AN EMPIRICAL ANALYSIS OF THE DETERMINANTS OF INTRAJURISDICTIONAL PROPERTY TAX PAYMENT INEQUITIES

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I. Introduction

The differential burden of local property tax payments has long been the focus of both popular and academic discussions. Previous empirical studies [Black (1972), Cheng (1970a, 1970b, 1976), Edelstein (1976), Engle (1965), Gloudemans (1977), Kochin and Parks (1980), Oldman and Aaron (1965), Paglin and Fogarty (1972), and Reinmuth (1976)] have primarily concentrated on measuring the existence of dispersion in local property tax burdens. This study goes beyond these studies by both measuring the existence of inequitable intrajurisdictional property tax burdens and using micro data to parameterize its determinants. A major finding of this paper is that over 90 percent of the variation in local tax burdens is purely random. The remaining variance is about equally associated with "honest errors" and socioeconomic characteristics reflecting political influence.

Section II develops a simple empirical methodology for evaluating the determinants of local tax assessment errors. The third section uses this methodology to evaluate the sources of Philadelphia's property tax inequities in 1978. The empirical findings are compared to several models of the assessment process in the fourth section of the paper. The paper concludes with a brief summary of the major results.

II. Measurement Methodology

The property tax payment for the i^{th} property (T_i) is determined by the interaction of the legally established tax rate (t) and the assessed property value (A_i)

$$T_i = tA_i \quad . \tag{1}$$

The assessed property value can be expressed most simply as a proportion (a_i) of the true market value of the property (V_i)

$$A_i = a_i V_i \quad . \tag{2}$$

The effective tax rate (R_i) is the ratio of tax payments to true market value and is expressed as

$$3) \qquad R_i \equiv \frac{T_i}{V_i} = ta_i \ .$$

Thus, if (as is generally the case) the legal tax rate is invariant within a taxing jurisdiction, intrajurisdictional variations in the effective tax rate are caused solely by deviations of the assessment factor from the average assessment factor ($\bar{a}$).

Non-uniform assessment factors may be induced through either systematic misassessment or random errors in the assessment process. Since the systematic bias in the assessment process may be associated with the characteristics of either the resident (C_i) or the property (H_i), the assessment factor can be expressed as the average assessment factor, plus the bias component, plus a zero mean random error (e_i)

$$4) \qquad a_i = \bar{a} + f(C_i, H_i) + e_i \ .$$

Substituting (4) into (3) yields

$$5) \qquad R_i = t[\bar{a} + f(C_i, H_i) + e_i] = t\bar{a} + tf(C_i, H_i) + u_i$$

where u_i is a zero mean random component. To more clearly focus on the issue of disproportionate effective tax rates, one can define the effective tax gap (GAP) as the difference between the actual effective tax rate and the jurisdictions's average effective tax rate,

$$6) \qquad GAP_i \equiv R_i - t\bar{a} = tf(C_i, H_i) + u_i = g(C_i, H_i) + u_i \ .$$

If GAP_i is positive the property is taxed disproportionately high, while GAP less than zero indicates a lower than average effective tax rate. Thus, the presence of intrajurisdictional inequities in effective local tax rates can be

parameterized for a taxing entity by estimating a regression of the effective tax gap versus measures of the characteristics of the residents and their residences using micro data. If measures of personal and housing characteristics prove to be insignificant regressors, then one cannot reject the hypothesis that effective assessment variations are random. Alternatively, significant regressors measuring resident or residence characteristics indicate that some portion (indicated by R^2) of intrajurisdictional inequities are the result of systematically biased assessments.

The economic loss for the i^{th} property resulting from its being relatively overassessed is simply the assessment gap times the true property value,

$$7) \qquad LOSS_i \equiv GAP_i \cdot V_i \ .$$

Since the property value is a reduced form function of the resident demand characteristics, the dollar loss associated with misassessments will be a function of both personal and housing characteristics

$$8) \qquad LOSS_i = L(C_i, H_i) + v_i$$

where v_i is a mean zero random error. Thus, if data exists to parameterize the differential effective tax burden equation, these factors can also be used to measure the magnitude of any induced wealth transfers.

