of multiple family densities on single-family assessment-to-market value ratios. The multiple family effect is described in the previous discussion of the structure and lot size variables. All three of these neighborhood characteristics which are associated with single-family density suggest a negative relationship between single-family density and assessment-to-market value ratios.

Areal Share of Residential Land

A possible source of political pressure which would tend to benefit single-family properties may be exerted by all residential property owners. That is to say, the assessment process may favor all types of residential property in predominantly residential areas. A variable which measures residential density is the areal share of residential land or, more specifically, the fraction of total land area in each census tract which is devoted to permanent residential uses. The data for this variable are obtained from the land use survey conducted by the Metropolitan Area Planning Council.

2. A Problem in Estimation

Equation (IV.7) which was developed in IV.B. is a linear specification of equation (IV.1). Now that the various independent variables have been defined, it is appropriate to discuss the estimation problem associated with equation (IV.7). In the process of developing equation (IV.7), several implicit assumptions pertaining to the error term were made. These assumptions must now be made clear. Essentially, we hypothesized a model of the following general type:

$$A = [f(N_1, N_2, \ldots)]\, P + \eta \,, \qquad \text{(V.1)}$$

where η is the error term. This equation divided by P yields equation (IV.7), or, in terms of the above, (V.2) $$A/P = f(N_1, N_2, \ldots) + \eta/P.$$

Thus, we have two different error terms in (V.1) and (V.2). Which is the true error term, η or η/P? The assumption which has been made in this respect is that the latter is the more desirable formulation because η/P is more likely to be randomly distributed with constant variance than is η. In equation (V.1) the variance of the error, η, is probably a positive function of P, i.e., higher priced properties are more likely to have large absolute assessment errors than lower priced properties. Moreover, in equation (V.2) where A/P is the dependent variable, the variance of the error is likely to be more uniform. In short, division by P reduces the heteroscedasticity of equation (V.1).

Unfortunately, the above solution poses another problem. As suggested in the last section, one of the N's in equation (V.2) is expected to be P, the mean sale price of recorded transactions. This implies that the denominator of the dependent variable in equation (V.2) is itself an independent variable, i.e., equation (V.2) becomes

(V.3) $$A/P = f(P, N_1, N_2, \ldots) + \eta/P.$$

This situation allows possible spurious correlation between A/P and P to bias the estimated coefficient of P downward.

One way to avoid this problem is to estimate a multiplicative specification of equation (IV.7). If this is done, the heteroscedasticity problem does not exist.[1] Furthermore, the spurious correlation problem is removed. Unfortunately, however, a multiplicative model imposes an unrealistic requirement on the relationship between assessment-sales ratios and several independent variables. Specifically, the problem is that a multiplicative, or double-log, equation relates percentage changes between the dependent variable and the independent variables. Although this relationship may serve as a fairly good approximation over the observed range for several of the dependent variables such as income, market value, price change, structure size, and lot size, it is a less than adequate representation of the others.

The problem can be illustrated by an examination of the observed range of the variable defined as percent non-white housing unit occupancy. A multiplicative equation implies that a difference in Negro densities of 0.2% and 0.4% will have the same percentage effect on assessment-sales ratios as a difference of 40% and 80% because in each case one value is larger than the other by an equivalent percentage. Not only is this type of relation highly unlikely, but the problem of how to deal with zero value observations is also created. Thus, if the housing

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[1] In fact, estimation of (V.1) and (V.2) will yield exactly the same results; only the coefficient of multiple correlation will be different.

condition variable or any of the ethnic or racial variables turn out to be significant variables, a linear formulation is preferred.

Given a preference for a linear specification, the importance of the spurious correlation problem can still be diminished. Instead of using the same variable to represent market value on both sides of (V.3), some other variable may replace P on the righthand side of (V.3). If this other variable is less than perfectly correlated with P, then the spurious correlation is at least reduced. As noted in V.C.1.b., two variables representing neighborhood market value are available. Moreover, it is argued in V.C.1.b. that the alternative variable is preferred for theoretical reasons. The alternative to the mean transaction price is the average value of owner occupied dwellings.

3. Estimation of Neighborhood Assessment-to-Market Value Ratios: Single-Family Properties

Using the neighborhood assessment behavior model which is described by equation (IV.7), single-family assessment-to-market value ratios are estimated by ordinary least squares. For convenient reference the model to be estimated is restated as follows:

$$\text{(IV.7)} \quad (A_t/P_t) = \beta_0(\Delta P/P) + \beta_1 F(\Delta P/P) + \alpha_0 + \alpha_1 N_1 + \alpha_2 N_2 + \ldots,$$

where A_t and P_t are 1960 averages of assessments and sale prices on single-family properties; $\Delta P/P$ is the single-family percentage average price change between 1950 and 1960; F is the percentage of single-family properties which are sold per year; and the N's are various neighborhood characteristics which are discussed in one of the preceding sections of this chapter, C.1.b. Regression results based on various combinations of independent variables and on different data samples are shown in tables which are contained in Appendix A. A simple correlation matrix is presented in Appendix B. Each regression equation is labeled by its table number and its number within the table, e.g., in Table 3 the equations are labeled 3.1, 3.2, etc..

Each entry in the tables consists of the regression coefficient, the elasticity of the dependent variable with respect to each independent variable, and the t-statistic associated with the regression coefficient. The elasticity, which is in brackets below the regression coefficient, is presented in order to facilitate the comparison of the effects of different variables which are not measured in the same units. Each elasticity is calculated at the point of the means because the elasticities of a linear relationship vary continuously over the variable range. The t-statistic is in parentheses below the elasticity.

The entry of an asterisk in the table indicates that the independent variable did not significantly improve the explanatory power of the equation. The specific criteria used to decide whether or not a variable should be included are the t-statistics and the standard error of the regression. If the t-statistic of a variable is equal to or greater than 1.0 and the inclusion of that variable lowers the standard error of the regression, it is considered to be significant. The results presented are those without the insignificant variables. A dash indicates that there is *a priori* reason why the inclusion of the variable was deemed to be inappropriate. The particular reasons will be made clear in the course of the discussion.

The results shown in Table 3 indicate that the independent variables in each regression explain a substantial part of the variation of the dependent variable. Depending on the particular equation, the coefficients of multiple correlation indicate that from 74% to 81% of the variation is explained. The fact that the F-statistics are greater than what is required at the 0.01 confidence level denotes that highly significant associations exist between the independent and dependent variables in each regression.[1] Since the goal here is to attempt to explain the systematic variation in assessment ratios while recognizing that a significant part of the variation is random, the most important tests of the model lie in the significance

[1]For 86 observations and eight variables (including a constant), a F-statistic of 2.73 or greater is sufficient to reject the null hypothesis that no relationship exists.

and reasonableness of the results pertaining to individual variables.

In order to simplify the expostion, the regression results of one variable at a time are discussed. The variables representing price change and transaction frequency, racial and ethnic composition, and housing conditions are discussed first. The results of these variables are not significantly affected by certain constraints which are placed on the model in an effort to analyze the results associated with some of the other variables. The next variables discussed are income and market value. Because of the high collinearity between these two variables, the model is not estimated with both variables together. Regression equation (3.1) is the result of estimation without the income variables, and the regression equation (3.2) is the result of estimation without the market value variable. Following the discussion of the income and market value variables is a discussion of the structure and lot size variables and the problems of interpretation related to them. Finally, after the results of the full model have been presented, some further results connected with the racial effect and the transaction frequency effect are discussed.

Price Change and Transaction Frequency

According to the assessment lag hypothesis, price increases ought to be negatively related to assessment ratios, i.e., $\beta_0 \leq 0$. In addition, given the 1950 average assessment and the average level of market prices in 1950 and 1960, it is possible to calculate the value of β_0 which would result from a complete lack of assessment adjustment.[1] This minimum value of β_0 is -.41. The regression results provide rather good substantiation of the lag hypothesis. The estimated price change coefficient, β_0, is highly significant, and it lies in the expected range if -.41 to 0.[2]

Not supported by the results of Table 3 is the supposed effect of transaction frequency on the length of the assessment lag. Although the coefficient of the multiplicative term, β_1, is greater than zero, as expected, it is not significant. (Since the multiplicative term is not significant in any of the regressions shown in Table 3, no entry is made for it in the table.) However, given the poor quality of the transaction frequency data, this evidence cannot be considered conclusive. Another test of the transaction frequency effect is performed at the end of this section.

An indication of the magnitude of the price change influence on assessment-sales ratios can be obtained by calculating the estimated average value of the unobservable

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[1]See footnote 1, page 34.

[2]With 79 degrees of freedom, a coefficient is significant at the .01 level if its t-statistic is equal to or greater than 2.58.

variable, $(A_6/P_6)^d$, which is the desired 1960 ratio. The value of $(A_6/P_6)^d$ calculated from regression equation (3.1) is .467, and it provides an estimate of what the average assessment ratio would have been in 1960 if prices had not changed between 1950 and 1960.[1] This .467 estimate is 18% higher than the actual 1960 ratio of .396.

Ethnic and Racial Composition

Negro population density is the only one of the three racial and ethnic variables which is significant in equations (3.1) and (3.2). The coefficient of the Negro density variable passes the t-test at the .01 confidence level while the t-statistics of the Italian and Irish density variables are considerably less than 1.0. The positive sign on the Negro variable indicates that relatively high assessment ratios are associated with areas of relatively high Negro densities. Moreover, given the wide variation in Negro densities, a Negro density elasticity in the vicinity of .039, as shown in equation (3.1), implies that there is a substantial jump in assessment ratios in Negro areas, *ceteris paribus*. A detailed examination of the racial effect is undertaken following the variable by variable discussion of the results. At that time a more precise estimate will be made of the positive tax differential which is levied on Negro areas.

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[1] Calculation of this estimate involves multiplying the mean of the price change variable by its regression coefficient and subtracting this negative result from the mean of the dependent variable.

These results are consistent with those of the Oldman and Aaron assessment-to-market value ratio study of Boston. Their study estimates a 54% ratio of assessed value to market value on single-family properties in the predominantly Negro Roxbury section and a 34% ratio for single-family properties in the city as a whole.[1] A similar estimate made on the basis of the present study indicates that in the eight census tracts with the highest Negro densities, average density 64%, the assessment ratio on single-family properties is 64%. The ratio on single-family properties for the entire city is 40%.[2]

One possible explanation for this apparent tax rate discrimination against Negro neighborhoods is based on the fact that many Negro neighborhoods are slum neighborhoods. It can be argued that the relatively large negative housing market externalities and the below average inflation of property values in slum areas both combine to cause higher

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[1]O. Oldman and H. Aaron, "Assessment-Sales Ratios Under the Boston Property Tax," National Tax Journal, March, 1965, p. 40.

[2]The reason for the rather substantial difference between the absolute values of the Oldman and Aaron estimates and the estimates of this study is partially due to observations. This study's estimate is based on census tract observations. Oldman and Aaron's is based on individual property observations. Since there are relatively fewer individual property observations in Roxbury, these above average observations are given less weight in the Oldman and Aaron study. Also, the eight census tracts with highest Negro densities do not encompass the same geographical area as Roxbury because these census tracts are not all in Roxbury and all census tracts in Roxbury are not among the eight selected census tracts.

assessment ratios in Negro areas.[1] However, within the assessment model both of these factors are taken into account by specific variables, which in equation (3.1) are the density of deteriorated and dilapidated housing and the average price change of single-family properties. With these two variables also included in the regression, it is difficult to explain the strong performance of the Negro density variable based solely on a "declining" neighborhood argument.

A better explanation of the Negro effect is that it is the result of factors related to the relative political weakness of the Negro community. As suggested earlier, the city is probably not concerned about losing Negroes to the suburbs. A more likely fear is that of gaining large numbers of Negroes from the South. Moreover, the migration of middle-to-upper income families, almost exclusively white, to suburbia is of great concern to the city. Add to this situation the Negro community's lack of influence in Boston politics, and a political explanation for what is observed is certainly possible.

Although the signs of the Italian and Irish variables are negative, as expected, their insignificance in equations (3.1) and (3.2) suggests that these groups do not influence

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[1]The simple correlation between Negro density and density of deteriorated and dilapidated housing is .53. The average density of deteriorated and dilapidated housing units in Negro areas is .47 compared to .14 in the rest of the city. The average percentage price increase on single-family dwellings between 1950 and 1960 is 9% in Negro areas and 40% in the rest of the city.

assessment decisions.[1] Perhaps neither of these communities is sufficiently concentrated to allow an effective discriminatory policy on their behalf.

Housing Conditions

Only one of the three housing condition variables is significant when all three are included as explanatory variables. The density of deteriorated and dilapidated housing has a positive sign and is significant at the 95% confidence level in equation (3.1) and at the 98% confidence level in equation (3.2). As stated in C.1.b. of this chapter, a positive relation between poor housing conditions and high assessment-to-market value ratios can be attributed to three possible factors: the influence of negative housing market externalities associated with deteriorated and dilapidated housing, an application of a benefit principle to assessment decisions, and an assessment policy which favors "nice" neighborhoods.

