Capitalization of Property Tax Differentials Within and Among Municipalities

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The literature on capitalization effects in housing markets has been rich and varied. There have been many studies on the capitalization of property tax rate differentials (usually treated as random events) among both municipalities and single-family houses.[1] A second model of capitalization has been presented with respect to "fiscal zoning," the manipulation of zoning codes through lot and home size restrictions to allow a given level of revenue with lower tax rates.[2] This paper attempts to test both types of capitalization effects empirically, through modification of a model proposed by Hamilton. Both are found to be large and significant.

There are a number of supply constraints in housing markets that may allow capitalization effects to persist into the long term. Various forms of zoning may limit responses of builders to the quasi-rents generated in certain areas. Existing housing stocks are durable and not easily modified. Spatially, new construction generally requires land further from the Central Business District (CBD); increased transportation costs may lower the return to housing and make further expansion unprofitable to developers. To the extent that capital adjustment does occur, the capitalization effects may be shifted to the relatively immobile land through capital movement.

Recent models have proposed that housing prices reflect not only differentials in property tax rates (which are only partial effects), but also the tax bases within municipalities or taxing districts. These effects are due to the incidence of "fiscal deficit" (or "fiscal surplus") that occurs when owners of high (low) quality housing must subsidize (are subsidized by) owners of low (high) quality housing in the provision of municipal services.

In this paper, I attempt to implement a more general model that includes both property tax rate and tax base considerations. Estimated levels of random tax rate capitalization within municipalities in the New Haven SMSA vary between 97.9% and 113.6% of theoretically "perfect" levels. Capitalization of tax rate and tax base among municipalities occurs in general at levels approaching 60% of theoretically calculated levels. This finding is comparable to one presented by Hamilton (1979, pp. 169–80) using different data and analytical methods.[3]

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[1]Heinberg and Oates (1970, pp. 92–8), King (1977, 425–31), Orr (1968, pp. 253–62), Pollakowski (1973, pp. 994–1003), and Rosen and Fullerton (1977, pp. 433–40) use the municipality as the unit of measure. King (1974) and Smith (1970, pp. 177–94) use individual housing units.

[2]This description of fiscal zoning is much simpler than is justified to summarize the literature. For more detail see Ellickson (1977, pp. 388–510), Hamilton (1976, pp. 743–53), and the papers in Mills and Oates (1975). The seminal work is by Tiebout (1956, pp. 416–24).

[3]His sample had a very limited set of neighborhood variables and excluded the age of the house. The estimation procedure involved two-stage methods with a nonlinear package used in the hedonic price stage of the analysis.

A Restatement of the Model

Hamilton (1976, pp. 743–53) presents a model of housing price capitalization with respect to fiscal surplus or deficit using two types of housing. Although his analysis implies the workings of a market for a homogeneous commodity (the "housing services" approach presented by Muth in 1968, pp. 285–333), it can be generated into n types of housing within a municipality.

Consider a metropolitan area containing i municipalities. P_{ni} refers to the price of the nth type of housing structure and surrounding lot, adjusted for distance and neighborhood effects, in the ith municipality. There are f_{ni} houses of each type in the ith municipality, and

$$\sum^{n} f_{ni} = m_i$$

where m_i is the total number of houses in the municipality. The price of the house is the sum of the present discounted values of the gross annual rental income, Dy_n, and the flow of fiscal deficits (surpluses) resulting from the average cost pricing of the municipal services paid by a proportional property tax,

$$D(X_i - P_{ni}t_i)$$

$$P_{ni} = Dy_n + D(X_i - P_{ni}t_i) \qquad [1]$$

X_i equals the level of municipal services in dollar terms per house in municipality i. D is the discount factor used to capitalize the flow of fiscal deficits (surpluses). t_i is the proportional property tax used to finance the services.[4]

This formulation is general with respect to both residential and nonresidential properties. If $n = 1$, for example, is designated as nonresidential property, all of the results derived below continue to follow. To the extent that nonresidential properties use proportionally the same services as to residences, their presence should not necessarily lead to changed fiscal deficits or surpluses. Properties such as light industry or office complexes, on the other hand, may be quite desirable, as they probably generate substantial fiscal surpluses for other units in the municipality.