III. Data Description and Empirical Results

The 1978 Annual Housing Survey for the Philadelphia SMSA was used to estimate linear approximations of (6) and (8). This sample contained 2428 useable observations (owner-occupied dwelling units with complete responses to all relevant questions) in the City of Philadelphia. Table 1 displays the

Table 1 - 1978 Philadelphia Sample Means

Resident Traits	
Age of Head	54.3
1 if Married	.67
1 if Male Head	.75
Family Size	3.0
1 if Head White	.79
Family Income	13,853
Residence Traits	
Number of Rooms	6.4
Number of Bathrooms	1.4
1 if Single Attached Unit	.90
1 if Must Go Through Bedroom To Get To Bathroom	.02
1 if Roof Leaks	.11
1 if Cracks In Walls Or Ceiling	.06
Age of Building	37.2
1 if Regular Exterminator Service	.06
1 if Property Improved In Last 12 Months	.23
1 if Local School Is Viewed Adequate	.76
1 if Local Police Protection Is Viewed Adequate	.83
1 if Garbage Collection Publicly Provided	.87
1 if Neighborhood Crime Is Viewed Bad	.18
1 if Neighborhood Traffic Is Viewed Bad	.26
1 if Local Public Transit Is Viewed Adequate	.83
1 if Local Streets In Need Of Repair	.17
1 if Local Nonresidential Activity Viewed Bad	.33
1 if Local Hospitals Are Viewed Adequate	.91

means for a variety of personal and housing characteristics which are employed in this study. Table 2 reports the sample statistics for: property tax payments (T_i), self-reported property value (V_i),[1] the effective tax rate (R_i), and the loss from overassessment ($LOSS_i$).

Since the measure of the effective tax rate employed here is the actual property tax payment divided by self-reported property value, any systematic bias in the owner's estimate of property value relative to true property value will induce bias. Since previous studies of these questions fail to demonstrate any such bias, self-reported property value is used here as an unbiased estimate of true property value.[2]

In order to calculate GAP_i, the sample's average effective tax rate ($\bar{ta}$ = .01625) was subtracted from each observation's effective tax rate (R_i). The finding of substantial variations in the effective tax rates in Philadelphia are consistent with previous studies of other cities. The distribution of GAP in Philadelphia was non-symmetric and skewed towards underassessment. In fact, 41 percent of the sample was relatively overassessed while the remainder were relatively underassessed.

Table 3 reports the mean relative overassessment rate and dollar loss for

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[1]Since property value is reported in bracket value form, the midpoint of the observation's bracket was treated as their property value. This process reduces efficiency by introducing measurement noise but does not induce inconsistent estimates. The analyses reported in the paper were also conducted using (alternatively) the highest and lowest interval values as the property value. However, since all substantive results are identical, only the midpoint results are reported in the text.

[2]Kish and Lansing (1954) find that the owners of single family units on the average overestimated the value of their homes by about 4%. Kain and Quigley (1972) indicate that owners on average underestimate the value of their homes by less than 2%, and that the difference is not statistically significant. Kain and Quigley also fail to find systematic variation in the discrepancy between market value and owner-estimated values with respect to the socio-economic characteristics of the owner-occupants.

Table 2 - Summary Statistics For Tax Variables, Philadelphia 1978

	Mean	Std. Deviation
Tax Payments (T_i)	$ 435	244
Property Value (V_i)	$29,438	$16,355
Effective Tax Rate (R_i)	.01625	.00747
Overassessment Loss ($LOSS_i$)	$ -43.8	$ 192.7

Table 3 - Mean Differential Tax Burdens for Socioeconomic Groups

		GAP	LOSS + 43.8
Male Head		-.00008	2.50
Female Head		.00026	-7.40
White Head		-.00054	-10.11
Non-White Head		.00201	37.14
Married		-.00019	1.46
Unmarried		.00040	-3.08
Head Age 20-29		-.00030	17.61
Head Age 30-39		-.00022	0.37
Head Age 40-49		-.00017	-6.18
Head Age 50-64		.00019	5.89
Head Age Over 64		.00007	-7.85
1-2 Family Size		.00001	-5.61
3-4 Family Size		-.00018	1.17
5-6 Family Size		-.00011	5.34
Over 6 Family Size		.00202	43.64
Non-White Income:	0-$9,999	.00173	26.96
	10,000-14,999	.00230	29.82
	15,000-19,999	.00303	71.96
	20,000-24,999	.00128	35.28
	25,000-29,999	.00149	-37.03
	30,000 And Over	.00258	99.60
White Income:	0-$9,999	-.00018	-8.54
	10,000-14,999	-.00066	-8.32
	15,000-19,999	-.00072	-2.25
	20,000-24,999	-.00078	-5.11
	25,000-29,999	-.00069	-14.53
	30,000 And Over	-.00109	-29.26