The two housing condition variables which are insignificant in equations (3.1) and (3.2), neighborhood structure age and the index of crowding, are both positively correlated with the density of deteriorated and

[1]There are, however, certain conditions under which one or the other of these variables do enter the model with t-statistics slightly greater than 1.0. These cases will be discussed later in this chapter.

dilapidated housing.[1] In order to examine their relationship to the dependent variable, they are substituted for the deteriorated housing variable. As equation (3.3) shows, neither variable performs well even in the absence of the deteriorated and dilapidated housing variable. The structure age variable is barely significant at the 0.3 level. The index of crowding, having a t-statistic of less than 1.0, is considered insignificant and therefore is not entered in the table of results. Worth noting, however, is the negative partial correlation between structure age and assessment ratios.[2] Considering that deterioration is positively related to assessment ratios, a negative sign on the age variable suggests that it is not the effect of physical deterioration which this variable is explaining. Perhaps the uncertainty of market value estimation which is associated with older properties is responsible for this negative partial correlation.

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[1]The simple correlation between the density of deteriorated and dilapidated housing and structure age is .26, and that between the density of deteriorated and dilapidated housing and the density of structures with 1.01 or more persons per room is .40.

[2]Since the definition of structure age is the density of structures built before 1939, the negative partial correlation means that neighborhoods with older buildings tend to have lower assessment-to-market value ratios.

Market Value and Median Family Income

As stated earlier, high collinearity exists between market value and median family income. The simple correlation between the two variables is .72, and, when both variables are entered into the same regression, neither is significant. However, regressions (3.1) and (3.2) show that if either one of the variables is excluded from the estimation process, the other is significant at about the 96% confidence level. Moreover, the two equations, (3.1) and (3.2), are very similar in other respects. The coefficients of multiple correlation of the two regressions are almost equal, and the same group of other independent variables is significant in each regression. Also, the coefficients of the other independent variables are comparable. Thus, it appears that the income and market value variables are explaining the same general source of variation in assessment-to-market value ratios.

Possible explanations for the negative relationship between these two variables and the dependent variable are exactly the same as those which applied to the positive relationship between deteriorated and dilapidated housing and the dependent variable. Housing market externalities, the application of a benefit principle, and a policy favoring "nice" neighborhoods are all possible explanations.

This negative relationship between market value and assessment-to-market value ratios is also observed in two other property tax studies. Based on assessment ratio data on non-farm housing obtained from a nationwide sample, Frederick Bird concludes that there is a "measurable degree" of "regression" in the assessment of these properties.[1] The regressivity is observed in large and small cities with various types of assessment organizations.

The other source of data on this relationship is found in the Oldman and Aaron Boston study. They found that the relationship between price and assessment-to-market value ratios is negative within any one property type.[2] As in the case of the national data, this relationship is observed without taking into account other possible sources of assessment-to-market value variation.

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[1] F. L. Bird, The General Property Tax: Findings of the 1957 Census of Governments, (Chicago: Public Administration Service, 1960), pp. 58-60. The source of data used in Bird's study is based on Table 14 in the 1957 Census of Governments, Vol. V, "Taxable Property Values in the United States, 1959." Regressivity is measured by taking the average of the assessment ratios and dividing it by the "sales-based" average assessment ratio. This latter ratio is defined as the ratio of the total assessed value of all the properties in the sample to the total market value of all the properties in the sample. Thus, the denominator of the regressivity measure weights the assessment ratios of higher priced properties more heavily than lower priced properties. If the ratio of the two different assessment ratios is greater than one, then the higher priced properties must tend to have lower assessment ratios.

[2] Oldman and Aaron, "Assessment-Sales Ratios under the Boston Property Tax," National Tax Journal, March 1965, p. 43.

The data of the present study display the same type of relationship. For example, the simple correlation between the market value of single-family properties and the assessment-to-market value ratio on single-family properties is -.200. However, within the context of a multiple regression equation, the price change variable explains part of the variation associated with market value. Without the price change variable in equation (3.1), the estimated coefficient of the market value variable is a much larger negative number, -.0493, and is highly significant at the .01 confidence level. Thus, part of the observed inverse relationship between market value and assessment-to-market value ratios, by themselves, can be attributed to a true market value effect; another part must be ascribed to the effect of assessment lags in a period of rising market prices.

More information on inter-relationships between the market value and income variables and the other independent variables is presented in the following discussion of the structure and lot size variables.

Structure Size and Lot Size

As equations (3.1) and (3.2) show, significant partial correlation coefficients are estimated for both the structure size and lot size variables. In both cases the coefficients are significant at the 99% confidence level. Also, both coefficients are positive.

Earlier in this chapter it was suggested that there are at least three interpretations of these significant regression results. First, the assessor may simply be over-weighting the importance of structure size and lot size in the calculation of his market value estimates. Thus, properties with taller buildings and/or larger lots are assessed at a higher proportion of market value than average properties. Given that many neighborhoods are fairly homogeneous with respect to structure size and lot size, this type of assessment bias is very likely to be a significant factor in explaining inter-neighborhood assessment-to-market value ratio variation.

A second interpretation of the structure size result is suggested by the possibility of a "multiple family" effect on single-family properties. As suggested in V.C.1.b., the presence of high densities of multiple family properties may tend to pull up the assessment-to-market value ratios on single-family properties.[1] Thus, if taller single-family structures are more likely than not to be located in areas of high multiple family densities, single-family structure size will tend to be positively related to assessment-to-market value ratios.

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[1]In Section A of this chapter, data are presented which clearly indicate that assessment-to-market value ratios are positively related to the number of families per structure.

The third explanation for the structure size and lot size results is somewhat more involved than either of the previous two. In addition to the possibility of representing the effects of assessment biases or of high multiple family assessment ratios, these variables capture other significant neighborhood characteristics, which are not measured as well by other independent variables. An indication that this may in fact be the case is the remarkable strength shown by the structure size variable.[1] The t-statistic and elasticity of the structure size variable are considerably above those of the other significant variables. Although this does not necessarily prove that the variable is explaining a variety of factors, it does suggest the possibility. In an effort to test this possibility, the structure size variable is excluded from the estimation process. If structure size is in fact picking up the influence of factors represented by other independent variables, then these variables will perhaps enter significantly when the structure size variable is excluded.

The results of estimation without the structure size variable, shown by equation (3.4), indicate that the absence of structure size substantially alters the estimated model. Three new independent variables enter significantly:

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[1]The simple correlation between structure size and the dependent variable is .58.

Italian density, single-family density, and residential density. One variable, lot size, is no longer significant. Also, the estimated coefficients of two variables, the density of deteriorated and dilapidated housing and the market value of single-family properties, are greatly disturbed. The coefficient of the former is about 50% larger than before, and the sign of the latter coefficient is changed from negative to positive. Moreover, the coefficient of multiple correlation of regression (3.4) is considerably below that of regression (3.1).

The increase in the size of the estimated coefficient of the deteriorated and dilapidated housing variable probably indicates that some of the variation in assessment-to-market value ratios due to this variable is explained by variations in structure size. The simple correlation between structure size and deteriorated and dilapidated housing is .302. This positive correlation is probably caused by newer single-family structures which have been built since the War and which are probably still in good condition and are not as tall as older structures. Also, older and taller single-family structures are more likely than not to be located in areas which have undergone a general decline in housing quality.

The unexpected change in the sign of the market value regression coefficient is difficult to interpret. One explanation, however, can be based on the positive relationship between structure size and market value.[1] Perhaps, the partial correlation which is estimated for market value in equation (3.4) is positive because taller buildings are higher priced. Thus, it is a structure size effect which may actually be causing the result.

The absence of the lot size variable in the regression may also contribute to this result. Although the lot size variable is not excluded from the estimation process, it is not significant in equation (3.4). Like the structure size variable, it is positively related to market value.[2] Therefore, higher priced properties may be assessed at high ratios not only because their buildings tend to be taller, but also because their lots tend to be larger.

The insignificance of the lot size variable when the structure size variable is excluded probably occurs because of the tendency for tall structures to be associated with small lots and vice versa.[3] In order for lot size to show its positive effect on assessment-to-market value ratios, structure size must be held constant. Otherwise, the lot size effect is cancelled out by the structure size effect.

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[1]The simple correlation between structure size and market value is .296.

[2]The simple correlation between lot size and market value is .248.

[3]The simple correlation between structure size and lot size is -.511.

Assessment-to-market value ratios are higher to the extent that properties have large lots but lower to the extent that large lots usually have small structures. If the two effects are not separated, the net result is an insignificant relationship between lot size and the dependent variable.

Further evidence that the structure size variable is representing more than a structure size effect alone is the appearance in equation (3.4) of three new variables. One of these variables, single family structure density, is highly significant and enters the equation negatively. In C.1.b. of this chapter three reasons are suggested for expecting this negative relationship. The most likely explanation is the influence of multiple family properties on single-family assessment-to-market value ratios because the multiple family effect is probably one of the sources of variation which the absent structure size variable explains. Thus, when structure size is omitted from the regression, single-family density may tend to pick up this effect. Of course, it is also possible that structure size is related to the other factors which cause a negative relationship between single-family density and the dependent variable.[1]

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[1]The other factors suggested in V.C.1.b. are the political influence related to single-family density and the fact that many "nice" neighborhoods are likely to consist of predominantly single-family properties.

The second new variable in equation (3.4) is the areal share of residential property. It enters negatively and is significant at about the 88% confidence level. It is possible that the structure size variable is explaining variation due to the political effect which may be attributed to this variable.

The entrance into equation (3.4) of the Italian density variable is somewhat unexpected. The partial correlation coefficient which is estimated for this variable is negative and is significant at the 95% confidence level. This change is probably caused by the fact that the average structure and lot size in Italian areas is less than the citywide average although this result may also be demonstrating another example of the structure size variable standing in for an associated neighborhood characteristic. Another explanation for the existence of an independent Italian effect is based on political pressures. However, if political pressures of this type do exist, one would also expect the Irish variable to show some significant influence on assessment-to-market value ratios, which it does not.

Equation (3.5) shows the results of estimation when family income is substituted for market value and structure size is excluded. In general, these results are consistent with those in equation (3.4). The argument which explains the change in the sign of the market value variable in equation (3.4) also explains the insignificance of the income variable in equation (3.5). The one new variable which enters equation (3.5) very significantly, Irish density, contradicts the argument of the above paragraph which discounts the importance of ethnic political pressure in the assessment process.

In summary, the structure size variable seems to have two roles in the assessment behavior model. It explains variations in assessment-to-sales ratios which are caused by variations in specific property characteristics and by neighborhood characteristics with which it is associated. It is unlikely that structure size is <u>only</u> a proxy for neighborhood characteristics because coefficients of multiple correlation of regressions without structure size, but with several substitutes, are substantially lower than those with structure size.

Although lot size does not enter equation (3.1) as significantly as structure size, it may also be performing somewhat the same function in the model as structure size. Therefore, the model is also estimated excluding the lot size variable. Equations (3.6) and (3.7) show the results of estimation with first the market value variable and then the income variable.

As equations (3.6) and (3.7) indicate, the omission of the lot size variable does not disturb the results with respect to other independent variables nearly as much as the omission of structure size. Moreover, the total explanation is only slightly reduced in comparison. The changes in the results which do occur are of the same general nature as the changes caused by the exclusion of structure size. The decline in the size and significance of the market value and family income coefficients is consistent with the explanation given for the change in the sign of the market value coefficient in equation (3.4). Also, the same argument which explains the insignificance of the lot size variable in equations (3.4) and (3.5) applies to the decline in the magnitude of the structure size coefficients in equations (3.6) and (3.7). The presence in equation (3.6) of the structure age variable, which is not very significant, is probably due to the tendency for newer structures to be built on larger lots than older structures. The Italian density variable which enters equation (3.7) is also rather insignificant. It is probably due to the same factors which explain the significance of the Italian density variable in equations (3.4) and (3.5).[1] When both structure and lot size are omitted from the estimation process, the results are identical to those shown by equation (3.4) and (3.5).

Further Examination of the Effects of Racial Composition

There are at least two interesting aspects of the

[1]Part of the explanation given in connection with equations (3.4) and (3.5) is that the average lot size is generally smaller in Italian neighborhoods.

composition effect which warrant investigation. First, it is possible that the type of Negro effect which is observed is a threshold effect, i.e., a certain minimum Negro density must be reached before assessment ratios increase. In areas where this minimum density is passed, assessment ratios are reasonably constant with respect to variations in Negro densities. In order to test for the existence of a threshold effect, a dummy variable is substituted for the Negro density variable in the assessment behavior model. Thus, the performance of the Negro dummy variable can be compared to that of the Negro density variable. Of course, the likelihood of any substantial difference in the performance of these two variables is small because Negro areas are rather concentrated. Therefore, the Negro density variable already displays considerable discontinuity over its range.