The average cost pricing of municipal services implies a tax rate of:

$$t_i = \frac{X_i m_i}{\sum^{n} f_{ni} P_{ni}} \qquad [2]$$

Aggregating equation [1] over the n types of housing throughout the municipality and substituting equation [2] yields:

$$\sum^{n} f_{ni} P_{ni} = \sum^{n} f_{ni} Dy_n \qquad [3]$$

This states that the sum of house values is invariant to the capitalization of fiscal surpluses and deficits. The capitalization effects sum to zero and gains in the values of some houses are transfers from the values of other, more expensive, houses.

Solutions for the i tax rates and P_{ni} across municipalities are:

$$t_i = \frac{X_i m_i}{\sum^{n} f_{ni} Dy_n} = \frac{X_i}{B_i}$$

where

$$B_i \equiv \frac{\sum^{n} f_{ni} Dy_n}{m_i} \qquad [4]$$

$$P_{ni} = \frac{D(y_n + X_i)}{1 + \frac{X_i}{B_i} D} = \frac{D(y_n + X_i)}{1 + t_i D} \qquad [5]$$

An increase in a municipality's tax base, through the construction of above-average value homes, for example, lowers the property tax rate necessary to finance X_i. Through equation [5] this raises the value of all houses in municipality i.

Equations [4] and [5] present difficulties in empirical work because the per house expenditure measure, X_i, may not be an appropriate measure of municipal service where the costs of providing equivalent education, police protection, or sewer serv-

[4]Municipal services such as fire and police protection are considered to be uniform across the municipality, as distinct from neighborhood services such as schools, which may differ in quality within the municipality.

ices may vary by municipality.[5] Redefine equation [5] as

$$P_{ni} = \frac{Dy_n + t_i B_i D}{1 + t_i D} \qquad [5']$$

using a substitution from equation [4]. Full differentiation of equation [5′] yields

$$dP_{ni} = \frac{(B_i - P_{ni})D}{(1 + t_i D)}\, dt_i + \frac{t_i D}{(1 + t_i D)}\, dB_i \qquad [6]$$

Thus the differing tax rates and levels of expenditures can be redefined in terms of tax rates and property tax bases. Equation [6] will predict the change in house valuation from moving a house from one municipality to another. The coefficient of dB_i implies that an increase in property tax base at a given rate will yield more public services, increasing the price of the house.

In an expositional sense, the first term in equation [6] may be thought to represent a "Tiebout world" since if, for example, communities were homogenous (i.e., $B_i = P_i$), there would be no tax capitalization. Differences arising in dt_i would result in different services corresponding to the different tastes among communities, but the coefficient of the first term would remain zero. Differences in tax bases could still make migration attractive, however, and so result in tax base capitalization.

Any estimation procedure must also account for the possibility of tax rates that vary within the municipality, typically due to misassessment. Given the constant level of municipal services, the effect of differing within-municipality tax rates is recovered by partially differentiating equation [5] with respect to the tax rate

$$\frac{\partial P_{ni}}{\partial t_i} = \frac{-P_{ni} D}{(1 + t_i D)} < 0 \qquad [7]$$

This expression is familiar from Oates (1969, pp. 957–71) and other studies.

Regression Specification and Results

This section presents the specification of the regression testing the effects discussed above. The results imply that random tax rate differentials are capitalized into housing prices at rates approaching 100% of theoretical levels. Tax and expenditure differentials among municipalities are capitalized at rates varying from 52.9% to 97.2% among similar suburbs.