various socioeconomic groups. The average dollar loss for each group is adjusted by $-43.80 to reflect that overall the sample average loss was $-43.80 (that is, a gain of almost $44). A positive entry in either column reflects relative overassessment while negative entries indicate relative underassessment. Perhaps the most notable results displayed in Table 3 are the substantial differences associated with race and income (for whites). On average, white households are substantially underassessed (relative to non-whites), with the extent of and benefit from underassessment being the greatest among those with the highest incomes.

Another interesting aspect of the assessment process is displayed in Table 4, which reports the average GAP, LOSS, and the percent of the category which is overassessed for various property value brackets. The table clearly indicates that the proportion of properties which are overassessed declines (basically monotonically) with property value. Similarly, the average overassessment rate is the greatest for those with the lowest property values, and the least for those with the highest property values. Finally, the average loss associated with unequal assessment is positive up to property values of $20,000 and declines monotonically with property value.

Another perspective of the non-neutrality of the assessment process is provided in Table 5 which reports the average traits of the overassessed and underassessed populations. Although both the relatively overassessed and relatively underassessed populations consist of families with the same average head age and family size, the overassessed population contains a disproportionately large number of: non-whites, unmarried households, female headed households, and families with relatively low incomes. It is also noteworthy that the average loss from overassessment was approximately one percent of income for the overassessed, while the underassessed population

Table 4 - Differential Tax Burdens By Property Value Categories

Property Values	GAP	LOSS($)	Percent Of Sub-Group Which Is Overassessed
0-9,999	.01084	95	82
10,000-12,499	.00542	61	74
12,500-14,999	.00285	39	58
15,000-17,499	.00133	22	58
17,500-19,999	.00019	4	44
20,000-24,999	-.00111	-25	39
25,000-29,999	-.00217	-60	30
30,000-34,999	-.00236	-77	23
35,000-39,999	-.00115	-43	33
40,000-49,999	-.00191	-86	32
50,000-59,999	-.00452	-249	11
60,000-74,999	-.00367	-248	16
75,000-99,999	-.00396	-347	20
100,000-	-.00617	-694	9

Table 5 - Characteristics Of Over- Versus Underassessed Populations

	Relatively Over-Assessed Population	Relatively Under-Assessed Population
Mean Age of Head	54.5	54.2
Percent Married	66.1	68.2
Percent Male Headed	74.2	75.3
Mean Family Size	3.0	3.0
Percent White	71.3	84.1
Mean Family Income	13,198	14,301
Mean Property Value	23,412	33,574
Mean Property Taxes	493	395
Mean LOSS	113	-151
(Mean LOSS/Mean Family Income)·100	0.9	-1.1
Number of Observations	988	1440

realized an average gain slightly in excess of one percent of their income.

Taken together, the summary statistics on assessment practices in Philadelphia (in 1978) clearly indicate that these practices were not neutral with respect to the socioeconomic characteristics of the taxpayer. This view is reinforced by the regression estimates of equations (6) and (8) which are displayed in Table 6. Specifically, both the tax gap and overassessment loss are systematically related to a vector of personal traits[3] and a vector of residence traits. However, it is noteworthy that the low R^2 value indicates that more than 90 percent of all tax gap is purely random.[4]

Among the systematic determinants of the relative overassessment rate, marital status, family size, race, and income (for whites) are the most significant personal characteristics. As was suggested by the summary statistics, married households are systematically underassessed, while white households (particularly those with high incomes) are assessed at substantially lower rates than non-whites. The positive regression impact of family size on the effective tax rate was not obvious from evaluation of the sample averages. A less precise impact of male household heads is also found. No significant impact for either head age or legal relief status is found. The latter result suggests that Philadelphia assessment practices effectively offset the state subsidy provided to qualified taxpayers, although this result may simply represent reporting errors.[5]

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[3]The legal relief variable reflects a Pennsylvania state law which provides state reimbursement for those families with heads over 64 and incomes under $9,000.