A second interesting aspect of the racial composition effect is the possibility that assessment behavior is somehow different within the Negro community from what it is in the rest of the city. By first dividing the sample between predominantly white and non-white neighborhoods and then estimating the assessment behavior model based on each sample, this possibility can be examined.

For purposes of dividing the sample and creating a dummy variable, observations are classified according to their Negro densities. Fourteen observations are included in the Negro sample. Each one has a Negro density of over

10%, and the entire group has an average Negro density of 43%. The remainder of the city, consisting of 72 observations, has a Negro density of less than 1%. One of the two dummy variables, D1, is based on this division between white and non-white neighborhoods.[1] The other dummy variable, D2, is based on a more restrictive Negro density definition. Only eight observations with Negro densities in excess of 30% are considered to be Negro observations. The average Negro density in this group is 64% as opposed to 2% in the rest of the city.

As equations (4.1) and (4.2) show, the regressions using the dummy variables are generally consistent with equation (3.1). Both dummies perform rather well, especially the most restricted dummy, D2, which is significant at the 99% confidence level. Moreover, the coefficient of multiple correlation of equation (4.2) is almost as high as that of equation (3.1). Thus, it seems that the Negro effect on assessment-to-market value ratios can be almost as well characterized as a threshold-type relationship as it can be as a continuous relationship.

There is, however, some evidence in equations (4.1) and (4.2) which suggests that the "gradual" component of the Negro effect is at least partially absorbed by other independent variables. For instance, the emergence in equations (4.1) and (4.2) of a significant Irish density

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[1]For those observations which are classified as Negro observations, the dummy variable equals 1; for all other observations, it equals zero.

variable is probably the result of this variable's rather strong negative correlation with Negro density.[1] Also, in almost every case the size and significance of the regression coefficients which are estimated in equations (4.1) and (4.2) are greater than those of equation (3.1).

Further evidence that some kind of gradual Negro effect exists can be seen by comparing the coefficients of D1 and D2. As the average Negro density of the dummy observations is reduced, the dummy coefficient is also reduced, i.e., D2 is greater than D1.

In addition to suggesting that the Negro effect is rather discontinuous, equations (4.1) and (4.2) provide a direct estimate of the average positive assessment ratio differential which is imposed on Negro areas, _ceteris paribus_. For example, the 10.27 estimate of the D2 coefficient indicates that, _ceteris paribus_, assessment ratios in Negro areas are about 10 percentage points greater than in other areas. Of course, 10.27 is only part of the total average assessment ratio differential which exists between the white and non-white observations. The eight observations which are represented by D2 exhibit an average assessment-to-sales ratio of 64%. The average ratio for the other 76 observations is 37%. Thus, the average difference between these white and non-white assessment ratios is 27

[1]The simple correlation between Negro density and Irish density is -.49.

percentage points. Other factors which contribute substantially to this total differential are in their order of importance: the relatively low rate of inflation in Negro areas, the existence of generally taller structures in Negro areas than in other areas, and the above average density of deteriorated and dilapidated dwellings in Negro areas.[1]

The regression results which are based on the white and non-white samples are shown by equations (4.3) and (4.4) respectively. The results of equation (4.3) indicate that the explanation of assessment ratio variation in white neighborhoods is only slightly different from that in the city as a whole. The sign pattern among the independent variables in equation (4.3) is exactly the same as that of equation (3.1) with the exception of the additional significant variable, single-family structure density. Evidently, single-family structure density represents factors which significantly affect assessment ratios within white

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[1]Estimates of the percentage contribution of each variable to the total 27 percentage point Negro differential can be made as follows. The percentage contribution of the Negro effect is simply the coefficient of D2 as a per cent of 27 percentage points, or 37%. For the other variables, their absolute contributions are found by multiplying their regression coefficients by the differences of their white and non-white means. Then, each of these absolute estimates is taken as a per cent of 27. Based on equation (4.2), these calculations yield the following percentage contributions: price change, 23%; structure size, 15%; density of deteriorated and dilapidated housing, 13%; and market value of single-family dwellings, 5%.

areas but not in the city as a whole. Also, its influence is made more likely by the somewhat greater variability of single-family structure density over the white observations as compared to all of the observations.[1]

Another more general difference between equations (3.1) and (4.3) is that the independent variables in equation (4.3) have less impact on assessment ratio variation. Not only do they as a group explain a smaller proportion of the total variation in the dependent variable, but each individual variable which enters both equations (3.1) and (4.3) displays a smaller and less significant coefficient in equation (4.3). This phenomenon may be due to the fact that many of the extreme observations of the dependent and independent variables are excluded from the white sample.

The estimation of the assessment behavior model based on the non-white sample is not very satisfactory. The standard error of the regression, which is 9.99, is considerably above that of any of the other regressions. Moreover, the F-statistic does not indicate as high a level of significance as in other regressions.[2] Although the R^2 is rather high, this is to be expected with so few degrees

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[1]The standard deviation of single-family structure density is .187 for the white observations and .177 for the city as a whole.

[2]An F-statistic of 5.82 with (5,8) degrees of freedom indicates that a significant association exists between the dependent and independent variables at about the 97% confidence level.

of freedom. The lack of degrees of freedom also restricts the number of independent variables which can be tested at one time. Equation (4.4) shows the greatest number of significant variables which can be included without severely reducing the F-statistic of the regression. The interpretation of the results with respect to individual variables is made difficult by the high collinearity which exists among all the variables except the Negro density variable.

Although the coefficient of the Negro variable is significant at only the 85% level of confidence, it is worth noting that the size of the coefficient is not substantially smaller than it is in equation (3.1).[1] This suggests that even within the Negro community, variations in Negro densities have a considerable impact on variations in assessment ratios. This result may, however, still be consistent with a threshold effect. The boundaries of the Negro community may cut across census tract observations. If they do, then census tract averages in these areas would tend to create the impression in the regression results of a gradual effect.

The insignificance of the price change variable is understandable given that average price increases in Negro

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[1]With 8 degrees of freedom, a t-statistic of 1.40 indicates an 80% level of confidence.

areas were very small compared to those in the rest of the city.[1]

The sizeably larger estimate of the structure size coefficient in (4.4) compared to (3.1) may indicate that the effect of multiple family dwellings is much more important in Negro areas. In III.D., the description of the Negro sample shows that it contains a disproportionately large number of multiple family dwellings.

Because of the high collinearity which exists among the lot size, market value, and deteriorated and dilapidated housing variables, the results with respect to all three variables are questionable. Although the signs of the coefficients of the lot size and market value variables are consistent with those of equation (3.1), the sign of the deteriorated and dilapidated housing variable is changed. The collinearity problem probably causes this change in sign. When lot size and market value are excluded from the regression, the coefficient of deteriorated and dilapidated housing is positive.

In summary, assessment behavior in white areas of the city seems to be about the same as assessment behavior which is indicated by the citywide regressions. On the other hand, the estimated results for Negro areas are not good enough to support a general judgment one way or the other.

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[1]As noted earlier, the average price increase in Negro areas over the ten years between 1950 and 1960 was 9%. In the rest of the city it was over 40%.

<u>A Further Test of the Transaction Frequency Effect</u>

To review briefly, the multiplicative variable (transaction frequency times percentage price change) in the assessment behavior model described by equation (IV.7) provided a test of the transaction frequency effect. The coefficient of the multiplicative term, β_1, was supposed to estimate the positive effect of transaction frequency on the length of the assessment lag.[1] Although the estimated coefficient of the multiplicative term was positive, as expected, the coefficient was not significant.

The purpose of the present undertaking is to perform a different test on the transaction frequency effect. If transaction frequency is related to assessment ratios through its positive effect on assessment lags, then it ought to be positively related to assessment ratios in areas where prices have increased and negatively related to assessment ratios in areas where prices have decreased. For example, if there are two areas with equivalent rates of property value inflation, the area which has the highest rate of property turnover will presumably have the highest average assessment-to-market value ratio, *ceteris paribus*. With higher turnover rates, the assessment lag is supposedly shorter, and the actual assessment ratio is closer to the desired ratio which is above the actual ratio in areas of rising prices.

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[1]Because of the way price change is defined, the assessment lag is a negative number. Thus, a "positive effect" means that the absolute size of the assessment lag is reduced by an increase in transaction frequency.

In order to perform this test of the transaction frequency effect, the sample must, of course, be divided between areas of rising prices and areas of declining prices. The assessment behavior model with a transaction frequency variable replacing the multiplicative term is then estimated with each of the samples. The results of this estimation are shown in Table 5.

As in the case of the previous test, these results are not very satisfactory. Because there are only seven observations of declining prices, an adequate test of the negative effect is impossible. Moreover, the transaction frequency variable is insignificant when the sample of rising prices is used. Nevertheless, the results of Table 5 do offer some support for the possibility of a transaction frequency effect. For instance, based on the decreasing price sample, equation (5.1) shows that the transaction frequency variable is highly significant and negative. Although the model which is estimated by regression (5.1) does not compare well to regression (3.1), the negative coefficient on the transaction frequency variable is negative as expected. In the rising price regression, equation (5.2), the insignificant transaction frequency variable is entered in order to show that it does have a positive sign. This result is also consistent with the hypothesis.

Considering the results of Table 5 and the earlier results of the multiplicative variable, there is no strong evidence of a transaction frequency effect. However, the possibility that such an effect does exist cannot be ruled out because the limited results are consistent with the hypothesized effect.

4. Estimation of Neighborhood Assessment-To-Market Value Ratios: Other Property Types

In the preceding section, a model of assessment behavior was used to explain variations in assessment-to-market value ratios on single-family properties. This same model also should be able to explain neighborhood assessment ratio variation within other types of property. None of the assessment behavior hypotheses are unique to single-family properties. Thus, in this section the same model, equation (IV.7) is tested against three other classifications of residential property: two-family, three family, and four-family-and-over.[1]

In the investigation of assessment behavior, the major emphasis is on the results obtained from single-family data because of several disadvantages to using data on the other property types. First, the sample sizes for the other property types are all smaller and therefore probably less representative than the single-family sample. Secondly, there is probably considerably more heterogeneity with respect to the characteristics of properties within the other samples, especially the sample of properties with four

[1]Because of the relative scarcity of transactions of dwelling units which house four or more families, all of these types are lumped together.

families and over.[1]

Table 6 shows the results of estimation based on the three different multiple family property types: equation (6.1), two-family properties; equation (6.2), three-family properties; and equation (6.3), properties with four families and over. All the independent variables have the same definition as before. The transaction frequency variable is not tested because of the lack of data on the total number of properties of each of the three types within each census tract.

The results of Table 6 are not discussed in great detail. Instead, the estimated models are compared in a general way to the estimated single-family model. The discussion focuses on the similarities and differences among the models. Because of the lower quality of multiple family data, especially that of the four-family-and-over sample, the results of Table 6 must be considered somewhat less reliable than those based on single-family data.

The assessment lag hypothesis is very well supported by the regressions shown in Table 6. All of the estimated partial correlation coefficients of the price change variable are negative. The estimated price change coefficients in equations (6.1) and (6.2) are significant at the 99% level

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[1]The four-family-and-over classification includes everything from four-family structures up to and including large apartment buildings.

of confidence, and the price change coefficient in equation (6.3) is significant at the 95% level of confidence.

The results with respect to the Negro density variable are also consistent with those of the single-family model, except for equation (6.3). In equations (6.1) and (6.2) the regression coefficient of the Negro density variable is positive and significant at about the 98% level of confidence. In equation (6.3) the Negro density variable does not enter significantly. This lack of significance of the Negro density variable in the four-family-and-over regression would not merit much consideration were it not for the fact that this particular sample contains by far the highest average Negro density of all the samples. The average Negro density of each of the other samples is about 8% while the average Negro density in the four-family-and-over sample is more than 16%. Under these circumstances, one would expect the probability of observing a significant Negro density variable to be greater in the four-family-and-over regression than in any of the others. Thus, with respect to the Negro effect, the results of equation (6.3) provide what must be considered a significant exception to what is observed in all of the other regressions.

Like the Negro density variable, the market value variable enters two of the three multiple family regressions significantly and with a sign which is consistent with the single-family results. In the case of the market value variable, however, it is the two-family regression which is the exception. Market value enters negatively in both equations (6.2) and (6.3). The market value coefficient is of very high significance in equation (6.2) but of much lower significance in equation (6.3).

One of the two possible causes of the insignificance of market value in equation (6.1) is the relatively small variance of market value in the two-family sample.[1] A second possible cause is collinearity between market value and the density of deteriorated and dilapidated housing. Not only is the simple correlation between these two variables high, but also, if the deteriorated and dilapidated housing variable is excluded from the regression, market value does enter negatively and highly significantly.[2] Thus, it is possible that there is also a market value effect in the two-family sample but that it is not observable due to collinearity.