The model estimated is a hedonic price model, including structural, neighborhood, and fiscal variables. Following the functional form proposed by Box and Cox (1962, pp. 211–43), the regression equation estimated is

$$\frac{P_{ni}^{\lambda} - 1}{\lambda} = \sum \beta_j z_{jn} + \delta_1(t_{ni} - \bar{t}_i) + \delta_2 \bar{t}_i + \delta_3 B_i + \epsilon_{ni} \qquad [8]$$

or

$$\frac{P_{ni}^{\lambda} - 1}{\lambda} = \sum \beta_j z_{jn} + \delta_1 t_{ni} + (\delta_2 - \delta_1)\bar{t}_i + \delta_3 B_i + \epsilon_{ni} \qquad [8']$$

The parameter λ takes the value of 0 for logarithmic form and 1 for linear, and is estimated in a search process using maximum likelihood methods. $(t_{ni} - \bar{t}_i)$ refers to the variation in tax rate from the mean in the municipality. z_{jn} refers to the vector of all house and neighborhood variables included in the regression. Tax, age, and distance variables are estimated in logarithmic form to conform with the diminishing marginal effects predicted by theory.

The sample consists of 1,835 single-family houses in the New Haven SMSA, sold from 1967 through 1969. There are 10 municipal jurisdictions, and tax reassessment practices were sufficiently lagging and random to generate variation within jurisdictions. King (1974) and Goodman (1978, pp. 471–84) have appended neighborhood measurement to the sample of houses.[6]

[5]Since X_i refers only to current costs or expenditures, it also ignores the capitalization of the value of services from municipal infrastructure that has already been paid for. Hence, current measures of X_i may be flawed to the extent that the debt financing of infrastructure varies among municipalities.

[6]For more detail on the sample, including discussion on assessments and on the formation of neighborhood variables, see King (1974) and Goodman (1978, pp. 471–84).

Municipal tax rates are estimated by stratifying the sample by municipality and year. Residential property tax base is estimated as the mean house price, once again stratified by municipality and year. Three-year mean values are presented in Table 1. Tax rate is seen to vary from 1.50% in Woodbridge to 2.53% in East Haven. The residential tax base varies from $18,634 in East Haven to $44,894 in Woodbridge.[7]

Measured tax base could underestimate the resources available to pay for public services, if it is supplemented by intergovernmental transfers from the state or federal governments. Column (3) of Table 1 displays the shares of municipal revenues accounted for by property taxes in eight of the ten municipalities for the 1966–67 fiscal year.[8] With the exception of New Haven and Wallingford, all fall within a few percentage points of 70%.

The regression analysis is presented in Table 2. Maximization of the likelihood function for the Box-Cox test yields an estimate of the value for λ of .3, and firm rejection of either the simple linear or semilogarithmic functional forms. The "hedonic prices" or partial derivatives of the function with respect to the individual arguments are $\beta_i P^{1-\lambda}$, or $(\beta_i/z_i)P^{1-\lambda}$ for independent variables in their logarithmic forms.

TABLE 1

MEAN THREE-YEAR PROPERTY TAX RATES, TAX BASES, AND PROPERTY TAX SHARES FOR NEW HAVEN AREA BY MUNICIPALITY

Town	Rate	Base	Share*
Branford	1.9341%	$30,980	72.4%
Cheshire	2.0186	28,310	68.1
East Haven	2.5338	18,634	68.7
Hamden	1.9551	26,283	77.1
New Haven	2.4808	23,748	59.1
North Haven	1.7613	28,580	76.9
Orange	1.6381	35,330	—
Wallingford	1.9811	21,918	60.5
West Haven	2.3201	19,170	76.9
Woodbridge	1.4991	44,894	—

*Property Tax Share of Municipal Revenue
Source: Census of Governments, pp. 39–42. Orange and Woodbridge were not available.

TABLE 2

CAPITALIZATION REGRESSION

Dependent Variable: (Price ** .3−1)/.3
Independent Variable:

SIZE	.00001	(11.15)		
SPACE	.00128	(21.46)		
LAGE	−.49642	(19.59)		
RMS	.12193	(6.04)		
BATH	.33498	(8.98)		
LAV	.18115	(4.52)		
BRICK	.60051	(4.93)		
HW	.49296	(9.67)		
GAR	.32874	(11.60)		
FP	.16108	(4.79)		
LDIS	−.31401	(5.92)	$\bar{R}^2$	.85477
PCI	.25319	(4.56)	SEE	.77192
SCORE	.00216	(1.59)		
BLACK	−.00974	(5.08)	(t statistic)	
EDUC	.01562	(8.77)	Price measured	
POOR	−.03067	(7.47)	in 100's	
LRATE	−1.71771	(14.12)		
LMR	1.06696	(4.43)		
BASE	.00157	(2.91)		
Y68	.29654	(6.96)		
Y69	.63251	(9.54)		
CONSTANT	11.09004			

All variables have their expected signs and the R^2, adjusted for degrees of freedom, is .8548.