[4]This interpretation of the R^2 statistic assumes the absence of specification, measurement, and missing variable errors.

[5]It is also possible that respondents inappropriately reported their gross rather than net local tax payments.

Table 6 - Regression Results For Philadelphia 1978

	GAP	LOSS
Age of Head	1.3×10^{-3} (0.96)	0.15 (0.42)
1 if Married	-.137 (2.35)	-25.42 (1.70)
1 if Male Head	.098 (1.65)	29.99 (1.95)
Family Size	.029 (2.55)	8.72 (3.01)
1 if White Head	-.090 (1.52)	-17.66 (1.16)
Family Income For Blacks	3.7×10^{-6} (1.19)	1.04×10^{-3} (1.31)
Family Income For Whites	-3.8×10^{-6} (2.37)	-1.15×10^{-3} (2.69)
1 if Qualified For Legal Relief	-.402 (1.09)	-106.67 (1.12)
Legal Relief * Family Income	-3.6×10^{-6} (0.22)	2.31×10^{-3} (0.55)
Legal Relief * Age Of Head	5.8×10^{-3} (1.13)	0.39 (1.06)
Number Of Rooms	.028 (2.05)	1.41 (0.41)
Number Of Bathrooms	.029 (0.98)	-1.45 (0.19)
1 if Single Attached Unit	.113 (2.11)	65.47 (4.76)
1 if Through Bedroom To Bathroom	-.226 (2.03)	-28.85 (1.01)
Age of Building	-.003 (2.74)	-1.75 (5.81)
1 if Roof Leaks	.092 (1.89)	7.47 (0.60)

Table 6 (continued)

	GAP	LOSS
1 if Cracks In Walls Or Ceiling	.194 (2.91)	40.20 (2.34)
1 if Regular Exterminator Service	.129 (1.90)	19.57 (1.12)
1 if Property Improved In Last 12 Months	-.047 (1.31)	-27.98 (3.01)
1 if Local School Is Adequate	-.141 (3.69)	-23.07 (2.35)
1 if Local Police Protection Is Adequate	-.031 (0.73)	-6.63 (0.61)
1 if Garbage Collection Publicly Provided	-.032 (0.65)	5.92 (0.47)
1 if Neighborhood Traffic Is Bad	-.070 (1.99)	-16.25 (1.80)
1 if Local Public Transit Is Adequate	.082 (1.95)	27.11 (2.50)
1 if Local Streets Need Repair	-.114 (2.79)	-15.45 (1.47)
1 if Local Nonresidential Activity Is Bad	-.107 (3.29)	-35.91 (4.28)
1 if Neighborhood Crime Is Bad	.077 (1.92)	17.48 (1.70)
1 if Local Hospitals Are Adequate	-.174 (3.18)	-41.18 (2.92)
Constant	.058 (0.37)	-7.54 (0.19)
R^2	.071	.070

Absolute t-values in parentheses.

Similar qualitative impacts in terms of the personal traits are found with respect to the annual dollar loss associated with assessment errors. Married (relative to unmarried) households gain about $25 from assessment errors while each additional family member induces a loss of almost $9. Surprisingly, male (versus female) headed households lose almost $30 from assessment errors. Non-white (relative to white) households lose a base amount of almost $18 with an additional loss of $2.19 per thousand dollars of income.[6]

A number of the residence characteristics prove to be significant determinants of both the relative assessment rate and the assessment loss. Further, an analysis of variance indicates that the vector of residence traits accounts for approximatley two-thirds of the "explained" variances of both the overassessment rate and dollar loss. The source of these significant results for the residence characteristics is explored more thoroughly in the next section.

In sum, the evidence presented in this section indicates that the assessment practices in Philadelphia: (1) resulted in considerable variation in effective tax rates; (2) had over 90 percent of this variation associated with random assessment errors; (3) had a small but significant portion of the total variation associated with the socioeconomic characteristics of the taxpayer; (4) disproportionately tax non-whites; (5) that a small but significant proportion of the variance in effective tax rates is associated with residence characteristics; and, (6) that these assessment practices are clearly non-neutral with respect to taxpayer characteristics. In the next

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[6]This reflects the relatively imprecise $1.04 (per thousand) loss for non-whites plus the $1.15 (per thousand) gain for whites.

section these empirical results are evaluated in the context of a variety of models of assessment practices.