From the regressions of Table 6, only in (6.2) does the lot size variable have a significant positive relationship to the dependent variable as in the single-family estimation. Although lot size is not significant in equation (6.1), it does enter positively. Its very low significance in equation (6.1) may be due to the relatively small amount of variation of two-family lot sizes compared to that

[1]The coefficient of variation (standard deviation divided by the mean) of market value is smaller in the two-family sample than in any of the other samples although it is only slightly smaller than that of the three-family sample.

[2]The simple correlation between market value and density of deteriorated and dilapidated housing is .68.

of other property types.[1] The lack of significance of lot size in equation (6.3) may be due to the great heterogeneity of the four-family-and-over sample. For example, the data on lot sizes for this property classification frequently include garage areas and parking lots. Given the rather small number of four-family-and-over observations in each census tract, one observation of an especially large apartment property could greatly influence the census tract averages. Such an observation could affect not only the average census tract lot sizes but also the average of structure sizes, market values and assessments.

In equations (6.1) and (6.2) structure size enters significantly and positively as it does in the single-family model. The inconsistent result of equation (6.3), where the estimated partial correlation coefficient is negative, probably reflects the phenomenon noted in V.A.. Table 2 of V.A. shows that the 1960 average assessment ratio for dwellings containing eight families or more is markedly below that of the other property types. Since this group of properties is heavily weighted within the four-family-and-over sample and buildings containing eight or more families are generally tall buildings, a negative sign on the structure size variable in equation (6.3) is not unexpected.

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[1]The coefficient of variation of the lot size variable is lower in the two-family sample than in any other sample.

The results with respect to the density of deteriorated and dilapidated housing are fairly consistent with those of the single-family model. This variable enters positively and significantly in equations (6.1) and (6.2). Only in equation (6.3) is the density of deteriorated and dilapidated housing insignificant although it does enter with a positive sign. It appears that for the four-family-and-over sample two other housing condition variables, density of housing units with 1.01 or more persons per room and the density of old structures, are replacements for the density of deteriorated and dilapidated housing. When these two other housing condition variables are excluded from the regression, the density of deteriorated and dilapidated housing becomes significant and positive.

The density of single-family property does not enter the single-family model significantly except when the white sample is used or when the structure size variable is omitted from the regression. However, in equation (6.2) the density of single-family property is a significant variable, at the 80% level of confidence, and its sign is negative. Within the three-family property class, a negative sign on this variable could reflect the results of political pressure if it is assumed that single-family property owners are successful in not only influencing their own assessments but also those of other property types in the same neighborhood. A more likely explanation of the negative relationship between single-family property density and the dependent variable is that it is further evidence of the negative relationship between "nice" neighborhoods and assessment-to-market value ratios.

The significance of the Irish and Italian density variables in equations (6.2) and (6.3) suggests that with respect to the properties with three families or more there is an ethnic effect on assessment ratios. Although these two variables are generally insignificant in the other two samples, they always enter negatively. Perhaps, the greater variation of both variables in the three-family and four-family-and-more samples causes these variables to enter more significantly.

The negative partial correlation coefficients estimated in equations (6.1) and (6.2) for the density of housing units with 1.01 or more persons per room are difficult to explain. The expected signs are positive and in fact, the simple correlations between this variable and the dependent variables are positive.[1] A possible explanation is that in these property classes crowded housing, ceteris paribus, means high property values, and thus this variable may be picking up a market value related effect.

In summary, although much of the preceding discussion is concerned with the differences between the results

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[1]The simple correlation between the dependent variable and the density of housing units with 1.01 or more persons per room is .32 in the two-family sample and .41 in the three-family sample.

of multiple family estimation and single-family estimation, the existence of general consistency between the estimated results is not denied. The results of single-family and multiple family estimation demonstrate many of the same relationships between assessment-to-market value ratios and the independent variables. For instance, the price change variable is negatively related to assessment ratios. The Negro variable, poor housing conditions variable, and structure size variable are all positively related to assessment ratios. There is also evidence of a negative relationship between market value and the assessment-to-market value ratios although this evidence is not as clear as that for the other variables. Even though the lot size variable lacks significance in all but one equation, its results do not contradict the single-family results.

D. Individual Property Model

Most of the hypotheses of Chapter II are directed at explaining variations in neighborhood assessment-to-market value ratios. However, not all of the neighborhood variation is necessarily caused by assessment behavior which is associated only with neighborhood characteristics. In fact, the discussion in Chapter II suggests several aspects of assessment behavior which may be a function of individual property assessment decisions as opposed to neighborhood assessment decisions. In order to investigate individual property assessment behavior, an individual property assessment behavior model is estimated. This model was developed in IV.C., and its final formulation is reproduced below:

$$\text{(IV.8)} \quad \frac{(a_t/p_t)_{ij}}{(A_t/P_t)_i} = \gamma_0 + \gamma_1 \left(\frac{n_{ij}}{N_i}\right)_1 + \gamma_2 \left(\frac{n_{ij}}{N_i}\right)_2 + \dots ,$$

where $(a_t/p_t)_{ij}$ is the assessment-to-market value ratio on the j^{th} individual property in the i^{th} neighborhood; $(A_t/P_t)_i$ is the average ratio in the i^{th} neighborhood; $(n_{ij}/N_i)_1$ represents characteristic 1 as the ratio of that characteristic for the j^{th} individual property in the i^{th} neighborhood to the average of that characteristic in the i^{th} neighborhood, etc.. The estimation of the above is based on observations of single-family property characteristics.

1. Variables of the Model

Ideally, in this model one would like to test each of the variables used in the neighborhood model. Unfortunately, this is not possible. Only three independent variables are available on an individual property basis. A discussion of the expected relationship of each variable to the dependent variable accompanies the description of each of these three variables, which is given below.

Structure Size and Lot Size

The discussion of V.C.1.b. presents several reasons for expecting variations in neighborhood assessment ratios to be associated with variations in the average structure and lot sizes of neighborhoods. One reason is that with respect to individual properties there may be systematic errors in assessments due to the improper weighting of structure and lot size characteristics in the assessment process. The results of tests of these variables in the neighborhood model show that both variables are significant and positively related to assessment-to-market value ratios. What the neighborhood results do not show, however, is whether or not these positive relationships are due to systematic assessment errors made on individual properties or to relevant neighborhood characteristics which are associated with these variables. Systematic assessment errors can cause a positive or a negative effect. The associated neighborhood characteristics suggest positive relationships. Thus, the observed positive relationships are consistent with both effects. The testing of both these variables in the individual property model should help to determine whether or not there are systematic assessment errors, and if there are, what their effects are on assessment-to-market value ratios. For example, if on an individual property basis the results indicate a negative relationship between structure size and assessment-to-market value ratios, then the observed positive neighborhood relationship must be due to neighborhood factors.

Market Value

There are two reasons to expect market value to be a significant variable in the individual property model. First, the discussion of assessment behavior in II.A. suggests that the benefit principle may influence individual property assessment decisions. The hypothesis holds that within any given neighborhood the assessor may assume that benefits are evenly distributed and therefore attempt to equalize tax burdens with respect to total tax bills. To the extent that this is true, market value ought to be negatively related to individual assessment-to-market value ratios within neighborhoods.

The existence of an assessment lag effect is a second reason to expect market value to be negatively related to assessment-to-market value ratios. Since there is no price change variable in the individual property model, the market value variable will tend to pick up the assessment lag effect. The likelihood of this actually occurring is very great considering the strong evidence of an assessment lag effect which is revealed by the neighborhood model.

2. A Problem in Estimation

The sampling method used in gathering data creates an estimation problem with regard to the individual property model. As previously indicated, a random sample of data was not collected. Instead, in the later of two collection periods only those properties which turned over during the period between 1959 and 1961 were sampled. Thus, the proportion of properties sampled in each part of the city is not necessarily equal. Areas with higher turnover rates are represented by a disproportionately large number of observations. Consequently, regression results based on this unevenly weighted sample will be biased in a direction which reflects the experience of properties in the more heavily weighted areas.[1]

A possible solution to this problem is to delete at random observations from those areas which are weighted too heavily. A likely goal in a deletion process would be to make the number of observations in each area proportional to the number of properties of a particular type within the area. A regression using this reduced sample would be more likely to reflect the experience of a typical property.

No weighting correction, however, is made in this study. A precise estimation of regression coefficients is

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[1]A similar, though less important, weighting problem exists with regard to the neighborhood model to the extent that census tracts containing residential property with an insufficient number of property transaction observations were excluded from the sample. However, attempts were made to minimize the number of such census tracts by undertaking more intensive sampling in areas with relatively infrequent transactions. The fact that the number of recorded transactions in each census tract is not equal is unimportant because the purpose of the neighborhood model is to explain variations among regions and not among typical individual properties in different regions.

not particularly important for the purposes of this study. It is considered unlikely that the biases are great enough to either alter the signs of the coefficients or to significantly change the identification of significant variables.

3. Estimation of Single-Family Individual Property Assessment-To-Market Value Ratios

Given the specific variables which are to be tested in the individual property model, equation (IV.8) can be rewritten as,

$$\text{(V.4)} \quad \frac{(a_t/p_t)_{ij}}{(A_t/P_t)_i} = \gamma_0 + \gamma_1 \left(\frac{p_{ij}}{P_i}\right) + \gamma_2 \left(\frac{l_{ij}}{L_i}\right) + \gamma_3 \left(\frac{s_{ij}}{S_i}\right) .$$

For individual properties $(a_t/p_t)_{ij}$ is the assessment-to-sale value ratio, p_{ij} is the market value, l_{ij} is the lot size, and s_{ij} is the structure size. The corresponding capitalized symbols are the neighborhood averages. Equation (V.4) is estimated with a data sample which is considerably greater than that of the neighborhood model. Whereas the neighborhood model uses observations on single-family properties from 86 different areas, this model uses observations on 1922 properties within the same total area.

The first three regression equations in Table 7 are estimates of equation (V.4). The equations differ only with respect to the samples used in estimation. Equation (7.1) is based on the total sample, and equations (7.2) and (7.3) are based on observations from predominantly white and non-white neighborhoods respectively. The dividing line between the last two samples is drawn at exactly the same point as in the neighborhood model. There are 1777 white observations and 145 non-white observations.

The entries in Table 7 for the first three regressions are slightly different from those of other regressions. Because the means of all the variables in the first three equations are equal to one, their elasticities and regression coefficients are equivalent. Thus, only one entry is made for each variable. Moreover, although the variables in the first three equations are all ratios, the elasticity of the numerator of the dependent variable with respect to the numerator of any independent variable is also equal to the coefficient which is entered in Table 7.[1]

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[1]The elasticity of $(a_t/p_t)_{ij}$ with respect to $(n_{ij})_1$ is defined as $(n_{ij})_1/(a_t/p_t)_{ij} \times \partial(a_t/p_t)_{ij}/\partial(n_{ij})_1$. In this case where the relationship is

$$\frac{(a_t/p_t)_{ij}}{(A_t/P_t)} = \gamma_0 + \gamma_1 \left(\frac{n_{ij}}{N_i}\right)_1 + \ldots ,$$

and

$$\frac{\partial(a_t/p_t)_{ij}}{\partial(n_{ij})_1} = \gamma_1 \frac{(A_t/P_t)_i}{(N_i)_1} ,$$

the elasticity, $E(a/p,n_1)$, is written

$$E(a/p,n_1) = \gamma_1 \frac{(A_t/P_t)_i}{(N_i)_1} \times \frac{(n_{ij})_1}{(a_t/p_t)_{ij}} .$$

If $E(a/p,n_1)$ is evaluated at the point of the means, $(A_t/P_t)_i/(a_t/p_t)_{ij} \simeq 1$, and $(n_{ij})_1/(N_i)_1 \simeq 1$. Therefore, $E(a/p,n_1) = \gamma_1$. The ratios of the means are not exactly equal to one because each neighborhood does not contain the same number of observations.

The regression results of Table 7 indicate that the statistical tests for all of the equations are highly significant. The t-statistic on each variable is significant at the .01 level, and the F-statistic of each regression is significant above the .01 level.

The regression results of Table 7 also indicate that the independent variables of the individual property model explain a rather low proportion of the total variation in deviations of individual property assessment ratios from the average assessment ratio in each neighborhood. Equation (7.4) is a neighborhood model regression with the same three independent variables, although not in ratio form, that are used in the individual property model. The coefficient of multiple correlation of equation (7.4) is over three times as large as that of equation (7.1). However, this difference in the proportion of variance explained is to be expected. The individual property model is attempting to explain variations in assessment ratios on individual properties within neighborhoods. No attempt is made to explain the variations among individual properties in different neighborhoods.

