PROPERTY TAX CAPITALIZATION IN A MODEL WITH TAX-DEFERRED ASSETS, STANDARD DEDUCTIONS, AND THE TAXATION OF NOMINAL INTEREST

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Abstract—Previous property tax capitalization studies assume that families itemize, that they save in taxable assets, and that real interest income is taxed. However, many families do not itemize, many families invest in tax-deferred assets, and nominal interest income is taxed. As a consequence, prior studies likely misspecify the property tax capitalization equation for roughly ninety percent of their samples. Taking federal tax provisions into account increases the precision of our estimated capitalization rate. In addition, our results suggest that biases in prior studies likely contribute to the variety of capitalization estimates in the literature.

I. Introduction

PRIOR studies of property tax capitalization effectively ignore the federal income tax code by implicitly assuming that all families itemize, that families save in assets for which interest is taxed on receipt, and that real interest income (as opposed to nominal interest income) is taxed.[1] With few exceptions, these studies suggest that there is incomplete capitalization of the property tax, a finding that has contributed to debate about the role and impact of the property tax on property markets.[2] Recent research, however, indicates that up to 55 percent of homeowners do not itemize (e.g., Follain & Ling, 1991; Follain & Dunsky, 1997; Maki, 1994), while many families save for retirement using tax-deferred assets.[3] In addition, nominal as opposed to real interest income is taxed. In this paper, we evaluate both the manner and the extent to which capitalization of the property tax is affected by federal tax provisions that create differences in the tax status of homebuyers. Results suggest that, if differences in the tax status of homebuyers are ignored, the capitalization equation is misspecified for roughly ninety percent of all owner-occupied homes. Correcting these specification errors results in a more efficient estimate of the capitalization rate. Moreover, biases resulting from specification problems in prior studies are sensitive to homebuyer tax status and are likely to differ across samples and market conditions. These biases have likely contributed to the wide variety of capitalization estimates in the literature.

The principle underlying all capitalization studies is that house prices vary to ensure that mobile buyers are indifferent between similar homes that provide access to the same level of local public services. As such, house prices depend on the capitalized value of future property taxes, a value that depends on the federal income tax status of the prospective homebuyer. For homes sold to families that take the standard deduction, the property tax stream that is capitalized into the house price is larger than if families itemize and deduct their property taxes. Thus, incorrectly assuming that homeowners itemize would cause one to understate the ‘‘after-tax’’ property tax stream and overestimate the property tax capitalization rate, *ceteris paribus.* Analogously, assets that generate tax-deferred interest (denoted *tax-deferred assets*) earn a higher rate of return than assets for which interest is taxed on receipt (denoted *taxable assets*). Thus, for families whose savings at the margin are in tax-deferred assets, future tax payments are discounted at a higher rate, which reduces the present value of the property tax stream. As a result, if one mistakenly assumes that homeowners hold marginal savings in taxable assets, the present value of the property tax stream will be overstated and the property tax capitalization rate will be underestimated, *ceteris paribus.* Finally, taxation of nominal as opposed to real interest income effectively reduces the real after-tax interest rate when inflation is present. If one incorrectly assumes that real interest income is taxed, the capitalized value of the future property tax flow will be understated and the property tax capitalization rate will be overstated, *ceteris paribus.* Combining these three observations, the overall effect of failing to control for the homebuyer’s tax status on estimates of the property tax capitalization rate is ambiguous, a priori.

Our theoretical model derives the property tax capitalization equation taking differences in tax status across homebuyers into account. The model is based on the bid-rent approach as used by Brueckner (1979), Yinger (1982), and Yinger et al. (1988). In this approach, housing stocks are fixed and families are mobile between communities. Accordingly, in equilibrium the ‘‘total price’’ of a house—the purchase price plus the capitalized value of future property taxes—must be the same for similar homes located in different communities that otherwise provide similar levels of local public services and amenities. Under those conditions, the property tax burden is shifted backwards onto owners of housing, and there is full capitalization. In contrast, the ‘‘new view’’ of the property tax (e.g., Mieszkowski, 1972; Zodrow & Mieszkowski, 1986) assumes that

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[1] Yinger et al. (1988) make the first two assumptions explicit.

[2] Tables 2-2 to 2-7 in Yinger et al. (1988) summarize empirical studies of the property tax capitalization rate.

[3] For example, IRAs, 401(k) plans, and Keogh accounts generate tax-deferred interest and are now widely used by families saving for retirement. Also, as will become apparent, holding nondeductible consumer debt has similar implications for property tax capitalization as saving in tax deferred assets.

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families are immobile but capital is mobile. Under those conditions, differences in property tax rates across communities have ‘‘excise tax’’ effects resulting in less than full capitalization of the property tax because a portion of the property tax differential across communities is shifted forward onto consumers of housing (and new homebuyers). Thus, the extent to which property taxes are capitalized into house values depends on the relative mobility of households and capital and is an empirical issue.

Quantifying the property tax capitalization rate is difficult, however, because one must obtain information on the tax status of individual homebuyers. Also, it is necessary to control for locational effects that may be correlated with property tax payments, in addition to simultaneity between house prices, property tax payments, and other endogenous variables to be noted later. Our strategy is to estimate a hedonic house price equation for 1989 using only homes that turned over between 1985 and 1989, where all homes are drawn from the neighborhood supplements to the 1985 and 1989 American Housing Survey (AHS). Although the AHS does not contain detailed information on the tax status of homeowners, we show that one can use the size of the homebuyer's mortgage to determine whether the homebuyer takes the standard deduction or itemizes, and whether the homebuyer invests at the margin in tax-deferred or taxable assets. In addition, because the neighborhood files are composed of clusters of adjacent housing units, neighborhood fixed effects can be used to control for differences in locational amenities across homes. Finally, because considerable remodeling takes place among homes that turn over between the 1985 and 1989 sample dates, the 1985 structural attributes can be used as instruments in a 2SLS procedure designed to control for the endogenous righthand-side variables.

Given that we control for locational fixed effects, our empirical model should be interpreted as providing an estimate of the intrajurisdictional property tax capitalization rate (as opposed to the interjurisdictional capitalization rate). Results indicate that ignoring differences in tax status across homebuyers—as in previous studies—causes the property tax capitalization equation to be misspecified for roughly 90% of the sample. However, the various specification errors appear to net out for our sample so that there is little difference in the estimated capitalization rate when federal tax provisions are taken into account versus when they are ignored. Nevertheless, it should be emphasized that the impact of controlling for federal tax provisions depends on the distribution of tax status across households in the sample and is likely to vary across samples. Moreover, controlling for household tax status results in a much more precise estimate of the capitalization rate, as would be expected since incorporating tax effects into the model introduces additional information.

The remainder of the paper is organized as follows. Section II outlines the house price equations taking account of differences in tax status across homebuyers. Section III describes the empirical model. Section IV describes the data. Section V presents the results, and section VI concludes.