Table 3 shows the random tax capitalization within municipalities for each municipality represented in the sample. The "theoretical" price difference is calculated using equation [7], for a house that is misassessed at one percentage point higher than the mean municipality value. A 5% discount rate and a 40-year horizon are used.[9]

[7]The absence of nonresidential property in this tax base might be problematic. However, per capita assessments at the municipality level (10 municipalities) have a .73 correlation with the residential mean house price (when Branford, with only 2.8% of the observations, is omitted, the correlation rises to .79). Since only residential properties are being examined, it seems appropriate to use the residential tax base. The data are from the Connecticut Tax Commissioner (1968, 1969), Table 7.

[8]Data for Orange and Woodbridge were not available.

[9]Oates (1969, pp. 957–71), Pollakowski (1973, pp. 994–1003) and others have customarily used these parameters to analyze housing and land markets of

TABLE 3
PARTIAL CAPITALIZATION OF WITHIN-JURISDICTION TAX RATE DIFFERENTIALS

Town	Price (Dollars)	Rate (Percent)	Theoretical (Dollars)	Estimated (Dollars)	Percent Capitalization
Branford	30,980	1.9341	−3770	−3912	103.8
Cheshire	28,310	2.0186	−3410	−3549	104.1
East Haven	18,634	2.5338	−2113	−2199	104.1
Hamden	26,283	1.9551	−3190	−3457	108.4
New Haven	23,748	2.4808	−2710	−2652	97.9
North Haven	28,580	1.7613	−3553	−3980	112.0
Orange	35,330	1.6381	−4460	−4882	109.5
Wallingford	21,918	1.9811	−2652	−3012	113.6
West Haven	19,170	2.3201	−2228	−2413	108.3
Woodbridge	44,894	1.4991	−5768	−6175	107.1

The "estimated" difference is then calculated with the capitalization regression, using a one percentage point deviation from the mean municipality value. The capitalization percentage is the estimated value as a fraction of the theoretical value. As noted in column (5), this percentage varies from 97.9 for the city of New Haven, to 113.6 for the town of Wallingford, representing almost "perfect" capitalization of assessment differentials.

Hamilton (1979, pp. 169–80) interprets a 100% rate of capitalization of random variation as the result of a demand shift, for housing services, in the face of a totally inelastic supply. Since the within-jurisdiction variation in property tax is random, its replication cannot be planned, hence the entire present value of the increased (decreased) liability is capitalized into the parcel value. With the discount rate and horizon used, the percentages within the 10 municipalities are consistent with this explanation.

The test for full capitalization is presented in Table 4. Using values from Table 1, consider a "mean" house in the suburb of Hamden, selling for $26,283 and carrying the mean tax rate of 1.955. Table 4 shows the theoretical capitalization from equation [6] if the house is "moved" into each of the other municipalities (column 3). Column (4) displays the estimated capitalization from the regression equation in Table 2. Column (5) shows column (4) as a percentage of column (3).[10]

These capitalization magnitudes vary from 10.3% between Hamden and Cheshire, to 122.4% between Hamden and New Haven, with the rest "clustering" between 34% and 97%. To put them in better perspective, compare Hamden with similar suburbs in the inner ring around New Haven, that is, East Haven, North Haven, Orange, West Haven, and Woodbridge.[11] Among these 6 municipalities, full capitalization of the property tax differential varies from 52.9% (West Haven) to 97.2% (North Haven) with a pronounced clustering around 60%.[12]

One can speak of a producer response among municipalities. Producers may view the capitalization of fiscal surpluses (de-

the 1960s. Although this is the procedure that is typically used, it is doubtful that assessment discrepancies are likely to persist as long as 40 years. Most buyers are likely to consider the risk of this removal of reassessment and apply a correspondingly higher discount rate. Following Mieszkowski (1972, pp. 73–96), it might be useful for researchers to examine the determination of the discount rate as an endogenous process.