There are at least two reasons for the large proportion of unexplained intra-neighborhood variation, and these reasons need not be mutually exclusive. First of all, the three explanatory variables used in the regression provide a rather incomplete physical description of a piece of property. For example, besides the lot size and the number of stories in a structure, the total floor space and the number of rooms are probably important. There may also be a distinction made between owner-occupied and renter-occupied properties. Secondly, measurement errors, imperfections in the residential housing market, and non-systematic assessment errors probably cause considerable noise in this model.

Market Value

As expected, equation (7.1) shows that the estimated partial correlation coefficient between market value and the dependent variable is highly significant and negative. Moreover, the elasticity of the market value variable in equation (7.1), -.428, is about the same size as that estimated by the comparable neighborhood model, equation (7.4), -.398. This similarity of elasticities suggests that the cause of the market value discrimination is fundamentally an individual property phenomenon. If there were important neighborhood effects with respect to price discrimination, one would expect the neighborhood elasticity to be larger than the individual property elasticity.

Thus, the market value effect which is observed in the neighborhood model may only be reflecting an individual property phenomenon. As stated earlier, there are two possible causes of the individual property effect: assessment lags and the application of a benefit principle. The fact that in the neighborhood model assessment lags are taken into account by the price change variable and the market value variable is still significant and negative suggests that the cause of this negative effect in the neighborhood model is the application of an individual property benefit principle.

Because the above argument is based on the similarity between elasticity estimates, it should not be given very high significance. The estimated coefficients of the individual property model in particular are of questionable accuracy because of the weighting problem which was discussed earlier. Given the possible margin of error, these results may still be consistent with the existence of both an individual property and a neighborhood market value effect.

<u>Structure Size and Lot Size</u>

Both the lot size and the structure size variables are significant in equation (7.1), and they both enter the regression with the same positive signs as in the neighborhood model. These results suggest rather strongly that systematic assessment errors are made in connection with these two individual property characteristics. Furthermore, it seems very likely that these individual property effects are reflected in the results of the neighborhood model.

A comparison of the estimated elasticities of lot size and structure size of the individual property model with the neighborhood model indicates that the neighborhood structure size elasticity is substantially larger. This implies that structure size in the neighborhood model is explaining more than just the systematic assessment errors of individual properties. This implied result is fully consistent with the evidence gained from the investigation of the neighborhood model which suggests that the neighborhood structure size variable is standing in for several important neighborhood characteristics.

A Comparison Between White and Non-White Areas

In general, the results of Table 7 indicate that assessment behavior with respect to individual properties is about the same in both white and non-white areas. When the sample is divided between white and non-white areas, the estimations of the individual property model, equations (7.2) and (7.3), do not show much variation. All three variables are highly significant in both cases, and the sign patterns are the same.

The relative magnitudes of the estimated structure size coefficients are the only source of substantial variation between equations (7.2) and (7.3). The larger non-white estimate shown in equation (7.3) is consistent with the relatively larger structure size coefficient which is estimated by the non-white neighborhood model. In both cases it is difficult to understand why this occurs. Perhaps, the assessor simply overestimates the contribution of structure size to market value to a greater extent in non-white areas than in white areas.

E. Another Test

The empirical results obtained from testing the assessment behavior model developed in this study leaves an important issue unresolved. From the results it is not possible to distinguish between two of the broad types of explanation for assessment ratio variation which have been suggested: deliberate use of neighborhood characteristics to achieve policy objectives and inadvertent mis-estimation of market value by failure to take neighborhood characteristics into account. Since the results are consistent with both explanations, it is not possible to reject either hypothesis.

There is, however, one further test which may help to disentangle these two hypotheses. Suppose that assessment ratio variation is caused solely by errors in estimating market value resulting from giving exclusive attention to individual property characteristics and neglecting neighborhood influences on market value. If this were the case, then the <u>level</u> of assessment (the numerator of the assessment-to-market value ratio) is determined only by individual property characteristics. Thus, if a regression of the assessment level variable on the independent variables of the neighborhood model indicates that individual property characteristic variables are significant and neighborhood variables are insignificant, then the hypothesis that there is a deliberately discriminatory assessment policy according to neighborhood characteristics can be rejected. On the other hand, if both individual property and neighborhood variables are significant, this hypothesis cannot be rejected.

Unfortunately, the ability of this test to reject the deliberate discrimination hypothesis, even if it is correct, is diminished by the fact that the neighborhood characteristics are, of course, correlated with market value. Therefore, they are likely to be significant even if they do not enter into the assessor's calculation. In addition, the results will be confused by the possibility that the two individual property variables, structure and lot size, may themselves reflect important neighborhood characteristics. Nevertheless, although it is unlikely that this test will yield any new information, it is undertaken because it does have the potential power to reject one of the two hypotheses.

The equation which is tested with single-family property data is written

$$(V.5) \qquad (A_t) = \delta_0 + \delta_1 N_1 + \delta_2 N_2 + \ldots,$$

where the N's are most of the same variables which are tested in the neighborhood assessment ratio model. The dependent variable, A_t, is 1960 average single-family assessment. The observational units are census tracts.

Two of the N's, single-family structure and lot size, are individual property variables. The rest of the N's are neighborhood variables: Negro density, Italian density, Irish density, density of deteriorated and dilapidated housing units, density of single-family housing units, density of housing units built before 1939, and density of housing units with 1.01 or more persons per room. The market value of single-family properties is not included as an independent variable because it clearly represents both individual property and neighborhood characteristics. It would certainly be highly significant in a regression of equation (V.5) even if none of the neighborhood variables were significant, its presence in the regression would not allow a rejection of the deliberate discrimination hypothesis. Because of the high correlation of median family income with market value, it is also excluded from the regression.

Regression results are shown in Table 8, and, as equation (8.1) indicates, all variables are significant. Both individual property characteristics and neighborhood characteristics have a significant effect upon assessment levels. Given the relatively high fraction of the total variance in assessment levels which equation (8.1) explains (R^2 = .74), these results are simply additional evidence that a deliberately discriminatory assessment policy is being followed and/or assessors are inadvertently mis-estimating market value.

CHAPTER VI

Intertemporal Study

The preceding discussion has been almost exclusively devoted to an examination of assessment behavior at one point in time, 1960. This chapter focuses on changes over time in both assessment behavior and effective tax rate patterns. The specific time period examined is 1950 to 1960.

The 1950 to 1960 time period is particularly interesting because it is marked by greatly increased demands on Boston's property tax resources. Total property tax revenue rose during these 10 years by approximately 64%. Per capita tax levies jumped from $112 to $212. Although the nominal tax rate rose from $63 to $100 per one thousand dollars of assessed valuation, the effective tax rate increases were somewhat less severe. The general decline in assessment-to-market value ratios partially offset the steep nominal tax rate increase. The net result of the nominal tax increase and the assessment ratio decreases were effective tax rate increases of 3.3% to 4.0% on single-family properties, 3.6% to 4.1% on two-family properties, 4.3% to 5.1% on three-family properties, and 5.6% to 6.4% on four-family-and-over properties.

As stated above, two different aspects of assessment practices are investigated in this section. First, 1950 assessment behavior is analyzed and compared to results of the preceding investigation of 1960 assessment behavior. The purpose of such a comparison is to determine whether or not any discernable changes in assessment behavior occurred over the 1950 to 1960 period. Second, the 1960 cross-sectional distribution of effective tax rates is compared to the 1950 cross-sectional distribution. The purpose of this second part of the investigation is primarily descriptive. The intertemporal comparisons are made in order to reveal changes in the consequences of assessment practices rather than to identify fundamental changes in assessment behavior.

A. Assessment Behavior Comparison

The method of investigating 1950 assessment behavior is almost exactly the same as that used in Chapter V to examine 1960 assessment behavior. The assessment behavior model which is developed in Chapter IV is estimated by ordinary least squares using a 1950 cross-section of single-family property data. The relationship which is estimated is reproduced below:

$$\text{(IV.7)} \quad (A_t/P_t) = \beta_0 \Delta P + \beta_1 F\ \Delta P + \alpha_0 + \alpha_1 N_1 + \alpha_2 N_2 + \dots .$$

Both the 1950 and 1960 estimations of the above equation are presented in Table 9, by (9.1) and (9.2) respectively. The 1960 estimation of (IV.7) was, of course, presented earlier by regression (3.1), however, it is repeated in Table 9 in order to facilitate the 1950-1960 comparison. Also, regression (9.2) is based on a sample size of 86 while regression (9.1) uses only 81 observations. Five 1950 observations had to be dropped because 1940 estimates of market value are not available for them.[1]

A comparison of regressions (9.1) and (9.2) indicates that there are both similarities and differences between 1950 and 1960 assessment behavior. Although price change is a significant negative influence on assessment ratios in 1950 as well as in 1960, the absolutely larger 1950 price change coefficient suggests that the assessment mechanism responded more quickly to price changes which occurred between 1940 and 1950 than it did to price changes which occurred between 1950 and 1960.[2]

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[1]The 1940 estimates of market value are necessary in order to generate the $\Delta P/P$ variable.

[2]A zero value for the coefficient of $\Delta P/P$ indicates perfect adjustment. The speed of adjustment is slower the further the coefficient of $\Delta P/P$ is below zero.

The magnitudes and signs of the structure size, lot size, and market value variables are roughly consistent between the 1950 and 1960 regressions.

On the other hand, the racial effect and the effect of deteriorated and dilapidated housing, both of which are very important in 1960, are not significant in 1950. Also, the significance of the Irish density variable in equation (9.1), although it is not very highly significant, suggests the existence of an Irish ethnic effect in 1950. For single-family property estimation in 1960, the Irish density variable is significant only under a few special conditions.[1] Notice that in these instances where the explanation differs the most there have been relatively large differences in the mean values of the variables. This suggests that the changes in the quantitative importance of these variables over time may have caused a change in assessment behavior with respect to these variables. Such a reaction is certainly possible, especially in the case of the Negro, and deteriorated and dilapidated housing variables.

There also is one overall difference between equations (9.1) and (9.2). A greater proportion of the total variation in single-family assessment-to-market value

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[1]The single-family regressions in which the Irish density variable enters significantly are (3.5), (4.1), and (4.2).

ratios is explained in 1960 than in 1950. This occurs even though there is substantially more variation in the 1960 ratios than in the 1950 ratios.[1] This relatively low 1950 R^2 suggests that there may be an important aspect of assessment behavior in 1950 which is not represented by the independent variables included in the model. In addition to this possibility, it is also possible that assessors estimated market value more precisely in the earlier period by responding more accurately to neighborhood externalities. Evidence that the speed of response to price changes was faster in the earlier period tends to support this explanation because it indicates that in the earlier period market value was a relatively more important determinant of assessments. Moreover, to the extent that intentional discrimination was a less important force in the assessment process in the earlier period, the neighborhood variables would also be expected to explain a smaller proportion of the observed variation.

B. Comparison of the Effects of Assessment Practices

The preceding comparison of 1950 to 1960 assessment behavior suggests that there probably are some important differences between the 1950 and 1960 distributions of effective tax rates. The purpose of the present

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[1]The coefficient of variation of assessment-to-market value ratios in 1960 is .32; in 1950 it is .18.

section is to determine how the characteristics of neighborhoods with differentially high or low effective tax rates have changed between 1950 and 1960. An attempt is made to describe the differences between 1950 and 1960 effective tax rate distributions with respect to several interesting neighborhood characteristics: racial and ethnic composition, general housing conditions, and median family income.[1] By using ordinary least squares regression analysis, the partial correlation coefficients between the variables representing neighborhood characteristics and effective tax rates can be estimated.

One way to compare the effective tax rate distribution of 1950 to that of 1960 is to attempt to explain the variations in assessment-to-market value ratios in both 1950 and 1960 by variations in neighborhood characteristics. Thus, the following equation is estimated with 1950 and 1960 census tract data:

(VI.1) $$A_t/P_t = \alpha_0 + \alpha_1 N_1 + \alpha_2 N_2 + \ldots .$$

The dependent variable is single-family assessment-to-market value ratios. The independent variables represent five neighborhood characteristics: Negro density, Irish density, Italian density, density of deteriorated and

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[1]The price change variable is omitted from the regression because no attempt is made to explain <u>why</u> the rates vary but simply to describe <u>how</u> they vary.

dilapidated housing, and median family income. Observational units are census tracts, and the sample size is exactly the same as that used in the estimation of the assessment behavior model.

The 1950 and 1960 estimations of equation (VI.1) are shown by equations (9.3) and (9.4) respectively. The sign pattern of the independent variables in (9.3) and (9.4) indicates that in both 1950 and 1960 Negro neighborhoods are likely to have differentially high effective tax rates and that Irish and Italian neighborhoods are likely to have differentially low effective tax rates. In addition, effective tax rates are negatively related to median family income in both periods.