II. The Capitalization of Future Property Taxes into Current House Prices

This section makes two important points. First, we show that the form of the capitalization equation depends on the homebuyer's tax status, and, second, we demonstrate that the homebuyer's tax status can be inferred from the mortgage. The presentation is intuitive; the formal model is presented in de Bartolomé and Rosenthal (1998).[4]

A. *Market Equilibrium and the Capitalization Equation*

We first derive the capitalization equation that would be relevant in the absence of federal taxes, and then show how it is modified by the federal tax code. When purchasing a house, the homebuyer buys a joint bundle consisting of housing plus the public services provided by the community in which the house is sited. The present value of the funds committed to purchase the house is the house purchase price (v) plus the capitalized value of the future property taxes (pv), or is $v + [pv/(i - \pi)]$, where the property tax rate of the community is p, the nominal interest rate is i, the inflation rate is π, and the real interest rate is $i - \pi$. This expression is the ‘‘bundle price’’ for the house plus the public services provided in the community.

If families are mobile across communities, competition implies that the bundle price of a particular house of size h in a particular community providing public services z equals the market bundle price $Q(h, z)$ for the given level of housing and public services, or $Q(h, z) = v + [pv/(i - \pi)]$. Rearranging, the house purchase price is[5]

$$v = Q(h, z) - \frac{pv}{i - \pi}. \tag{2.1}$$

If there are houses of the same size in two communities that provide the same public service level but with different property tax rates, the purchase price of the house in the community with the higher property tax rate must be less so that the bundle price is the same.

Equation (2.1) is the property tax capitalization equation in the absence of federal income taxes. To take the federal income tax code into account, note that property tax payments are deductible for families that itemize. If a family itemizes, therefore, the net property tax paid by the family is $(1 - \tau)pv$ not pv, and the numerator of the second term on the right-hand side of equation (2.1) is premultiplied by $(1 - \tau)$.

[4] In de Bartolemé and Rosenthal (1998), lowercase letters typically denote variables in real terms while capitals typically denote nominal values. For the intuitive presentation here, we use real values denoted by lowercase letters.

[5] Equation (2.1) is an equilibrium condition that determines how the house price is impacted by the community's property tax rate. The equation says nothing about the level of the price $Q(h, z)$, which is jointly determined by demand and supply conditions as in Rosen (1974).

TABLE 1.—TAX STATUS OF HOMEBUYER AND CAPITALIZATION EQUATION

Case	Itemization Status	Marginal Investment	Property Tax Term	Interest Rate	Capitalization Equation	Mortgage
1.	Itemize	Tax-deferred	$(1-\tau)pv$	$i-\pi$	$v = Q(h,z) - \frac{(1-\tau)pv}{i-\pi}$	$\hat{m} < m$; $m = m_{\max}$
2.	Itemize	Mortgage with PMI	$(1-\tau)pv$	$i(1-\tau) + pmi - \pi$	$v = Q(h,z) - \frac{(1-\tau)pv}{i(1-\tau)+pmi-\pi}$	$\hat{m} < m$; $.8v \le m < m_{\max}$
3.	Itemize	Mortgage without PMI or Taxable	$(1-\tau)pv$	$i(1-\tau)-\pi$	$v = Q(h,z) - \frac{(1-\tau)pv}{i(1-\tau)-\pi}$	$\hat{m} < m$; $0 \le m < .8v, m_{\max}$
4.	Standard deduction	Mortgage with PMI	pv	$i + pmi - \pi$	$v = Q(h,z) - \frac{pv}{i+pmi-\pi}$	$m \le \hat{m}$; $.8v \le m$
5.	Standard deduction	Mortgage without PMI or Tax-deferred	pv	$i-\pi$	$v = Q(h,z) - \frac{pv}{i-\pi}$	$m \le \hat{m}$; $0 < m < .8v$
6.	Standard deduction	Taxable	pv	$i(1-\tau)-\pi$	$v = Q(h,z) - \frac{pv}{i(1-\tau)-\pi}$	$m \le \hat{m}$; $0 = m$

Consider also that homebuyers capitalize future property tax payments using the interest rate earned on marginal savings, and that the federal tax code causes this interest rate to differ across homebuyers. In particular, the federal tax code allows families to save a limited amount in tax-deferred assets such as IRAs, 401(k) plans and Keogh accounts. We approximate tax-deferred assets to be tax exempt. If a family's marginal saving is in tax-deferred assets, a homebuyer's property tax flow is capitalized at rate $i - \pi$ as in equation (2.1). However, if the homebuyer's new savings exceed the maximum amount that may be contributed to tax-deferred assets, and, if the additional saving is placed in taxable assets, the nominal interest earned on the marginal savings is taxed. Therefore, the real interest rate used to capitalize is $i(1-\tau) - \pi$ not $i - \pi$, and the denominator of the second term on the right-hand side of equation (2.1) must be adjusted accordingly.

Tax-deferred assets and taxable assets are only two of the possible saving instruments available to the homebuyer. A third possibility is to use new savings to pay down the mortgage. The nominal interest rate on the mortgage is i, and mortgage interest payments are deductible for homeowners who itemize.[6] Therefore, if there are no other interest expenses associated with the mortgage, the interest rate used by itemizing families who use marginal savings to pay down the mortgage is $i(1-\tau) - \pi$, and the denominator of the second term on the right-hand side of equation (2.1) is adjusted accordingly. However, homebuyers taking out mortgages in excess of 80% of the house value must pay an interest premium (private mortgage insurance, or PMI) in accordance with industry standards: this premium is denoted *pmi* and is not deductible. If an itemizing family paying PMI uses its marginal saving to reduce its mortgage, the interest rate used to capitalize the property tax flow in the denominator of the capitalization term in equation (2.1) is $i(1-\tau) + pmi - \pi$.

Table 1 summarizes the discussion for itemizers as well as for families who take the standard deduction and for whom similar arguments to those above apply. Observe that, for homebuyers who itemize, using savings to pay down the mortgage is equivalent to investing in taxable assets: both are associated with an interest rate of $i(1-\tau) - \pi$. Similarly, for homebuyers who take the standard deduction, the relevant interest rate is $i - \pi$ if marginal savings are used to pay down the mortgage or to invest in tax-deferred assets. Accordingly, column (1) identifies six distinct specifications of the capitalization equation that can arise depending on the homebuyer's tax status. Columns (2) and (3) characterize the homebuyer's itemization status and marginal investment. Columns (4) and (5) show the property tax flow that is capitalized and the interest rate used to capitalize that flow. Column (6) presents the capitalization equation.

In reviewing table 1, it is important to note that the capitalization equation for Case 5 is the equation estimated by prior property tax capitalization studies. However, in formulating the equation, previous authors typically make two assumptions. First, they explicitly assume that all homeowners itemize, and, second, they implicitly assume that real as opposed to nominal interest payments are taxable (or, equivalently, that real as opposed to nominal mortgage interest payments are deductible). (See Yinger et al. (1988), for example). The two assumptions offset, so it is ''as if'' prior studies have ignored the federal income tax code.[7]

[6] As with Yinger et al. (1988, p. 67), one can assume that the value of prepayment and default options embedded in the mortgage rate approximately account for the difference between the mortgage rate and the interest rate on financial assets with similar risk characteristics. Thus, by implicitly incorporating valuable ''hidden'' options in the mortgage contract into the homebuyer's problem, we assume that the present value of a mortgage transaction discounted at the interest rate on savings is approximately zero. (See also Hendershott and Ling (1986) for a similar argument.) Hence, we approximate the mortgage interest rate by the market interest rate earned on saved assets.