[10]As always, there exists here an "index number problem" with respect to the bundle that is chosen. Alternative reference bundles provide similar, although not identical, levels of capitalization.

[11]This is in the "spirit" of Oates's 1969 examination of several New Jersey "bedroom suburbs" in a ring around New York City.

[12]Pauly (1976, pp. 231–42) studies some theoretical problems inherent in calculating expected full capitalization. I discuss these in the concluding section where I look at several shortcomings in this general type of model.

TABLE 4
FULL CAPITALIZATION OF FISCAL DEFICITS AND SURPLUSES

To	Tax Rate Differential (Percentage Points)	Tax Base Differential (Dollars)	Theoretical (Dollars)	Estimated (Dollars)	Percent Capitalization
Bradford	−.0210	+ 4697	+1175	+ 399	33.9
Cheshire	+.0635	+ 2027	+ 526	+ 54	10.3
East Haven	+.5787	− 7649	−2414	−1427	59.1
New Haven	+.5257	− 2535	− 786	− 962	122.4
North Haven	−.0194	+ 2297	+ 529	+ 514	97.2
Orange	−.3170	+ 9047	+1961	+1270	64.8
Wallingford	+.0260	− 4365	−1115	− 381	34.2
West Haven	+.3650	− 7113	−2083	−1102	52.9
Woodbridge	−.4560	+18611	+3715	+2297	61.8

ficits) and act accordingly based on fixed production costs, and on the belief that their increments to the housing stock will be "small" in comparison to the overall stock and price structure. Using this interpretation, it can be seen that for the inner ring of suburbs supply response undoes approximately 40% of the posited capitalization of the property tax among municipalities. This is plausible in that there was active housing construction in all of the municipalities in the inner ring.

Table 5 presents two measures of producer response in more detail. The first is net increase in the housing stock (i.e., the percentage change in number of units from 1960 to 1970). These data (columns 1, 2, and 4) show a 4.6% decrease in New Haven, as opposed to increases of over 20% everywhere else. The second measure is construction response (i.e., number of units built in the past five years as a percentage of 1970 stock). This response (columns 2, 3, and 5) varied from 4.9% in New Haven to 20.5% in West Haven. The response for the city of New Haven in particular, using either measure, suggests that its 122% capitalization may be explained to some extent by an apparently low supply elasticity.

In addition to supply adjustments, the property tax base term reflects the cost of supplying the public goods within the metropolitan area, and assumes implicitly that it is constant. If this cost is higher in the central city due to higher land cost, congestion, outmoded capital plant, or bureaucratic distortions (which break the link between X_i and t_iB_i), for example, then the tax rate multiplied by the tax base differential may provide a misleading estimate of the difference in the value of services.[13] Since this value is what is being capitalized, the theoretical capitalization estimate may be too small, leading to an upward bias in the percent capitalization calculated from the regression (columns 3, 4, and 5 in Table 4).

Conclusions

This paper presents a model of house price capitalization that subsumes several previous approaches in the literature. Using a framework that permits both random and intermunicipality capitalization of the property tax, I find that both are significant and substantial. The former is derived using an analysis proposed by Oates, King, and Pollakowski and others, concentrating on the property tax rate.[14] Although this

[13]Rosen and Fullerton (1977, pp. 433–40) present a similar argument for the differing costs of providing education services.