There also are at least two interesting differences between regressions (9.3) and (9.4). First, the estimated partial correlation coefficient and the elasticity of the Negro density variable are considerably smaller in the 1950 regression. Moreover, the t-statistic of the Negro density variable is much lower in 1950 compared to 1960. Secondly, a comparison between 1950 and 1960 of the Italian and Irish variables shows that the extent of preferred tax treatment of Italian and Irish neighborhoods has declined. Thirdly, the estimated coefficient of the housing condition variable in 1950 is not only barely significant, but its sign is different from what it is in the 1960 regression. Thus, it appears from these results that between 1950 and 1960 there probably was an increase in effective tax rate discrimination against Negro neighborhoods and against neighborhoods with relatively poor housing conditions, and a decrease in effective tax rate discrimination in favor of Italian and Irish neighborhoods.

A more direct method of describing possible changes in the distribution of effective tax rates is to measure the changes in effective tax rates in each neighborhood and to explain the variation in these changes by variations in neighborhood characteristics. In order to measure effective tax rate change, the percentage deviation of each observation's assessment-to-market value ratio from the mean assessment-to-market value ratio of these two deviations is calculated for 1950 and 1960. The difference of these two deviations is used as a measure of the 1950-1960 change in the relationship of each observation's effective tax rate to the mean effective tax rate of the sample.[1] For example, if a particular observation has an

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[1] $\Delta t_i =$

$$\left[\left(\frac{(A/P)_{i5} - (\overline{A/P})_5}{(\overline{A/P})_5}\right) - \left(\frac{(A/P)_{i6} - (\overline{A/P})_6}{(\overline{A/P})_6}\right)\right] \times 100,$$

where Δt_i is the value of the dependent variable for the i^{th} observation, $(A/P)_{i5}$ and $(A/P)_{i6}$ are the effective tax rates for the i^{th} observation in 1950 and 1960 respectively, and $(\overline{A/P})_5$ and $(\overline{A/P})_6$ are the mean effective tax rates in 1950 and 1960 respectively.

effective tax rate which is 10% below the mean in 1950 and 30% below the mean in 1960, the measure of effective tax rate change would equal +20%, i.e., there would be a 20 percentage point improvement for the observation in terms of the relationship of its tax rate to the mean tax rate.

In order to determine how changes in effective tax rates are distributed, the following equation is estimated:

$$\text{(VI.2)} \qquad \Delta t = \psi_0 + \psi_1 N_1 + \psi_2 N_2 + \ldots ,$$

where Δt is the measure of effective tax rate change and the N's are the same collection of variables described in connection with equation (VI.1).

Equation (9.5) shows the results of the estimation of equation (VI.2).[1] Both the Negro density and the housing condition variables are highly significant in regression (9.5). Their negative signs indicate that in Negro areas and in areas of poor housing conditions effective tax rates tended to move upward with respect to the mean tax rate of the sample. Such a result is consistent with the implications of the comparison of regressions (9.3) and (9.4) and provides further evidence that the change in assessment behavior which is observed during the 1950's caused definite changes in the incidence of

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[1]Elasticities are not calculated for this regression because the mean of the dependent variable is about equal to zero.

effective tax rates with respect to certain population and housing characteristics.

One factor which may have contributed to the observed change in the distribution of effective tax rates is, of course, a change in relative cross-sectional neighborhood assessment levels. A way to test the influence of this factor is to attempt to estimate how the effective tax rate would have been distributed in 1960 if assessment levels had not changed during the 1950 to 1960 period. The relationship which is estimated is written as,

$$(VI.3) \qquad (A_5/P_6) = \phi_0 + \phi_1 N_1 + \phi_2 N_2 + \ldots .$$

Since the numerator of the dependent variable of this equation is the 1950 assessment level and the denominator is the 1960 level of market value, the dependent variable is the effective tax rate which would have existed in 1960 if, with prices changing, assessments had remained unchanged at their 1950 levels. The estimated partial correlation coefficients show how the hypothetical pattern of effective tax rates would have been distributed.

The estimation of (VI.3) is shown by equation (9.6). The considerably smaller estimate of the Negro density coefficient in (9.6) compared to (9.3) indicates that effective tax rate discrimination against Negro areas would have been less severe if the assessor had simply maintained the 1950 assessment levels through

1960. This result is also consistent with the other results of this section which show a marked increase in the degree of effective tax rate discrimination against Negro areas during the 1950's.

CHAPTER VII

Summary of Findings and Conclusions

The purpose of this study is to describe the pattern of effective residential property tax rate variation in the City of Boston and to attempt to determine possible causes of the observed pattern. Important findings related to each of these two objectives are summarized below in A. and B.. These summaries are followed by a discussion of some general conclusions and then a policy suggestion.

A. The Nature of Effective Property Tax Rate Variation

With respect to the overall nature of effective rate variation, it is clear that the variation is systematic. Although a random element must also contribute to the variation, there is very convincing evidence of many different kinds of substantial systematic variation.

Effective tax rate variation according to different types of property is perhaps the most obvious kind of variation. Both 1950 and 1960 data indicate that effective tax rates tend to increase with the number of families occupying any given structure. For instance, in 1960 as the number of families per structure increases, the assessment-to-market value ratio progressively increases to over 80% the size of the assessment-to-market value ratio on single-family properties. This variation by property type is observed not only in the city as a whole but also within individual census tracts with only a few insignificant exceptions.

What limited data there are on properties with newly constructed buildings suggest that these properties are likely to be assessed at a higher fraction of market value than other residential properties occupied by the same number of families. In 1960 newly constructed single-family properties had assessment-to-market value ratios which were on the average about 15% - 20% higher than other single-family properties. However, it should be emphasized that the sample of new construction is unsatisfactory in several respects.

The remainder of the findings relevant to describing the nature of effective rate variation are produced by regression analysis. The primary purpose of most of the regression analysis is to identify the causes of effective tax variation. A few other regressions are performed for the sole purpose of obtaining information about the nature of effective rate variation. The results from the first group of regressions also provide useful information about the nature of the variation, and they are summarized in the following pages. The additional information gained from the second group of regressions is summarized in the last part of this section.

Regression results clearly indicate that there is a highly significant relationship between the average rate of neighborhood property value inflation and effective tax rates. The relationship is a negative one, and it is observed in all the tests involving data from each of the property type classifications. It is estimated that if there had been no change in property values between 1950 and 1960, assessment ratios on single-family properties in 1960 would have averaged about 18% greater than they did.[1] Findings from 1950 data indicate the same kind of relationship between the rate of property value inflation and effective tax rates although the extent of the discrimination against neighborhoods with relatively less rapid rates of property value inflation was probably somewhat less severe in 1950.

Effective tax rate discrimination against neighborhoods with relative high Negro population densities is clearly evident. Assessment ratios on single-family

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[1]This does not imply that effective tax rates would also have been 18% higher in 1960 because rises in nominal tax rates would certainly have been less than they were. It is unlikely that the 1960 average city-wide effective tax rate under conditions of perfect assessment adjustment would have been much different from what it actually was in 1960.

properties in neighborhoods with the highest Negro population densities are on the average 27 percentage points, or over 70%, greater than in the rest of the city. Within the framework of a regression equation, it is estimated that about 17 percentage points of the total 27 percentage point spread is accounted for by certain characteristics of high density Negro areas which are associated with differentially high assessment-to-market value ratios in the rest of the city. Nevertheless, *ceteris paribus*, about 10 percentage points of the total spread appears to be related only to neighborhood racial composition. Data on two-family and three-family properties display this same general result. The one significant exception to these findings is produced by the four-family-and-over sample in which Negro densities are not found to be significantly related to effective tax rates. Although limited tests of 1950 data also fail to reveal a significant relation between assessment ratios and Negro densities, this is not necessarily inconsistent with the 1960 findings. Instead, the 1950 finding suggests that effective tax rate discrimination against Negro neighborhoods may be a relatively new phenomenon.

Findings on other population characteristics, Italian and Irish densities, are rather inconclusive. Although there is some evidence of a negative relationship between these two characteristics and effective tax rates, in all but one regression the statistical significance of the relationship is very low.

Another kind of effective tax rate variation is indicated by the regression results on three rather highly correlated neighborhood characteristics: mean family income, density of deteriorated and dilapidated housing units, and average property market value. Properties in neighborhoods which have relatively high densities of deteriorated and dilapidated dwellings, or low family incomes, or low property market values tend to be assessed at higher fractions of market value than properties in other areas. Moreover, to the extent that neighborhoods exhibit more than one of these three characteristics, which is fairly common, effective tax rate discrimination against them is even greater. These general findings are supported by the results of every regression based on both 1950 and 1960 data.

Effective property tax rates also appear to vary with respect to somewhat more specific neighborhood property characteristics: average structure size and average lot size. *Ceteris paribus*, as the average size of buildings increases and/or the average size of lots increases, assessment ratios tend to increase. Almost all of the regression results are consistent with this finding, and in most tests statistical significance is high.

Finally, there are several neighborhood characteristic variables which do not appear to be significant in the regression tests of the assessment behavior model. These variables represent housing unit age, the degree of crowding within housing units, single-family structure density and areal share, and the frequency of property transactions. Some evidence does suggest, however, that transaction frequency may be positively related to assessment ratios, i.e., properties in neighborhoods with rising property values and high average transaction frequencies tend to be assessed at higher fractions of market value than properties in neighborhoods with the same rate of price inflation but lower average transaction frequencies.

The previous findings on the nature of effective rate variation are produced by various tests of the assessment behavior model. Findings from a second group of regressions aimed solely at describing the nature of effective rate variation are generally consistent with the previous findings.[1] However, this second group of regressions does yield some additional information. First they provide

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[1]Because the purpose of these regressions is to identify interesting population and housing characteristics associated with assessment-to-market value ratios, no attempt is made to account for variations due to dynamic characteristics. Therefore, the price change variable, $\Delta P/P$, is excluded from these regressions.

somewhat stronger evidence of a negative, *ceteris paribus*, relation between both Italian and Irish densities and effective tax rates. Moreover, the findings indicate that the extent of preferential effective tax rate treatment in Italian and Irish neighborhoods declined between 1950 and 1960 while effective tax rate discrimination against Negro neighborhoods increased. Results also show that if the assessor had frozen assessments at 1950 levels, the extent of effective tax rate discrimination against Negro neighborhoods would have been less than it was in 1960. In addition, effective tax rates are found to discriminate to a greater extent against neighborhoods with high densities of deteriorated and dilapidated housing in 1960 than in 1950.

B. Causes of Effective Property Tax Rate Variation

We turn now to the findings which are relevant to the question of what causes the observed pattern of effective tax rate variation. In Chapter II three broad types of explanation are offered: deliberate use of assessments to achieve certain policy goals; inadvertent but systematic mis-estimation of market value; and failure to keep assessments up-to-date with changing market values. In the discussion which follows, findings relating to each of these types of explanation are summarized.

There is substantial evidence that the existence of lags in the assessment process is an important cause of effective tax rate variation. The coefficient of the variable representing the rate of inflation is negative and highly significant in regressions based on each property type classification of 1960 data and on 1950 single-family property data. In addition, evidence that properties with new construction tend to be assessed at differentially high fractions of market value also supports the assessment lag explanation. Although the findings on a transaction frequency effect are not very significant, they are consistent with this explanation. A comparison of the influence of inflation rates on assessment ratios in 1950 and 1960 indicates that the speed of assessment adjustment to price changes was probably faster in 1950 than in 1960.

Results also support the hypothesis that effective tax rates are deliberately discriminatory. Moreover, the findings do not rule out any of the several objectives of a discriminatory policy suggested in Chapter II. Again, these objectives are: application of a type of benefit principle; the minimization of political pressure; and the pursuit of certain social goals.

The observed neighborhood effective tax rate discrimination against multiple-family dwellings in neighborhoods with relatively poor housing conditions, low median family income, and low average property market value is what would be expected if a benefit principle of assessment is in fact employed, i.e., if assessments are designed so that tax collections reflect the city's cost of providing public services to each neighborhood. In addition, tests of the individual property model suggest that a slightly different type of benefit principle may cause the observed market value discrimination among individual properties.[1]

The importance of political factors in the assessment process is implied by the apparent ceteris paribus discrimination against predominantly Negro neighborhoods. This is well substantiated by almost every test of the assessment behavior model. Although the favorable tax treatments of Italian and Irish neighborhoods is of a very low level of significance, this is consistent with the existence of an assessment system which is vulnerable to political pressures.

Most of the findings which are consistent with either of the above two objectives of a deliberately discriminatory assessment policy are also consistent with the third possible objective, the pursuit of certain social goals. The observed Negro neighborhood effect may in part be caused by an effort to maintain a "desirable" racial balance. Both competition with suburbia for middle-to-

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[1]This kind of modified benefit principle results from the assessor's presumption that benefits from public expenditures are about the same for neighboring properties, and, therefore, tax bills (assessed valuations) ought to be similar.

upper income residents by allowing effective tax rates to fall in middle-to-upper income neighborhoods and/or discouragement of the physical deterioration of any "nice" neighborhood by means of favorable tax treatment can explain the general type of effective tax rate variation described above.