[7] Also note, that with heterogenous preferences and housing stock, Q is not fixed but instead differs for each home in the market as a function of the house specific elements of h and z. This precludes the possibility that

B. *Using the Mortgage to Identify the Tax Status to which a Home Belongs*

As will become apparent, our data do not include direct information on either the marginal investment for individual homebuyers, or on whether homebuyers itemize or take the standard deduction. As an alternative, we show that the homebuyer's mortgage (which is available in our data) can be used to infer both the household's marginal investment and whether the household itemizes or takes the standard deduction; this is portrayed in column (7) of table 1.

To begin, consider itemization and denote the mortgage as m. Itemizable deductions include property tax payments (pv), mortgage interest payments (im), and nonhousing deductions (x). Homebuyers itemize if itemizable deductions exceed the standard deduction (d), or if $pv + im + x > d$. So, homebuyers itemize if $m > \hat{m} \equiv [(d - pv - x)/i]$, and they take the standard deduction if $m \leq \hat{m} \equiv [(d - pv - x)/i]$, where $\hat{m}$ denotes the critical mortgage value above which the homebuyer itemizes.

To use the mortgage to infer the tax status of marginal savings, we need to recall that federal restrictions limit a household's annual contribution to tax-deferred assets, to approximate an asset that defers tax to be tax exempt, and to note that households that obtain mortgages with loan-to-value ratios in excess of 0.8 must pay PMI which is not deductible. For realistic parameter values, PMI is sufficiently small that, for itemizers,[8]

$$i(1 - \tau) - \pi < i(1 - \tau) + pmi - \pi < i - \pi, \tag{2.2}$$

while, for nonitemizers,

$$i(1 - \tau) - \pi < i - \pi < i + pmi - \pi. \tag{2.3}$$

Inequality (2.2) says that, for itemizers, the return earned on tax-deferred assets exceeds the after-tax interest cost of a mortgage with PMI. This latter interest cost exceeds the after-tax interest cost of a mortgage without PMI, which in turn is equal to the after-tax interest rate on taxable assets. Inequality (2.3) indicates that, for nonitemizers, the interest cost of a mortgage with PMI exceeds the interest cost of a mortgage without PMI—which equals the rate of return earned on tax-deferred assets—which in turn exceeds the after-tax rate of return on taxable assets. Finally, in addition to inequalities (2.2) and (2.3), we assume that there is no uncertainty (all investments are risk free), and there is a maximum size mortgage (m_{max}) that lenders are willing to issue to a given family.[9]

Consider now an itemizing homebuyer ($\hat{m} < m$) for whom the return on tax-deferred assets, $i - \pi$, exceeds the return on all other assets. The homebuyer is willing to increase the mortgage if necessary in order to make the maximum allowable contribution to the tax-deferred asset.[10] It follows that if a homebuyer holds the maximum mortgage permitted by lenders ($m = m_{max}$), the homebuyer would likely prefer to increase the mortgage but cannot because of the binding debt constraint. Under these conditions the marginal investment is tax-deferred and earns $i - \pi$: Case 1 is the relevant case in table 1.

If a homebuyer itemizes ($\hat{m} < m$) and takes out a mortgage below the maximum permitted by lenders ($0 < m < m_{max}$), the homebuyer could hold more mortgage debt but chooses not to. This implies that the homebuyer is unable to increase his/her savings in tax-deferred assets by increasing the mortgage and must, therefore, have made the maximum allowable contribution to the tax-deferred asset. Under these conditions, inequality (2.2) shows that, if the homebuyer has PMI, any new savings in excess of that required to fund the maximum contribution to tax-deferred assets is used to pay down the mortgage: the relevant case in table 1 is Case 2 and the interest rate on the marginal savings is $i(1 - \tau) + pmi - \pi$. If the homebuyer does not have PMI, the interest rate is $i(1 - \tau) - \pi$, and savings over and above that used to fund tax-deferred assets are used to pay down the mortgage and/or to save in taxable assets. The relevant case in table 1 is Case 3.

Analogously, homebuyers with $m \leq \hat{m}$ take the standard deduction. For these households, inequality (2.3) shows that the mortgage interest rate ($i + pmi - \pi$) exceeds the rate of return on all alternative assets. Nonitemizers with PMI (i.e., with mortgages m such that $0.8v \leq m \leq \hat{m}$) therefore use all new savings to reduce the mortgage: the relevant interest rate is $i + pmi - \pi$, and the relevant case in table 1 is Case 4. For nonitemizers with mortgages for which PMI is not required (i.e., mortgages such that $0 < m \leq \hat{m}, 0.8v$), savings yield the highest return in both tax-deferred assets and

families belonging to the case that yields the greatest tax advantage (Case 1 in table 1) would have the highest bid for each home on the market. Further, unlike the physical and locational attributes of the home, property tax flow (which is also a characteristic of the house) is endogenously determined and depends in part on the tax status of the homebuyer. In that regard, homebuyer tax status affects the household's willingness to pay for h and z and can, therefore, be expressed as a function of h and z by inverting the household's bid function (e.g., Rosen, 1974). Partly for that reason, in the empirical section to follow, endogeneity is addressed using two-stage least squares in which the household's property tax flow is first regressed on current and lagged attributes of the home.

A further implication of our model not explored in this paper concerns household sorting. In equilibrium, identical adjacent homes must have the same value, which implies one of two possibilities: either identical adjacent homes are occupied by households with the same tax status, or differences in tax status across adjacent households are offset by differences in the benefits those households derive from their housing consumption. These implications are left for future research.

[8] In our sample period, the value of PMI satisfied the assumed relationship in inequalities (2.2) and (2.3).

[9] Assuming risk-free assets simplifies the discussion considerably but likely has little effect on the empirical results. The reason is that our ultimate goal in the discussion below is to motivate use of the mortgage to infer the approximate real after-tax discount rate that individual homebuyers use to capitalize their property tax flows, not to model portfolio composition.

[10] This argument has implications for the demand for mortgage debt since itemizing homebuyers for whom $m < m_{max}$ may take on more mortgage debt than is necessary to finance their homes (e.g., Jones, 1993, 1994).

paying down the mortgage: the relevant interest rate is $i - \pi$ and Case 5 in table 1 applies.

Finally, if $0 = m \leq \hat{m}$, the homebuyer holds no mortgage debt and could potentially be saving at the margin in either taxable or tax-deferred assets. However, families that can purchase their homes without a mortgage are typically wealthy. For that reason, in the analysis to follow we assume that nonitemizing homebuyers with $m = 0$ have sufficient means to make the maximum contribution to the tax-deferred asset, so that the marginal investment is taxable. For these homebuyers, the discount rate used to capitalize the property tax flow is $i(1 - \tau) - \pi$, and Case 6 in table 1 applies.