IV. Alternative Models of the Assessment Process

A variety of alternative descriptions of the assessment process have been offered in the past. In this section the empirical implications of the five most popular descriptions are evaluated in terms of the empirical findings presented in the previous section on the existence of systematic intrajurisdictional tax inequity.

One popular version of the assessment process is that properties are reassessed very infrequently and therefore properties with growing property values will tend to be relatively underassessed. A common extension of this description argues that properties with desirable housing traits are appreciating at relatively high rates and therefore the effective tax gap should be a negative function of desirable housing traits and positively related to undesirable housing traits. An examination of Table 6 reveals that there are eight desirable and 10 undesirable housing traits in the tax gap equation.[7] Five of the eight desirable traits exert negative impacts on the tax gap, while half of the undesirable traits exert positive tax gap effects. Since only 10 of the 18 housing traits display the sign predicted by this systematic version of the infrequent assessment model, it seems clear that it should be rejected.[8]

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[7]The desirable housing traits, based on hedonic price studies (see, for example, Linneman [1981]) are: rooms, bathrooms, property improvements, adequate schools, police protection, transit, and local hospitals, and public garbage collection.

[8]An alternative version of this model would suggest that property values regress towards the mean and, therefore, bad housing traits imply property value growth. This version can also be rejected.

An alternative description of the assessment process argues that citizens who receive relatively large amounts of local public services must pay relatively high taxes in order for the jurisdiction to compete successfully with other communities. This description of the local tax system is an intrajurisdictional extension of the familiar Tiebout (1956) hypothesis that states in equilibrium residents of high tax communities will be compensated with equivalently higher valued local service bundles. Applied to a large city like Philadelphia, the intrajurisdictional Tiebout model argues that in order to compete effectively with suburban communities the central city must offer higher service bundles to those who are heavily taxed and lower effective taxes for those receiving relatively few local services. Since the legal tax rate is the same for all residents, the city could adjust its assessment of the property until the tax revenues received from each household defray the costs of the local public services they demand from the city. The intrajurisdictional Tiebout hypothesis, therefore, implies that those residents receiving relatively good public services should pay relatively higher taxes, that is, they should have relatively large dollar losses from the assessment process. Seven measures of local public services are included in the LOSS regression displayed in Table 6.[9] Only three of these variables (garbage service, public transit, and street conditions) display the signs predicted by the intrajurisdictional Tiebout hypothesis. Therefore, the data appear to reject the hypothesis that variations in relative taxation reflect equivalent variations in the provision of public services.

A third possible description of the local assessment process is that the

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[9]The locally provided service variables are: adequate schools, police protection, garbage collection, transit, street repair, local crime, and local hospitals.

assessors do the best job they can to fairly assess the true market value of each property. However, it is impossible for them to fully evaluate all housing traits of the property in arriving at their property assessment. Therefore, the assessors will make "honest errors" in their assessments that will cause properties with difficult to observe but relatively desirable (undesirable) housing traits to be relatively underassessed (overassessed). The "honest error" hypothesis implies that all personal characteristics and easy to observe housing characteristics will be insignificant explanatory variables in the tax gap regression. As was noted in the last section the vector of personal characteristics was significant in the tax gap regression. Similarly, many easy to observe housing traits (for example, the number of rooms) were also found to be significant regressors in the tax gap equation. However, four of the five hard to observe housing traits exhibit tax gap effects which are consistent with the "honest error" hypothesis.[10] An analysis of variance indicated that approximately 2 percent of the total variance (about a third of the explained variance) in effective local tax rates is explained by these hard to observe housing traits. Taken together these results suggest that some, but certainly not all, of the systematic variation in effective tax rates is associated with honest assessment errors.