Like the other two broad types of explanations, a practice of unintentional systematic mis-estimation of market value can also explain much of the observed pattern of effective tax rate variation. If the assessor fails to take into account positive or negative influences on market value created by certain characteristics of the neighborhood in which the property is located, then one would expect to find the differentially high tax rates which are observed in low income neighborhoods containing very low quality housing of low market value.

Systematic assessment errors may also be made by improper weighting of individual property characteristics in the assessor's calculation of market value. With respect to this possibility, the findings show that properties with taller structures and/or larger lots tend to be assessed at differentially high fractions of market value. Such a result does not necessarily reflect incorrect value weighting with regard to these characteristics. Given the large impact which these two highly significant variables have on assessment-to-market value ratios, especially the structure size variable, it is very likely that they are representing neighborhood characteristics correlated with these individual property characteristics. Another possibility is that the assessment ratio variation by property type influences assessment ratios on properties of the same type and that the structure size and lot size variables are to some extent explaining this effect.[1]

C. Some General Conclusions

Although the findings of this study clearly identify assessment lags as an important cause of inequalities in effective property tax rates, the findings also indicate that assessment lags explain only part of the total variation. Another important part of the total variation is explained by either or both of two hypotheses: inadvertent mis-estimation of market value and intentional tax rate discrimination according to certain policy goals. However, because the same general group of results support both hypotheses, it is impossible to determine to what extent either or both hypotheses are correct.

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[1]For example, single-family properties may be assessed at higher fractions of market value when they are located among multiple-family properties which are generally assessed at higher fractions of market value than single-family properties; greater average neighborhood structure size would probably indicate such a situation.

Nevertheless, it is difficult to believe that the large amount of variation in effective tax rates which has persisted over at least a ten-year period is attributable only to the existence of assessment lags and the mis-estimation of market value.[1] These two explanations are similar in that they are based on a failure to achieve a desired goal of non-discriminating assessment according to market value. It is unrealistic to conclude that failures of such large magnitude would be allowed to persist for as long as ten years. In short, some part of the total variation must be attributable to an assessment policy of deliberate tax discrimination; otherwise, one is left with an implausible conclusion.

Also related to the evidence of persistent, systematic tax rate variation is the question of why the public has not pressed for greater tax rate uniformity. Either taxpayers are ignorant of the prevailing pattern of effective tax rates and of the magnitude of some of the tax rate differentials, or they are not motivated to complain effectively about the situation. In fact, both of these factors are probably partially responsible for the lack of interest in property tax reform. Assessment ratio

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[1]For example, data on the most homogeneous property type, single-family properties, show that in 1960 the mean ratio of assessed value to market value was .40, the standard deviation was .13, the highest ratio was .80 and the lowest ratio was .23.

information of the type presented in this study has never been published.[1] Although some taxpayers must have knowledge of individual cases of assessment ratio inequality, they are not likely to be aware of the widespread and systematic nature of the inequalities.

However, even if some idea of the nature of the inequalities were generally known, taxpayers may fear that change from *status quo* will raise their property tax bills. Since most taxpayers realize that their property is considerably underassessed in relation to its market value, it is possible that the differential between assessed valuation and market value is viewed as a potential source of increased taxation. In other words, although equalization of effective tax rates would create tax reductions equivalent to tax increases, taxpayers who are uncertain about their own prospects for gain or loss are likely to be reluctant to promote tax rate uniformity; their fear of increased tax liability is not offset by their chance of reduction.

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[1] Oldman and Aaron did publish similar though less detailed, statistics in 1963 which is after the period of time spanned by this study. It is interesting to note that their findings did not generate any noticeable agitation for reforms.

D. A Policy Suggestion

The results show that with respect to residential property in Boston actual assessment practices virtually ignore the clear intent of property tax law.[1] Given what is generally considered to be acceptable performance for other types of taxes, the extensive divergence from the legal requirement of effective tax rate uniformity is intolerable. In view of this obvious shortcoming of the existing assessment system, a fundamental change in overall assessment policy is needed. It is suggested that an effective effort to assess properties at the best estimate of their current market value would greatly improve the quality of assessment administration, i.e., reduce variation in effective tax rates.

Ideally, a change to current market value assessment would not only reduce the variation in effective tax rates but also would require any deliberate effective tax rate discrimination to be determined openly. The more or less secretive process by which assessment-to-market value ratios are now established would be abolished because the act of assessing would be clearly aimed only at the goal

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[1]For a discussion of legal requirements, see: "Inequalities in Property Tax Assessments: New Cures for Old Ill," Harvard Law Review, Vol. LXXV, May, 1962, p. 1376.

of current market value assessment. Any variations in effective tax rates which are deemed to be desirable, e.g., variations according to property type, housing conditions, etc., would have to be determined in the same way that nominal tax rates now are. Thus, variations established by a legislative process would be clearly evident to taxpayers.

Under the proposed current market value assessment process, some errors in assessments would be unavoidable. Current market value can only be estimated, except in cases where recent transactions have occurred. If sales data were frequently examined for evidence of new trends in market value and past assessment errors and if assessments were adjusted as quickly as possible to new market value estimates, errors in current market value appraisals would be minimized. Moreover, the establishment of a tax abatement mechanism readily available and well-known to all taxpayers would generate another source of information on the accuracy of existing assessments.

This study does not attempt to evaluate how well such a system would perform. Such an estimate would require information about the trade-off between improved assessment quality and the costs of assessment administration. In general, assessment administration cost is considered to be low.[1] However, regardless of what the actual costs are, within the present assessment administration budget, performance would certainly be improved simply by substituting the goal of current market value assessment for the factors which now influence assessments. Admittedly, accurate current market value assessments are not made any easier by the small fraction of properties which turn over each year. For instance, in Boston not more than 6% of all single-family properties are bought and sold each year.[2] Moreover, the problems of substantial heterogeneity and low turnover associated with current market assessment of commercial and industrial properties are even greater than for residential properties.[3] Only by examination of the procedures and organization of the assessment system itself is it possible to determine whether or not the property tax can be administered reasonably well at a moderate cost.

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[1]Dick Netzer, Economics of the Property Tax, pp. 174-175. In the City of Milwaukee where assessment quality is relatively high (The variance of assessment-to-market value ratios is low.), property tax administration costs are about 1.5% of total annual property tax revenue.

[2]U. S. Bureau of Census, Census of Governments: 1967, Vol. 2, "Taxable Property Values," Table 19.

[3]In Boston commercial and industrial properties accounted for 55% of the gross assessed value in 1966. Residential properties accounted for 41%. Ibid., Table 19.

APPENDIX A

Tables of Regression Results

<u>Key to Table 3</u>

$\Delta P/P$) Percentage average price change for single-family properties

N) Negro density

S) Average structure size for single-family properties (stories)

L) Average lot size for single-family properties (square feet)

D) Density of deteriorated and dilapidated housing units

P) Average market value for single-family properties

Y) Median family income

SFD) Density of single-family housing units

RD) Areal share of residential land use

A) Density of structures built before 1939

PPR) Density of housing units with 1.01 or more persons per room

IT) Italian density

IR) Irish density

TI) Transaction frequency term ($\Delta P/P$ x transaction frequency for single family properties)

The dependent variable is single-family assessment-to-market value ratios.

Key to Table 4

D1) Dummy variable for Negro census tracts with more than 10% Negro population

D2) Dummy variable for Negro census tracts with more than 30% Negro population

All other variables are defined as in Table 3.

Key to Table 5

T2) Transaction frequency for single-family properties

All other variables are defined as in Table 3.

Key to Table 6

Variables $\Delta P/P$, S, L, and P are redefined for two-family properties in equation (6.1), for three-family properties in (6.2), and for four-family-and-over properties in (6.3).

All other variables are defined as in Table 3.

Key to Table 7

p_{ij}) Market value of individual single-family properties

l_{ij}) Lot size of individual single-family properties

s_{ij}) Structure size of individual single-family properties

P_i) Same as P in Table 3

L_i) Same as L in Table 3

S_i) Same as S in Table 3

The dependent variable in regressions (7.1) - (7.3) is the ratio of individual property assessment ratios to census tract assessment ratios. The dependent variable in regression (7.4) is the same as in Table 3.

<u>Key to Table 8</u>

The dependent variable is the level of assessed valuation on single-family properties. All other variables are defined as in Table 3.

<u>Key to Table 9</u>

The independent variables are defined as in Table 3 where the subscripts, 5 and 6, refer to 1950 and 1960 measurements of the variables. The dependent variables in regression (9.5), Δt, is defined in footnote 1, page 142.

Table 3. Single-Family Neighborhood Model
Estimated Regression Coefficients[1]
[Elasticities]
(t-statistics)

Indep. Var. \ Equation	3.1	3.2	3.3	3.4	3.5	3.6	3.7	Mean Indep. Var.
Constant	14.89 (3.14)	24.27 (4.29)	20.54 (3.33)	47.22 (10.36)	53.28 (14.61)	28.70 (5.48)	32.99 (5.61)	
ΔP/P	- .200 [- .179] (-4.93)	- .208 [- .186] (-5.18)	- .208 [- .186] (-5.04)	- .252 [- .224] (-5.37)	- .247 [- .220] (-5.25)	- .189 [- .169] (-4.43)	- .197 [- .176] (-4.76)	35.39
N	.198 [.039] (4.82)	.183 [.036] (4.36)	.228 [.044] (5.77)	.240 [.047] (4.96)	.211 [.041] (3.56)	.236 [.046] (5.81)	.216 [.042] (-5.15)	7.72
S	7.043 [.695] (6.51)	6.00 [.593] (7.27)	8.08 [.800] (7.31)	—	—	5.62 [.556] (5.72)	4.70 [.470] (6.16)	3.92
L	.116 [.128] (2.88)	.098 [.108] (2.62)	.110 [.121] (2.67)	*	*	—	—	43.69
D	.097 [.046] (2.04)	.110 [.053] (2.47)	—	.145 [.069] (2.56)	.112 [.054] (2.27)	.090 [.043] (1.82)	.080 [.039] (1.79)	19.01

Table 3. (continued)

Equation / Indep. Var.	3.1	3.2	3.3	3.4	3.5	3.6	3.7	Mean Indep. Var.
P	- .343 [- .106] (- 2.01)	—	- .550 [- .171] (- 3.55)	.241 [.116] (1.46)	—	- .183 [- .569] (-1.10)	—	12.37
Y	—	- .143 [- .216] (-2.07)	—	—	*	—	- .124 [- .187] (-1.72)	59.95
SFD	*	*	*	- .106 [- .056] (-2.51)	- .097 [- .051] (-2.25)	*	*	21.0
RD	*	*	*	- .068 [- .070] (-1.60)	- .072 [- .073] (-1.66)	*	*	40.3
A	*	*	- .055 [- .126] (- 1.01)	*	*	- .063 [- .145] (-1.12)	*	91.5
PPR	*	*	*	*	*	*	*	8.03
IT	*	*	*	- .167 [- .032] (-1.94)	- .252 [- .049] (-2.82)	*	*	7.6

Table 3. (continued)

Indep. Var. \ Equation	3.1	3.2	3.3	3.4	3.5	3.6	3.7	Mean Indep. Var.
IR	*	*	*	*	- .153 [- .046] (-1.09)	*	*	11.8
T	*	*	*	*	*	*	*	.945
R^2 (F-stat.)	.81 (56.9)	.81 (57.1)	.80 (54.2)	.74 (32.2)	.74 (31.7)	.79 (51.2)	.80 (52.4)	
Mean Dep. Var. (Std. Error Est.)	39.6 (5.67)	39.6 (5.67)	39.6 (5.78)	39.6 (6.68)	39.6 (6.72)	39.6 (5.92)	39.6 (5.86)	

[1]Total observations: 86 for all regressions.