III. Empirical Model

To simplify the exposition, define $C_1 \ldots C_6$ as a set of 1-0 variables corresponding to the six cases listed in table 1. Note that the case to which a home belongs is a function of its structural (h) and locational (z) characteristics, and let i and s index house i and location s, respectively. Then, $C_{j,is} \equiv C_j(h_{is}, z_s)$, $j = 1, \ldots, 6$, where h is subscripted by is because it varies both within and across locations, z is subscripted only by s because it varies only across locations, and j indexes the six cases. The property tax term in the capitalization equation for house i is denoted by g_{is}, where,

$$\begin{aligned} g_{is} \equiv pv_{is} \Bigg[& C_{1,is} \frac{(1-\tau_{is})}{i - \pi} \\ & + C_{2,is} \frac{(1-\tau_{is})}{i(1-\tau_{is}) + pmi - \pi} \\ & + C_{3,is} \frac{(1-\tau_{is})}{i(1-\tau_{is}) - \pi} + C_{4,is} \frac{1}{i + pmi - \pi} \\ & + C_{5,is} \frac{1}{i - \pi} + C_{6,is} \frac{1}{i(1-\tau_{is}) - \pi} \Bigg], \end{aligned} \tag{3.1}$$

where τ_{is} is the marginal income tax rate for the homebuyer of house i. Now express the bundle price, $Q(h_{is}, z_s)$, as a linear combination of the vectors of structural (h_{is}) and locational (z_s) attributes for house i at location s, $Q(h_{is}, z_s) = \lambda_z z_s + \lambda_h h_{is}$. Then the capitalization equation can be written as

$$v_{is} = \lambda_z z_s + \lambda_h h_{is} - \phi g_{is} + e_{is}, \tag{3.2}$$

where the error term e_{is} is assumed to be normally distributed with mean zero. Note also that ϕ is the property tax capitalization rate.

In order to obtain consistent estimates of ϕ, several empirical problems must be addressed.[11] First, one must control for z_s in order to avoid omitted variable bias. That is because pv_{is}, τ_{is}, and $C_{j,is}$ all depend on z_s causing the property tax term, g_{is}, to be correlated with z_s. Since we cannot accurately measure z_s, let, $\beta_s \equiv \lambda_z z_s$, and substitute into equation (3.2) to get

$$v_{is} = \beta_s + \lambda_h h_{is} - \phi g_{is} + e_{is}. \tag{3.3}$$

Observe that β_s is a location-specific effect. Thus, differencing off the locational means from equation (3.3) gives

$$v_{is} - \bar{v}_s = \lambda_h(h_{is} - \bar{h}_s) - \phi(g_{is} - \bar{g}_s) + e_{is}, \tag{3.4}$$

where the overbars denote locational means, and the average value of e_{is} within location s is assumed to equal zero.[12] Note also, that the locational fixed effects drop out of equation (3.4), which resolves the omitted variable problem.[13]

A further complication is that pv_{is}, τ_{is}, and $C_{j,is}$ also likely depend on v_{is} causing the property tax term, g_{is}, to be correlated with the error term in equation (3.4).[14] To control for simultaneity, equation (3.4) can be estimated by 2SLS, provided suitable instruments can be found. That problem is addressed by expressing $g_{is} - \bar{g}_s$ in the first stage equation as a function of current and lagged values of $h_{is} - \bar{h}_s$. Provided there is sufficient variation in h_{is} over time to satisfy the required identification conditions, lagged values of $h_{is} - \bar{h}_s$ make good instruments since they are exogenous but are correlated with current period property values.[15]

[11] See Yinger et al. (1988) for a description of empirical problems common to property tax studies.

[12] The assumption that e_{is} has mean zero within each location s is not necessarily innocuous. For example, suppose that homes are of two sizes, large and small, and of two qualities, high and low. House prices increase with house size and quality, but house size is observed and quality is unobserved. Further, high-quality large homes are only in large-home neighborhoods, but low-quality large homes are found in mixed-size neighborhoods. Analogously, high-quality small homes are found in mixed-size neighborhoods, but low-quality small homes are only in small-home neighborhoods. Then e_{is} would not have mean zero within each neighborhood because homes would be sorted by quality. Moreover, fixed effect models such as equations 3.3 and 3.4 would underestimate the coefficient on house size: this occurs because the coefficient on house size would be estimated based only on information from mixed-size neighborhoods that are filled with low-quality large homes and high-quality small homes. While such simultaneity problems cannot be entirely ruled out in this paper, in practice it seems unlikely that estimates from our model are sensitive to such effects given that most neighborhoods contain a mix of homes with different observable and unobservable traits. See also Robinson (1989) and Maddala (1983) for further discussion.

[13] As shown by Hsiao (1986) and others, equations (3.3) and (3.4) yield algebraically identical estimates of the slope coefficients, including ϕ. However, equation (3.4) is computationally more tractable, since it is not necessary to estimate the locational fixed effects, β_s, which total 265 for our sample.

[14] The property tax payment is clearly endogenous since pv is proportional to house value (v). In addition, housing demand studies have demonstrated that the user cost of owner-occupied housing is inversely related to the homeowner's marginal income tax rate (e.g., Rosen, 1979). Thus, housing demand increases with the marginal income tax rate, causing τ to be positively correlated with the error term in the hedonic equation. The case to which a home belongs, C_j, is sensitive to the size of the homebuyer's mortgage (m) as discussed in section 2. Since the homebuyer's mortgage is a function of v, C_j must also depend on v and is therefore endogenous.

[15] Given that g_{is} is the only righthand-side endogenous variable, in order to identify ϕ, $h_{is} - \bar{h}_s$ must include at least one important determinant of g_{is} that does not otherwise belong in equation (3.4). Also, in principle, nonlinear transformations of $h_{is} - \bar{h}_s$ can be included in the first-stage

A final estimation problem is that the estimated property tax capitalization rate increases with the real pretax discount rate, $i - \pi$, but there is debate in the literature regarding the correct value of that rate. To the extent that the discount rate used to capitalize the property tax flow is proportional to $i - \pi$, as in Case 1 and 5, estimates of the property tax capitalization rate double with a doubling of $i - \pi$: this is the situation for all prior property tax studies, since those studies effectively assume that all homes in their samples belong to Case 5. On the other hand, with reasonable parameter values for Case 2, 3, and 6, an increase in $i - \pi$ has more than a proportional effect on the discount rate, and, therefore, has more than a proportional effect on the estimated capitalization rate.[16] Thus, taking nominal taxation of interest into account likely increases the sensitivity of the estimated capitalization rate to selection of the real pretax discount rate.

The last issue concerns interpretation of ϕ. Capitalization studies typically distinguish between interjurisdictional capitalization (the extent to which differences in property tax rates across communities are capitalized into house prices) and intrajurisdictional capitalization (the extent to which differences in property tax payments across homes within a given community are capitalized). In order to estimate interjurisdictional capitalization rates, one would have to estimate equation (3.2) including the property tax term as a regressor, an approach that would suffer from omitted variable bias for reasons already noted. For that reason, we difference the data as in equation (3.4) and focus on $g_{is} - \bar{g}_s$, a variable that reflects variation in property tax payments within locations. Our estimate of ϕ, therefore, measures the intrajurisdictional property tax capitalization rate.[17]

IV. Data

A. The Sample

Data for the estimation are drawn from a unique subset of the 1985 and 1989 national core files of the American Housing Survey (AHS). In 1985, the AHS selected 680 urban housing units at random from the overall core file of roughly 55,000 housing units. For each selected housing unit, the AHS then conducted a full survey of up to ten of that unit's "closest neighbors." Given the dense pattern of development in most urban areas, the 680 housing clusters compose a distinct neighborhood cluster in which member families face the same locational attributes. The neighborhood feature of the data enables us to control for location-specific fixed effects as described earlier.