A fourth alternative model of inequities in the assessment process is that the system is biased not because of assessment bias, but rather because of selection bias in the assessment appellate process. A simple example illustrates this model most vividly. Imagine that the assessor's office assesses all properties in an unbiased but imperfect manner. Thus, properties would exhibit totally random variations in their local tax burdens as the

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[10]The hard to observe housing traits are: roof leakage, exterminator service, property improvement, privacy of bedroom, and cracks.

result of the actual assessment process. However, these random assessments may be appealed through judicial review. It seems unlikely that any property which is relatively underassessed would seek legal redress through the appellate process. However, owners of relatively overassessed properties have an incentive to appeal their assessment in hopes of reducing their tax burden. Whether an overassessed property owner successfully appeals their assessment depends upon two factors: (1) the strength of their case; and, (2) the net benefit of appealing. As the degree of overassessment rises, the strength of the case rises. This factor should not induce biased final tax burdens because the original assessment error was assumed to be random. However, the net benefit of appealing one's overassessment clearly rises with the value of the property. That is, if all residents face the same costs of appealing their assessment, the tax saving by redressing a randomly high assessment is greatest for those with high property values. For example, the benefits of eliminating a 10 percent overassessment are greater for someone with a $100,000 property than for someone with a $10,000 property. Thus, successful appeals will be disproportionately made by owners of expensive properties. This selection bias in the legal redress procedure would induce systematic errors in the assessment process even though all properties were initially randomly assessed. This bias will be reflected through a variety of personal and residential traits due to the correlation of these traits and property values.

This model suggests that traits which are positively (negatively) related to property values should be negatively (positively) related to the tax gap. An examination of Table 6 reveals that only 10 of the 18 residential characteristics displayed the expected signs. Further, among the personal characteristics, only marital status and income for whites display GAP effects

which are consistent with the legal redress hypothesis. These results clearly indicate that the legal redress model of the assessment process fails to adequately explain observed assessment patterns.

A final model of inequities in the assessment process argues that local tax inequities reflect the differential political influence of various socioeconomic groups. For example, high income residents tend to be more politically influential than those with relatively low incomes because their campaign contributions make them extraordinarily important constituents. In order to repay these high income constituents for their political support, local politicians create a local tax system (the assessment process) which is baised in favor of high income residents. Similar political economy arguments can be made with respect to other socioeconomic characteristics in terms of assessment inequities.

In short, the political economy hypothesis of assessment errors implies that: (1) residential characteristics should be of no importance in explaining inequities in local tax burdens; and, (2) personal characteristics associated with increased political influence should be negatively related to the dollar loss associated with assessment errors. An evaluation of Table 6 reveals that, contrary to the political economy hypothesis, residential traits possess important explanatory power in terms of local tax inequities. However, consistent with the political economy hypothesis, high income white constituents realize substantial gains from the local assessment process. Similarly, married households are able to translate their differentially high voting propensities into small gains from the assessment process. The losses suffered by those with larger family sizes are consistent with the political economy hypothesis if it is assumed that those with larger families (all else constant) divert some of their limited resources to their families from their

political activities. The finding that male headed households bear a disproportionately large tax burden does not appear to be consistent with standard descriptions of the political process.

An analysis of variance revealed that approximately 2 percent of the total, and 30 percent of the explained variance of the assessment process in 1978 Philadelphia is associated with the personal characteristics related, political economy hypothesis of the local assessment process. Thus, the data appear to support the presence of a limited amount of political bias in the assessment process.

In sum, this section compared the empirical implications of several popular models of the assessment with the empirical results presented in section III. The major conclusions are that most of the inequities in local tax burdens are either totally random or the results of "honest errors." Only a very small proportion of the inequity is associated with political influence. Further, neither inertia in the process nor variations in local public services appear capable of explaining observed effective tax patterns. Finally, the possibility of biased legal redress of a random assessment methodology is rejected.

V. Summary

This paper developed a simple empirical framework for evaluating inequities in the local tax assessment process. The framework models variations in effective local tax rates into a random component and a systematic component which is a function of both resident and residential characteristics. The framework was empirically implemented using a sample of Philadelphia homeowners for 1978. The data clearly indicate that considerable differences in effective tax rates existed. Further, these effective tax rate inequities were not neutral with respect to the socioeconomic characteristics

of the taxpayer.

Analysis of the variations in effective tax rates revealed that approximately 90 percent of all local tax rates is purely random while an additional 3 percent reflects "honest errors." Only about 2 percent of the total intrajurisdictional variation was associated with the differential political influence associated with various socioeconomic categories. Finally, the data reject the legal redress hypothesis, an intrajurisdictional Tiebout hypothesis, and the inertia hypothesis of the local assessment process.

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