Table 4. Further Tests of Racial Composition
Estimated Regression Coefficients
[Elasticities]
(t-statistics)

Indep. Var. \ Equations	4.1	4.2	Mean Indep. Var.	4.3	Mean Indep. Var	4.4	Mean Indep. Var.
Constant	14.52 (2.79)	14.47 (2.90)		19.92 (4.42)		32.57 (1.06)	
ΔP/P	- .199 [- .178] (-4.33)	- .201 [- .179] (-4.80)	35.39	- .169 [- .192] (-3.92)	40.58	*	8.71
D1	6.75 (2.35)	—	—	—		—	
D2	—	10.27 (3.51)	—	—		—	
N	—	—		—	7.43	.179 [.132] (1.63)	43.6
S	7.71 [.765] (6.86)	7.63 [.755] (7.07)	3.92	5.80 [.561] (5.80)	3.83	17.05 [1.270] (2.96)	4.42

Table 4. (continued)

Equations / Indep. Var.	4.1	4.2	Mean Indep. Var.	4.3	Mean Indep. Var.	4.4	Mean Indep. Var.
L	.145 [.161] (3.41)	.135 [.148] (3.33)	43.69	.084 [.104] (2.55)	44.37	.429 [.303] (1.47)	40.20
D	.101 [.048] (1.95)	.113 [.054] (2.38)	19.01	.053 [.020] (1.22)	13.57	- .414 [- .326] (-1.15)	47.0
P	- .442 [- .138] (-2.40)	- .423 [- .132] (-2.39)	12.37	- .216 [- .081] (-1.53)	13.04	-6.06 [- .912] (-2.61)	8.93
Y	___	___	59.95	___	61.32	___	45.90
SFD	*	*	21.0	- .050 [- .031] (-1.51)	22.3	*	
RD	*	*	40.3	*		*	
A	*	*	95.5	*		*	

Table 4. (continued)

Equations / Indep. Var.	4.1	4.2	Mean Indep. Var.	4.3	Mean Indep. Var.	4.4	Mean Indep. Var.
PPR	*	*	8.03	*		*	
IT	*	*	7.6	*		*	
IR	- .171 [- .051] (- 1.57)	- .125 [- .040] (- 1.19)	11.8	*		*	
Observations	86	86		72		14	
R^2 (F-stat.)	.79 (42.8)	.81 (47.2)		.62 (17.8)		.78 (5.83)	
Mean Dep. Var. (Std.Error Est.)	39.6 (5.99)	39.6 (5.76)		35.8 (4.36)		59.5 (9.99)	

Table 5. Further Tests of Transaction Frequency Effect
Estimated Regression Coefficients
[Elasticities]
(t-statistics)

Equations / Indep. Var.	5.1	Mean Indep. Var.	5.2	Mean Indep. Var.
Constant	- 25.2 (- 3.38)		15.92 (3.65)	
$\Delta P/P$	*	- 12.17	- .128 [- .137] (- 2.69)	39.6
N	*	40.00	.161 [.021] (- 3.75)	4.87
S	14.13 [.968] (11.20)	4.77	6.06 [.631] (6.18)	3.85
L	1.03 [.465] (8.69)	31.47	.085 [.103] (2.35)	44.77
D	*	55.67	.083 [.035] (1.90)	15.8

Table 5. (continued)

Indep. Var. \ Equations	5.1	Mean Indep. Var.	5.2	Mean Indep. Var.
P	.862 [.089] (1.315)	7.21	- .264 [- .092] (- 1.78)	12.83
Y	___	44.27	___	61.34
SFD	*		*	
RD	*		*	
A	*		*	
PPR	*		*	
T2	- 9.53 [- .161] (- 11.72)	1.17	.100 [.695] (.334)	2.58
Observations	7		79	

Table 5. (continued)

Indep. Var. \ Equations	5.1	Mean Indep. Var.	5.2	Mean Indep. Var.
R^2 (F-statistic)	.99 (215.6)		.66 (19.5)	
Mean Dep. Var. (Std. Error Est.)	69.68 (1.42)		36.96 (4.87)	

Table 6. Tests on Other Property Types
Estimated Regression Coefficients
[Elasticities]
(t-statistics)

Equations / Indep. Var.	6.1 (Two-Family)	Mean Indep. Var.	6.2 (Three-Family)	Mean Indep. Var.	6.3 (Four-Family +)	Mean Indep. Var.
Constant	32.35 (4.67)		12.44 (1.15)		2.91 (.105)	
ΔP/P	- .267 [- .234] (- 7.14)	36.3	- .169 [- .109] (- 3.82)	33.2	- .083 [- .042] (- 2.02)	32.7
N	.078 [.014] (2.38)	7.62	.098 [.015] (2.30)	7.95	*	16.5
S	.426 [.402] (2.46)	3.90	11.98 [1.15] (5.24)	4.92	- 4.96 [- .455] (- 2.99)	5.81
L	*	47.36	.173 [.122] (2.62)	36.35	*	60.5
D	.238 [.094] (5.24)	16.37	.081 [.034] (1.99)	21.3	*	23.9

Table 6. (continued)

Equation / Indep. Var.	6.1 (Two-Family)	Mean Indep. Var.	6.2 (Three-Family)	Mean Indep. Var.	6.4 (Four-Family +)	Mean Indep. Var.
P	*	13.87	- 1.326 [- .327] (- 4.97)	12.7	- .120 [- .067] (-1.46)	36.08
Y	—		—		—	
SFD	*	21.2	- .063 [- .019] (- 1.311)	15.6	*	9.8
RD	*	44.0	*	42.9	*	33.8
A	*	90.96	*	92.94	.952 [1.44] (3.70)	97.3
PPR	- .280 [- .055] (- 1.57)	8.19	- .312 [- .055] (- 1.49)	9.01	1.88 [.223] (2.87)	7.66
IT	*	7.79	- .074 [- .015] (- 1.35)	10.7	- .249 [- .041] (-2.36)	10.7

Table 6. (continued)

Indep. Var. \ Equation	6.1 (Two-Family)	Mean Indep. Var.	6.2 (Three-Family)	Mean Indep. Var.	6.4 (Four-Family +)	Mean Indep. Var.
IR	*	12.36	- .141 [- .032] (- 1.33)	11.8	- .972 [- .109] (- 4.21)	7.2
Observations	79		85		40	
R^2 (F-stat.)	.78 (51.6)		.80 (30.4)		.77 (15.7)	
Mean Dep. Var. (Std. Error Est.)	41.46 (4.29)		51.48 (4.92)		64.37 (8.52)	

Table 7. Single-Family Individual Property Model
Estimated Regression Coefficients
(t-statistics)

Equations / Indep. Var.	7.1	7.2 (White)	7.3 (Non-White)	Mean Indep. Var.	7.4	Mean Indep. Var.
Constant	1.15 (31.97)	1.14 (31.76)	.550 (2.28)		- .081 (-1.40)	
$\frac{p_{ij}}{P_i}$	- .428 (-17.75)	- .417 (-16.87)	- .628 (-6.63)	1.0	—	
$\frac{l_{ij}}{L_i}$	.186 (12.80)	.197 (12.95)	.126 (2.73)	1.0	—	
$\frac{s_{ij}}{S_i}$	.134 (4.88)	.115 (4.23)	1.011 (4.47)	1.0	—	
P_i	—	—	—		- 1.20 [- .398] (- 8.04)	13.18
L_i	—	—	—		13.55 [.262] (4.51)	43.69

Table 7. (continued)

Indep. Var. \ Equations	7.1	7.2 (White)	7.3 (Non-white)	Mean Indep. Var.	7.4	Mean Indep. Var.
S_i	—	—	—		.237 [1.340] (10.86)	3.92
Observations	1922	1777	145		86	
R^2 (F-stat.)	.17 (128.9)	.17 (118.6)	.29 (19.4)		.63 (46.9)	
Mean Dep. Var. (Std. Error Est.)	1.0 (.30)	1.0 (.29)	1.0 (.35)		39.6 (7.79)	

Table 8. Single-Family Assessed Valuation[1]
Estimated Regression Coefficients
(t-statistics)

Equation / Indep. Var.	8.1	Mean Indep. Var.	Indep. Var.	8.1 (continued)	Mean Indep. Var.
Constant	.428 (.170)		IT	- .046 (- 1.91)	7.6
N	- .034 (-2.80)	7.72	IR	- .126 (- 3.77)	11.8
S	2.42 (9.12)	3.92	R^2 (F-stat)	.74 (28.19)	
L	.044 (4.27)	43.69	Mean Dep. (Std. Error Est.)	5.02 (1.47)	
D	- .026 (-2.19)	19.01			
SFD	- .002 (- .147)	21.0			
A	- .028 (-1.51)	91.5			
PPR	- .203 (-2.94)	8.03			

[1]Unlike all the other regressions based on census tract observations, the dependent variable here is the level of assessments, A_{60}.

Table 9. Intertemporal Comparisons
Estimated Regression Coefficients
[Elasticities]
(t-statistics)

Indep. Var. \ Equations	9.1 (1950)	9.2 (1960)	9.3 (1950)	9.4 (1960)	9.5 (Dep. Var., Δt)	9.6 (Dep.Var., A_5/P_6)	Mean Dep. Var.
Constant	23.95 (2.87)	14.89 (3.14)	86.45 (15.41)	45.12 (6.474)	1.80 (.153)	45.23 (5.05)	
$\Delta P/P_5$	- .108 [- .120] (-2.17)	—	—	—	—	—	62.53
$\Delta P/P_6$	—	- .200 [- .186] (-5.18)	—	—	—	—	35.39
N_5	*	—	.101 [.006] (1.22)	—	—	—	3.06
N_6	—	.198 [.036] (4.36)	—	.240 [.047) (3.79)	- .664 (-6.12)	.106 [.028] (1.03)	7.72
S_5	9.19 [.695] (5.56)	—	—	—	—	—	3.92

Table 9. (continued)

Equation / Indep. Var.	9.1 (1950)	9.2 (1960)	9.3 (1950)	9.4 (1960)	9.5 (Dep.Var., Δt)	9.6 (Dep.Var., A_5/P_6)	Mean Dep. Var.
S_6	—	7.04 [.593] (7.27)	—	—	—	—	3.92
L_5	.150 [.131] (3.46)	—	—	—	—	—	45.22
L_6	—	.116 [.108] (2.62)	—	—	—	—	43.69
D_5	*	—	- .095 [- .022] (- 1.19)	—	—	—	12.06
D_6	—	.097 [.055] (2.47)	—	.211 [.101] (3.66)	- .283 (- 2.64)	- .276 [.138] (3.73)	19.01
P_5	- .702 [- .120] (-2.83)	—	—	—	—	—	8.85
P_6	—	- .343 [- .216] (-2.07)	—	—	—	—	12.37

Table 9. (continued)

Indep. Var. \ Equation	9.1 (1950)	9.2 (1960)	9.3 (1950)	9.4 (1960)	9.5 (Dep.Var., t)	9.6 (Dep.Var., A_5/P_6)	Mean Dep. Var.
Y_5	—	—	- .996 [- .563] (- 6.08)	—	—	—	29.80
Y_6	—	—	—	- .111 [- .166] (- 1.15)	.225 (1.27)	- .125 [- .198] (-1.01)	59.95
IT_5	*	—	- .730 [- .034] (- 2.49)	—	—	—	2.56
IT_6	—	*	—	- .261 [- .050] (- 2.45)	*	- .272 [- .055] (-1.98)	7.60
IR_5	- .465 [- .036] (- 1.52)	—	- .401 [- .030] (- 1.07)	—	—	—	4.03
IR_6	—	*	—	- .230 [- .069] (- 1.47)	- .400 (-1.50)	- .318 [- .099] (-1.58)	11.80
R^2 (F-stat.)	.58 (20.6)	.81 (57.1)	.49 (15.5)	.63 (27.4)	.59 (29.2)	.47 (14.4)	
Mean Dep. Var. (Std.Error Est.)	52.0 (6.28)	39.6 (5.67)	52.6 (7.01)	39.6 (7.90)	0.01 (14.8)	37.9 (10.1)	

APPENDIX B

Correlation Matrix of Variables of the Neighborhood Model Single-Family

<u>Variables</u>:

1) Assessment-to-market value ratio
2) Price change
3) Negro density
4) Market value of single-family properties
5) Median family income
6) Structure size (height)
7) Lot size (square feet)
8) Density of deteriorated and dilapidated housing units
9) Density of housing units with 1.01 or more persons per room
10) Fraction of structures built before 1939
11) Fraction of total housing units which are contained in single-family structures
12) Density of residential land use
13) Italian density
14) Irish density
15) Multiplicative term, (transaction frequency) × (price change)

Correlation Matrix:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1)	1.00						
2)	-.69	1.00					
3)	.70	-.50	1.00				
4)	-.20	.34	-.20	1.00			
5)	-.48	.41	-.43	.72	1.00		
6)	.58	-.28	.26	.30	-.09	1.00	
7)	-.26	.29	-.03	.25	.27	-.51	1.00
8)	-.65	-.53	.53	-.52	-.59	.30	-.38
9)	.19	-.22	.17	-.59	-.59	-.13	-.14
10)	.24	-.14	.15	-.12	-.06	.39	-.34
11)	-.30	.14	-.16	.11	.44	-.42	.31
12)	-.07	-.06	.15	-.08	.07	-.29	.25
13)	-.28	.10	-.23	-.21	-.09	-.32	-.14
14)	-.35	.19	-.49	-.11	.30	-.22	.09
15)	-.38	.51	-.35	.30	.32	-.11	.24

Correlation Matrix:

	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1)								
2)								
3)								
4)								
5)								
6)								
7)								
8)	1.00							
9)	.40	1.00						
10)	.26	-.31	1.00					
11)	-.21	-.20	-.42	1.00				
12)	-.18	-.11	.06	.06	1.00			
13)	-.13	.13	.03	-.06	-.10	1.00		
14)	-.19	.01	-.02	.25	.15	-.25	1.00	
15)	-.40	-.30	.01	-.07	.16	.00	.25	1.00