In 1989, the AHS resurveyed each of the neighborhood housing units. By linking these data with the 1985 surveys, we are able to observe changes in the structural attributes of the individual homes over the two sample dates. We use only owner-occupied homes that turned over between the two sample dates in order to increase the accuracy of owner-assessments of house value, reported property taxes, and the reported mortgage, all of which were used in the analysis.[18] Moreover, properties that have recently turned over often undergo remodeling as new buyers modify their home to suit their needs. That remodeling contributes to variation in the reported structural attributes over the 1985 to 1989 period and allows us to use the 1985 structural attributes as instruments for 1989 property tax payments when estimating the 2SLS model.[19]

Structural attributes for both 1985 and 1989 include floor space (in 1,000 sq. ft. units), number of rooms, number of bathrooms, number of bedrooms, lot size (in 1,000 sq. ft. units), whether the property is single family detached (SFD) or attached (SFA) (multifamily is the omitted category), and the year in which the structure was built.[20] In addition, federal marginal income tax rates were calculated for each family using 1989 household income and demographic data as reported in the AHS in conjunction with the 1989 tax tables.[21] After excluding observations with missing values and neighborhood clusters for which the average property tax rates were especially high or low (above 4.5% or below 0.2%), the resulting sample of owner-occupied homes totaled 566 homes spread over 265 neighborhoods.[22]

equation to account for nonlinearities in g_{is}. In practice, however, multicolinearity became a problem when this was attempted. Additional details on the instrument list are provided in the following section.

[16] For Cases 3 and 6, for example, note that the discount rate used to capitalize the property tax flow can be rewritten as $(i - \pi)[(1 - \tau) - \tau\pi/(i - \pi)]$. With either τ or π set to zero, $i - \pi$ would disappear from the term in brackets, and an increase in $i - \pi$ would have a proportionate effect on the discount rate. On the other hand, with positive values for τ and π, it is clear that an increase in $i - \pi$ increases the term in brackets, and $i - \pi$ has more than a proportionate effect on the discount rate. The argument for Cases 2 and 4 is similar.

[17] Note also that we constrain ϕ to be alike for the different neighborhoods in our sample in contrast to Yinger et al. (1988) whose data permit them to estimate separate values for ϕ across jurisdictions. Also, given that our focus is on intrajurisdictional capitalization of the property tax, our empirical work is best interpreted as focusing on *relative* house prices within neighborhoods as in equation (3.4). As such, when calculating the coefficient standard errors and corresponding *t*-ratios, the degrees of freedom were set equal to the sample size less the number of slope coefficients in equation (3.4). If instead one wanted to emphasize price level effects, the fixed effects should be added back into the equation (as in equation (3.3)) and the degrees of freedom and *t*-ratios adjusted accordingly.

[18] Property taxes are reported as a range (e.g., between \$600 and \$700), the midpoint of which is used.

[19] More generally, reported changes in the structural attributes arise from both actual changes and reporting error. However, reporting error is likely to be random across sample dates given that the 1985 and 1989 data are reported by different owner-occupants (since we focus on homes that have recently turned over). Thus, reporting error introduces noise into the instruments used in the 2SLS procedure but does not bias the results.

[20] The variable Year Built was coded as follows: Year Built equals 1, 2, 3, . . . , 9, respectively, depending on whether the structure was built after 1979, between 1975 and 1979, between 1970 and 1974, between 1960 and 1969, between 1950 and 1959, between 1940 and 1949, between 1930 and 1939, between 1920 and 1929, or earlier than 1920.

[21] The marginal income tax rate was calculated assuming that homebuyers take the standard deduction. This was done because in 1989 there were only three federal income tax brackets (for marginal tax rates of 0.15, 0.28, and 0.33), and the brackets were \$20,000 to \$40,000 wide. Thus, although many homeowners itemize, the assumption that homeowners take the standard deduction likely has little effect on the estimated marginal income tax rates while greatly simplifying the calculation of those rates.

[22] We also excluded neighborhood clusters with exceptionally low or high average appreciation rates (−50% and +300%, respectively).

B. *Determining the Case to which a Home Belongs*

The case to which a home belongs, $C_1, \ldots, C_6$, is determined by using the homebuyer's mortgage as discussed in section II and shown in table 1. A household itemizes if $m > \hat{m}$, or if $im > d - pv - x$. The data contain observations on the mortgage interest payment (im), the standard deduction (d) and the property tax payment (pv), but not on x.[23] For our ''base case,'' x is set equal to \$500 for all homebuyers.[24] At that level, our estimated sample proportion of nonitemizers is 45%, the same as obtained by Follain and Dunsky (1997) and consistent with estimates by Maki (1994), studies that observed both housing and nonhousing deductions.[25]

To obtain m_{max}, consider that mortgage insurance companies are free to deny insurance to high-risk applicants. In addition, the secondary mortgage market generally limits loan-to-value (LTV) ratios to 80%, and total house payment-to-income ratios to 28 percent, where house payments include mortgage payments, property taxes, hazard insurance (HI), and PMI.[26] Accordingly, we set $m < m_{max}$, if $m < c_1 v$ and $im + pv + \text{HI} + pmi < c_2 y$, and $m = m_{max}$, if $m \geq c_1 v$ or $im + pv + \text{HI} + pmi \geq c_2 y$, where c_1 is the maximum LTV ratio permitted by lenders, and c_2 is the maximum house payment-to-income ratio lenders will allow. We set HI equal to $0.005v$, or 0.5% of house value, while PMI is set equal to $0.0035m$, or 0.35% of the mortgage, values that are roughly consistent with industry norms.[27] For our base case, we set c_1 equal to 0.80 and c_2 equal to 0.30. At those levels, roughly 31% of our sample encounters mortgage debt constraints, which is broadly consistent with estimates of the share of credit constrained households in the U.S. as reported by Jappelli (1990) and Duca and Rosenthal (1994).[28]

V. Results

A. *Summary Statistics*

Variable summary statistics are provided in table 2. As expected, the standard deviations for the neighborhood differenced data are lower than for the levels data. The reduced standard deviations highlight the importance of having a large sample when controlling for locational effects in the manner used here, since differencing the data reduces variation in both the regressors and dependent variables. In addition, consider the ''No-Change'' row for each structural attribute and note that No-Change equals 1 when the attribute in question did not change in value over the 1985–1989 period, and equals 0 otherwise. Review of the No-Change values suggests that there are relatively frequent changes in the number of rooms, bedrooms, and bathrooms over the two sample dates. To the extent that this variation is driven by real changes in the structural attributes, then the 1985 structural attributes make good instruments when estimating the 2SLS model, allowing us to estimate the capitalization rate with ''reasonable'' precision.[29]

B. *The Capitalization Equation*

Table 3 presents 2SLS estimates for three different hedonic equations based on different specifications of the property tax term.[30] In each model, the nominal interest rate (i) is set to 7% and inflation (π) is set to 4%. This implies a

[23] Mortgage payments sometimes include property taxes, condominium fees, hazard insurance, and PMI. However, the AHS does not permit one to determine whether hazard insurance and PMI are included in the reported mortgage payment. Since those fees are not deductible, including them in the mortgage would overstate the propensity of homebuyers to itemize. To avoid that possibility, we calculated the nominal mortgage interest payment by multiplying the homebuyer's mortgage (m) by the average mortgage rate for the sample which equaled 9.8%.