[14]The capitalization examined by these references (and others in footnote 1) is usually a combination of both random and interjurisdictional. As such, it is hard to make direct comparisons. Oates and other users of his New Jersey sample of municipalities pay

TABLE 5
SUPPLY RESPONSES BY MUNICIPALITY
1960–1970

Town	Total Housing Units 1960*	1970**	Total Built 1965–1970**	Net Percent Increase 1960–1970	Percent Built In 5-Year Period
Branford	5,445	6,874	971	26.2	14.1
Cheshire***	—	5,474	1,075	—	19.6
East Haven	6,065	7,351	646	21.2	8.8
Hamden	12,499	15,984	2,068	27.8	12.9
New Haven	51,229	48,887	2,385	−4.6	4.9
North Haven	4,612	6,322	738	37.1	11.7
Orange	2,521	3,812	610	51.2	16.0
Wallingford***	—	10,600	1,036	—	9.8
West Haven	13,019	17,635	3,622	35.4	20.5
Woodbridge	1,505	2,295	420	52.5	18.3

*Source: *Census of Population and Housing*, 1960, PHC(1)-101.
**Source: *Census of Housing*, 1970, Tables 43 and 53.
***Cheshire and Wallingford not included in SMSA in 1960.

capitalization rate varies among municipalities, it is very close to the "theoretical" measure, and implies a shift in demand within municipalities that is not "undone" by supply response.

The among-municipality capitalization is derived for a system of jurisdictions in a metropolitan area, according to a hypothesis generalized from Hamilton, such that house prices vary systematically with the jurisdictions' tax rates and tax bases. Comparing similar suburban jurisdictions, this capitalization occurs at a rate of approximately 60%. The numbers are similar to those estimated by Hamilton, although they use a different sample and a different estimating technique.

This model, along with many others of its type, suffers from several shortcomings. Although it estimates the difference in house price paid by the marginal purchaser, it does not identify the willingness to pay for differing levels of public goods. Furthermore, the identification of the municipal public goods themselves is weak, and although this approach does not explicitly value them in dollar terms, it implicitly assumes the costs of providing them are the same.

There is also some question about the extent of capitalization that should be expected. Although the magnitudes predicted here follow directly from the theory in the model, Pauly (1976, pp. 231–42), for example, demonstrates how dissimilar preferences, or differences between short- and long-run equilibria (or disequilibrium states) can limit expected capitalization.

The results suggest, however, that other studies which use only a random property tax term (such as equation [8′] with $(\delta_2 - \delta_1)$ and δ_3 restricted to zero) are overly restricted. Under these circumstances estimated tax coefficient, δ_1, is likely to display an omitted variables bias.[15] Inclusion of mean tax rate and tax base permits decomposition of capitalization effects into random and interjurisdictional components.[16] These add considerably to the explanatory power of the hedonic price regression in a manner that is consistent with theory.

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some attention to the jointness of tax base and tax rate by using two-stage procedures. This is generally not done, however, for individual housing units.

[15] t_{ni} and t_i are almost certainly positively correlated. In the sample used the zero-order correlation is .58.

[16] While most studies do not contain a B_i term, many do include an expenditure term which captures some of its effect.

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APPENDIX

Variables		Symbols	
SIZE	lot size in square feet	*Subscripts*	
		i	municipality
SPACE	indoor living space in square feet	n	house type
		j	hedonic price variable index
LAGE	logarithm of house age	*Variables*	
RMS	number of rooms excluding bathrooms, lavatories	m	number of houses in municipality
BATH	number of full bathrooms	t	property tax rate
LAV	number of lavatories	z	one of a set of hedonic price variables
BRICK	"1" if fully brick; "0" otherwise	y	gross annual rental income
HW	"1" if hardwood floors; "0" otherwise	B	property tax base
GAR	number of covered garage spaces	D	discount factor
		P	house price
FP	number of fireplaces	X	level of municipal services in dollar terms
LDIS	logarithm of distance to CBD		
PCI	principal components measure of perceived quality of neighborhood	β, δ	regression coefficients
		λ	nonlinear parameter in Box-Cox search procedure
SCORE	percentile reading score of local elementary school		
BLACK	percentage black population in block group		
EDUC	percentage of population over age 25 with 13 or more years of education		
POOR	percentage of families with incomes less than $5,000		
LRATE	logarithm of house tax rate		
LMR	logarithm of municipality tax rate		
BASE	municipality tax base		
Y68 (Y69)	"1" if house was sold in 1968 (1969); "0" otherwise. Both Y68 and Y69 equal 0 if house was sold in 1967.		