[24] In 1989, median homeowner income was \$35,481 (Current Population Reports Series P-60, No. 168, Table 1, 1990, Bureau of the Census). For itemizers with incomes in the range of \$35,000 to \$40,000, average nonhousing deductions were \$413 (Statistics of Income—Individual Income Tax Returns 1989, Table 2.1, Internal Revenue Service).

[25] Using the 1989 Survey of Consumer Finances (SCF), Follain and Dunsky (1997) estimate that 45% of owner-occupiers do not itemize. With higher-quality IRS data, Maki (1994) reports that 72% of U.S. households do not itemize. Note now that 64% of U.S. families are owner-occupiers. If all renters take the standard deduction, Maki's estimate implies that 56% $(1 - 0.28/0.64)$ of owner-occupiers do not itemize. In addition, consider that Maki's sample is representative of the United States (as with Follain and Dunsky (1997)), whereas our sample is composed of urban homebuyers who purchased their homes in the last three years. Also, homeowners typically pay down their mortgage over time, and urban homebuyers take on the largest mortgages owing to the high cost of housing in densely populated areas. Thus, our sample is likely to include a larger than ''representative'' share of homebuyers with big mortgages and, as such, should exhibit a lower frequency of nonitemizers than found by Maki (1994).

[26] There are a variety of conditions under which prospective borrowers might face tighter—or possibly less restrictive—limits on the amount of mortgage debt lenders are willing to issue. See, for example, Follain and Wong (1995), Duca and Rosenthal (1991, 1993), or Gabriel and Rosenthal (1991). In addition, note that, when calculating household house payment-to-income ratios, the calculation of mortgage payments—as described earlier—implicitly assumes an interest-only mortgage. That assumption simplifies our calculations but likely has little effect on the results given that almost all of the mortgage payment in the first several years of a mortgage is interest.

[27] See, for example, Brueggeman and Fisher (1993), page 206.

[28] Using data from the 1983 Survey of Consumer Finances (SCF), Jappelli (1990) finds that 22% of U.S. households report having recently been turned down for loans or received less credit than desired without having successfully reapplied at an alternate lender. Duca and Rosenthal (1994) use the same SCF data and find that 11% of U.S. households are credit-constrained owner-occupiers. Since two-thirds of U.S. households own their homes, this suggests that 17% (0.11/0.66) of all homeowners are credit constrained. Consider, however, that our sample includes only homeowners that have recently purchased their homes, a group that is likely to report being credit constrained (e.g., Duca & Rosenthal, 1994). Thus, one would expect the share of credit-constrained homebuyers in our sample to be substantially higher than estimates based on Jappelli (1990) and Duca and Rosenthal (1994). In contrast, Linneman and Wachter (1989) report a much higher frequency of credit-constrained families than in our paper. However, it is important to note that Linneman and Wachter report results for a sample composed of both owner-occupiers and renters. For that reason, one would expect the frequency of credit-constrained individuals in our sample to be substantially lower than in Linneman and Wachter, since renters are believed to disproportionately encounter binding borrowing constraints.

[29] To the extent that changes in the structural attributes reflect reporting error, then the 1985 structural attributes add primarily noise to our instruments. Under these conditions, we should not be able to identify the property tax capitalization rate, in contrast to results reported below.

[30] The reported R-squared statistics in table 3 indicate the percentage of within-neighborhood variation in house prices explained by the model.

TABLE 2.—SELECTED SUMMARY STATISTICS FOR 1985 AND 1989 DATA (SAMPLE SIZE: 566; NUM. OF NEIGHBORHOODS: 265)

	Actual Levels[a]		Neigh Differenced[a]		Time Differenced[a]	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
House Value ($1,000)						
v_{1985}[b]	82.59	52.89	0.00	17.15	—	—
v_{1989}[b]	109.1	83.34	0.00	17.36	—	—
Property Tax Rate						
p_{1989}	0.011	0.010	0.00	0.00	—	—
Floor Space (1,000 sq ft)						
Floor Space 85	1.819	0.902	0.00	0.416	—	—
Floor Space 89	1.789	0.837	0.00	0.376	—	—
Floor Space 89-85	—	—	—	—	−0.029	0.619
No Change Floor Space[c]	—	—	—	—	0.587	0.493
Number of Rooms						
Rooms 85	6.187	1.661	0.00	0.905	—	—
Rooms 89	6.237	1.643	0.00	0.837	—	—
Rooms 89-85	—	—	—	—	0.049	1.379
No Change in Rooms[c]	—	—	—	—	0.396	0.489
Number of Bathrooms						
Bathrooms 85	1.525	0.634	0.00	0.322	—	—
Bathrooms 89	1.594	0.739	0.00	0.450	—	—
Bathrooms 89-85	—	—	—	—	0.069	0.604
No Change in Bathrooms[c]	—	—	—	—	0.818	0.386
Number of Bedrooms						
Bedrooms 85	2.926	0.943	0.00	0.592	—	—
Bedrooms 89	2.915	0.850	0.00	0.471	—	—
Bedrooms 89-85	—	—	—	—	−0.011	0.807
No Change in Bedrooms[c]	—	—	—	—	0.680	0.467
Lot Size (1,000 sq. ft.)						
Lot Size 85	10.14	20.21	0.00	9.028	—	—
Lot Size 89	9.758	23.01	0.00	12.08	—	—
Lot Size 89-85	—	—	—	—	−0.381	12.87
No Change in Lot Size[c]	—	—	—	—	0.306	0.461
Single Family Detached						
SFD 85	0.845	0.363	0.00	0.124	—	—
SFD 89	0.832	0.374	0.00	0.101	—	—
SFD 89-85	—	—	—	—	−0.012	0.192
No Change in SFD[c]	—	—	—	—	0.963	0.189
Single Family Attached						
SFA 85	0.046	0.210	0.00	0.073	—	—
SFA 89	0.060	0.238	0.00	0.072	—	—
SFA 89-85	—	—	—	—	0.014	0.178
No Change in SFA[c]	—	—	—	—	0.968	0.176
Year Structure Built						
Year Built 85	4.413	2.335	0.00	0.795	—	—
Year Built 89	4.435	2.359	0.00	0.727	—	—
Year Built 89-85	—	—	—	—	0.021	1.010
No Change in Year Blt[c]	—	—	—	—	0.781	0.414

Notes: [a] Columns 1 and 2 are in level terms, columns 3 and 4 difference off the neighborhood means, and columns 5 and 6 compare 1989 and 1985 values.
[b] v_{1985} and v_{1989} are the house values in 1985 and 1989, respectively.
[c] The ‘‘No Change’’ rows are coded 1 if the variable values are identical in 1985 and 1989, and 0 otherwise.

real interest rate of 3%.[31] Although the specifications across columns differ (in a manner to be discussed below), one can reject the null hypothesis of nonnegative property tax capitalization in each case.[32]

The specification in the first model is the same as in earlier studies: all homebuyers are assumed to itemize and to invest in marginal assets for which real interest income is taxed, and there are no PMI charges. As noted earlier, these assumptions are equivalent to assuming that all homes belong to Case 5 in table 1, or to ignoring the federal income tax structure. For this model, the estimated property tax capitalization rate equals roughly 0.40, consistent with the range of estimates obtained by Yinger et al. (1988).[33] Relative to the first model, in the second model the

The ‘‘full’’ R-square statistics that take into account both between- and within-neighborhood variation in the data are roughly 90%.

[31] Although Do and Sirmans (1994) have recently estimated that property taxes are discounted at a real after-tax rate of 4%, controversy undoubtedly remains regarding the ‘‘true’’ value for $i - \pi$. Accordingly, we set $i - \pi$ equal to 3% as in Yinger et al. (1988), since their book is the most widely known property tax capitalization study in recent years. Also, inflation is set equal to 4% to conform to the level of inflation experienced around 1989, our sample period. By comparison, over the 1988–1993 period, the average annual U.S. inflation rate (CPI-U) was 4.08% as reported by the Bureau of Labor Statistics.

[32] Based on a one-tailed test, the prob-values associated with the estimated property tax capitalization rates in columns 1 through 3 are 0.087, 0.040, and 0.001, respectively. In addition, for each model, the coefficients on variables other than the property tax are of plausible magnitude and significance in all models.

[33] Yinger et al. (1988) estimate that property tax capitalization rates range from 0.15 to 0.35.

TABLE 3.—HEDONIC EQUATIONS WITH $i = .07$, $\pi = .04$ (SAMPLE SIZE: 566; NUM. OF NEIGHBORHOODS: 265)

	Previous Model Itemize, Taxable Assets, Tax Real Interest		*Intermediate Model* Itemize, Taxable Assets, Tax Nominal Interest		*Preferred Model*[a] Itemize/Standard Deduction, Taxable/Tax-Deferred Assets, Tax Nominal Interest	
	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio
Property Tax	−0.3994	−1.362	−0.1988	−1.756	−0.4008	−2.339
Floor Space	4.8939	2.240	5.0379	2.257	3.5081	1.263
Rooms	2.1909	1.870	2.3071	1.939	1.4902	0.993
Bathrooms	1.2708	0.699	1.1402	0.615	0.2078	0.089
Bedrooms	2.8275	1.333	2.8761	1.329	4.8697	1.751
Lot Size	−0.0069	−0.110	0.0021	0.034	−0.0106	−0.137
SFD	25.779	2.336	22.746	2.134	33.692	2.389
SFA	21.978	1.520	24.343	1.639	44.030	2.141
Year Built	−2.7112	−2.156	−2.6559	−2.267	−2.6580	−1.991
Residual SS	156,621		156,224		154,662	
Std Error	16.77		16.75		16.66	
R-square	0.081		0.083		0.092	
R-square Adj.	0.067		0.070		0.079	

Note: [a] For the preferred model, for all homes we set $x = \$500$, $c_1 = 0.8$, and $c_2 = 0.30$.

assumption that real interest income is taxed is replaced with the more realistic assumption that nominal interest income is taxed: this lowers the estimated capitalization rate by twenty percentage points to roughly 0.20.[34]

The third model presents results from the full model outlined in section II as described by equation (3.4): homebuyers itemize or take the standard deduction, homebuyers save in taxable or tax-deferred assets, nominal interest income is taxed, and PMI is required for high-LTV loans. For this model, homebuyer tax status is inferred with nonhousing deductions set equal to \$500 and credit standards set equal to 0.80 and 0.30 for c_1 and c_2, the maximum allowable loan-to-value and house payment-to-income ratios, respectively. The effect of these assumptions is to move the estimated property tax capitalization rate back to 0.40, implying that the various specification errors associated with the capitalization equation from prior studies net out. This result, however, is quite sensitive to the distribution of homebuyer tax status and would not necessarily generalize to other samples. On the other hand, observe that the *t*-ratio on the capitalization rate is considerably higher in Model 3 as compared to Model 1. Thus, controlling for homebuyer tax status results in a more precise estimate of the capitalization rate, a finding that is likely to be robust, since controlling for tax status introduces additional information into the model.

C. *Robustness Checks and the Classification of Homes by Tax Status*

Table 4 presents estimates of the property tax capitalization rate for different values of the unobserved parameters to check the robustness of our results. The top panel of table 4 presents estimates of the capitalization rate along with the sample frequency of the cases to which homes belong for values of x ranging from 0 to \$5,450, where \$5,450 is sufficiently high to ensure that all homebuyers itemize (\$5,450 is the standard deduction for married filers in 1989).[35] In each case, the credit standards used to determine m_{max}, c_1 and c_2, are set equal to 0.8 and 0.3, respectively. As such, no households belong to Case 2 since any family with an LTV greater than 80% is assumed to hold as much mortgage debt as lenders allow, and therefore, save in tax-deferred assets.

Observe that the frequencies of Case 1 and 3 increase monotonically with x as homes classified as nonitemizers shift over to itemization status. However, the estimated capitalization rate varies little with x, especially for nonhousing deductions up to \$1,500. To understand why, recall from equation (3.1) that the property tax term in the hedonic regression (g) can be written as $g = pv[C_1\delta_1 + C_2\delta_2 + C_3\delta_3 + C_4\delta_4 + C_5\delta_5 + C_6\delta_6]$, where the C_j ($j = 1, 2, \ldots 6$) are 1-0 dummy variables for the six cases, and δ_j ($j = 1, 2, \ldots 6$) are the coefficients on C_j in equation (3.1). For homebuyers with positive income tax rates and parameter values consistent with our time period, $\delta_3 > \delta_5 > \delta_4 > \delta_1$.[36] Observe now that as nonhousing deductions x increase from 0 to \$1,500, nonitemizers are drawn from

[34] In Model 2, all homebuyers itemize, save in taxable assets, and there are no PMI charges.

[35] We also estimated table 4 with x as a percentage of gross family income, $x = \alpha y$, in which case x varies across families for a given value for α. With average household income in our sample equal to roughly \$45,000, each 0.01 increase in α resulted in an average increase in x of \$450 per homebuyer. For values of α from 0 to 0.03, results were nearly identical to those of table 4 when x was increased from 0 to \$1,500. With a further increase in α up to 0.06, the estimated property tax capitalization rate fell somewhat in contrast to table 4. With still higher values for α, the capitalization rate became similar to table 4 once more, as all homebuyers ultimately switch over to itemization status.

[36] Recall that $i = 0.07$, $\pi = 0.04$, and $pmi = 0.0035$. Setting $\tau = 0.15$—the lowest marginal income tax bracket in our period—and using equation (3.1):

$$\delta_3 = \frac{1-\tau}{i(1-\tau)-\pi} = 43.6, \quad \delta_5 = \frac{1}{i-\pi} = 33.3,$$

$$\delta_4 = \frac{1}{i+pmi-\pi} = 29.9, \quad \text{and} \quad \delta_1 = \frac{1-\tau}{i-\pi} = 28.3.$$

TABLE 4.—PROPERTY TAX CAPITALIZATION RATES AND SAMPLE FREQUENCIES WITH $i = 0.07$, $\pi = 0.04$ AND DIFFERENT LEVELS OF NONHOUSING DEDUCTIONS (x) AND CREDIT STANDARDS (c_1, c_2)[a]

		ITEMIZE Marginal Investment			DON'T ITEMIZE Marginal Investment		
		Tax Deferred Case 1	Taxable Case 2	Taxable Case 3	Tax Deferred Case 4	Tax Deferred Case 5	Taxable Case 6
	Itemization Status	$m > \hat{m}$	$m > \hat{m}$	$m > \hat{m}$	$m \le \hat{m}$	$m \le \hat{m}$	$m \le \hat{m}$
	Investment Status	$m = m_{\max}$	$.8v \le m < m_{\max}$	$m < .8v, m_{\max}$	$.8v \le m$	$0 < m < .8v$	$m = 0$
	Prop Tax Term	$\frac{(1-\tau)pv}{i-\pi}$	$\frac{(1-\tau)pv}{i(1-\tau)+pmi-\pi}$	$\frac{(1-\tau)pv}{i(1-\tau)-\pi}$	$\frac{pv}{i+pmi-\pi}$	$\frac{pv}{i-\pi}$	$\frac{pv}{i(1-\tau)-\pi}$
NONHOUSING[b] DEDUCTIONS	Capitalization Rate	Frequency Case 1	Frequency Case 2	Frequency Case 3	Frequency Case 4	Frequency Case 5	Frequency Case 6
\$0	−0.403	0.240	0.000	0.272	0.072	0.127	0.288
\$500	−0.401	0.256	0.000	0.293	0.057	0.106	0.288
\$1,500	−0.422	0.288	0.000	0.327	0.030	0.067	0.288
\$2,500	−0.478	0.316	0.000	0.391	0.005	0.041	0.247
\$5,450	−0.429	0.332	0.000	0.668	0.000	0.000	0.000
CREDIT STANDARDS[b]							
$c_1 = .80, c_2 = .30$	−0.401	0.256	0.000	0.293	0.057	0.106	0.288
$c_1 = .90, c_2 = .30$	−0.318	0.180	0.076	0.293	0.057	0.106	0.288
$c_1 = 1.0, c_2 = .30$	−0.289	0.104	0.152	0.293	0.057	0.106	0.288
$c_1 = .80, c_2 = .28$	−0.376	0.270	0.000	0.279	0.057	0.106	0.288
$c_1 = .80, c_2 = .30$	−0.401	0.256	0.000	0.293	0.057	0.106	0.288
$c_1 = .80, c_2 = 1.0$	−0.394	0.198	0.000	0.352	0.057	0.106	0.288

Notes: [a] The terms $\hat{m}$ and $m_{\max}$ were obtained as described in the text; c_1 and c_2 are equal to the maximum loan-to-value (LTV) and house payment-to-income ratios allowed by lenders, respectively.
[b] Only the indicated variable is varied. The remaining variables are set at base values: $x = \$500$, $i = 0.07$, and $\pi = 0.04$.

Case 4 and 5 and are roughly equally spread over Case 1 and 3. Accordingly, the property tax term, g, is increased for some households but decreased for others, and the effects largely offset.

The lower panel of table 4 presents estimates of the capitalization rate and sample frequency of the cases to which homes belong as c_1 is varied from 0.8 to 1.0, and c_2 is varied from 0.28 to 1.0. In the extreme case with $c_1 = c_2 = 1$, the possibility of credit rationing is eliminated. The table suggests that the estimated capitalization rate is relatively sensitive to changes in c_1, but relatively insensitive to changes in c_2. In particular, with $c_2 = 0.3$, increasing the LTV ratio from 0.8 to 1.0 causes the capitalization rate to fall from 0.40 to 0.29. This happens because an increase in c_1 raises m_{max}, the maximum mortgage allowed by lenders, and thereby shifts some homebuyers from Case 1 to Case 2. That lowers the discount rate for those families, causing the capitalized value of their future property taxes to increase and the capitalization rate to fall.[37]

VI. Conclusion

This paper extends previous studies of the property tax capitalization rate by noting that the federal tax code affects the property tax capitalization equation. Our estimate takes account of the fact that some homebuyers itemize while some take the standard deduction, that some homebuyers save in taxable assets while some save in tax-deferred assets, and nominal as opposed to real interest income is taxed. An important feature of our model is that we use the homebuyer's mortgage to identify household tax status, and thereby the relevant capitalization equation for the home. We also show that homebuyers who take out the maximum mortgage allowed by lenders capitalize their property tax flow using a before-tax interest rate: this implies a subtle but important connection between property tax capitalization and credit rationing in the mortgage market.

Data for the analysis are drawn from the neighborhood supplements to the 1985 and 1989 American Housing Survey (AHS). Results indicate that ignoring differences in tax status across homebuyers causes the capitalization equation to be misspecified for 90% of owner-occupied homes. Three key findings emerge as a result. First, controlling for federal tax provisions increases the precision of the estimated capitalization rate: this result is likely to be robust across samples since additional information is introduced into the model. Second, for plausible parameter values for

Noting that $d\delta_1/d\tau < 0_1$ and $d\delta_3/d\tau > 0$, it follows that $\delta_3 > \delta_5 > \delta_4 > \delta_1$, as claimed. Moreover, the values for δ become even more disparate with higher τ.

[37] Two additional robustness checks were performed. First, for nonitemizers, the model assumes that homebuyers with positive mortgages and no PMI use their marginal savings to either pay down their mortgages or to save tax-deferred assets, both of which yield the same "after-tax" rate of return. However, it is possible that, for reasons outside our model, some homebuyers with small positive mortgages may be saving in taxable assets. This suggests that some homebuyers classified as belonging to Case 5 really belong to Case 6. To evaluate that possibility, we reestimated the model classifying nonitemizers with LTV < 0.8 as Case 6 instead of Case 5. The estimated capitalization rate was close to the estimates reported in tables 3 and 4. We also estimated the model varying the inflation rate (holding the real interest rate at 3%) on the possibility that inflation expectations differed from 4% (the actual rate of inflation during the sample period). Reducing the inflation rate by one percentage point raised the capitalization rate by roughly five percentage points.

our sample period, the various specification errors appear to net out for our sample, so that the estimated capitalization rate is little changed when federal tax provisions are taken into account. Third, this latter result is not likely to generalize to other samples. Instead, biases resulting from failing to control for the federal tax code depend on the sample distribution of homebuyer tax status and are likely to have contributed to the wide variety of capitalization estimates in the literature. Thus, by showing that it is important to control for federal tax status when estimating the property tax capitalization rate, this paper advances the literature on property tax capitalization in much the same way that the introduction of tax effects has advanced the literatures on housing demand (e.g., Rosen, 1979) and home mortgage debt (e.g., Jones, 1993, 1994).

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