Housing Tax Deductions and Single-Family Housing Demand

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Abstract The effect of mortgage interest and local property tax deductions upon single-family housing demand in the U.S. is examined for the 1994-2003 period. A multi-equation model is developed to simulate the impacts from partial and complete elimination of the deductions. The results indicate that the deductions have moderate effects on housing demand. Complete elimination of the deductions could result in as much as a 12 percent decline in the annual number of single-family housing units that are purchased.

Keywords: Deductions, expenditure, price, stationary

JEL Classifications: R21, R31, H24

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1. Introduction

In November, 2005, the President's Advisory Panel on Federal Tax Reform released a lengthy report addressing many components of the federal tax system (2005). A large number of changes to the system were proposed. Among them were proposals to substantially modify the nature of housing-related deductions in the personal income tax structure, including complete elimination of the deductibility of state and local real estate taxes. Questioning the need for housing tax deductions is not new. Housing tax deductions have been intermittent targets over the years for policymakers, particularly when the federal budget is tight and there is a need to shore up revenue sources.

An argument against housing tax deductions can begin with the citation of various reports on housing tax expenditures, for example, the Joint Committee on Taxation (1986, 1989), the Congressional Budget Office (1996), and the Office of Management and Budget (1998). Deductions for mortgage interest and real estate taxes can be easily identified as substantial sources of foregone tax revenue in these reports. For example, in the CBO report cited above it was estimated that elimination of the mortgage deduction alone would increase income tax revenues by $42 billion. The second step of the argument points out that subsidies for owner-occupied housing cause reallocation of resources away from other assets such as facilities and equipment. This represents a distortion in the allocation of resources and brings with it a welfare cost. The third step of the argument is to point out that housing deductions make the income tax system more regressive than it otherwise would be, since the allocation of deductions is progressive. Homeowners with high incomes enjoy disproportionately higher benefits from deductions than do lower income homeowners. Bourassa and Grigsby (2000) offer evidence in this regard.

Several forms of tax preference are given to owner-occupied housing in the United States. Deductibility of mortgage interest and property taxes, absence of taxation of implicit rental values, and favorable treatments of capital gains are all specific forms of housing tax preferences. These tax preferences for homeowners are also viewed as housing tax expenditures by the federal government and, therefore, are targets of opportunity for revenue enhancement. Ongoing policy discussions periodically raise the prospect of fundamental changes to existing laws that would diminish or eliminate some or all of the tax preferences. In particular, elimination or extensive trimming of the deductibility of mortgage interest or property taxes, or both, has been a continuing policy topic, as indicated above.[1]

The focus of this study is on the mortgage interest and property tax deductions. A model of expenditure on single-family housing in the U.S. is constructed and simulated to measure the effects of the deductions upon expenditures and housing quantities purchased during the 1994-2003 period. Our measure of housing expenditure is the expenditure for purchases of single-family houses (new and existing) obtained as the product of the quantity of houses purchased and the "net" price of housing. It is in the net price of housing that the deductions are incorporated. The net price reflects adjustments for the loan-to-value ratio, the implicit rental subsidy to housing, the property tax liability, and the income tax deduction given to housing. Details of the adjustments are given in a later section.

Tax provisions have been handled in a variety of ways within studies of housing demand. Rosen (1979) provided a benchmark for housing analyses by emphasizing tax treatments. Effects from the income tax treatment of owner-occupied housing upon the quantity of housing consumed and upon tenure choice by various groups were examined. Cross-section data from 1970 were used to jointly estimate tenure choice and housing demand. Estimated parameters were used to assess the efficiency and equity implications of income tax law provisions. Rosen's results indicated that excess burden rose with income throughout most of the income range. Only at the highest income levels did excess burden fall because the decrease in the compensated price elasticity more than offset the increase in the implicit tax subsidy. Simulation results indicated that the removal of all favorable tax provisions for housing would produce reductions in the expected quantity demanded of owner-occupied housing. Elimination of all housing deductions would, on average, reduce demand by 4.4 percent.

Rosen and Rosen (1980) analyzed U.S. time series data in order to study tax-related determinants of the tenure choice between renting and homeownership. The analysis emphasized changes in the relative prices of owning and renting induced by provisions of the federal income tax. The results indicated that about one-quarter of the growth in the proportion of homeowners in the post-World War II period was a consequence of the tax system's favorable treatment of owner-occupied housing.

A number of studies have examined the effects of fundamental tax reform on housing. Goulder (1989) examined the effects of major components of the Tax Reform Act of 1986 (TRA) upon housing and other industries using a general equilibrium model with forward-looking behavior and adjustment dynamics. Simulation results revealed that while major TRA initiatives tended to discourage most nonresidential investment, they promoted increased housing investment in the short run. The results also showed that in the long run TRA tax reforms have negative influences on both real housing investment and the total value of housing assets since these reforms have adverse effects on economy-wide output and real income.

Skinner (1996) criticized traditional estimates of the welfare cost of tax preferences for housing since they were generally modest, ranging from .01 percent to .4 percent. Skinner estimated the dynamic efficiency cost of not taxing housing and found that the preferential tax treatment involves a welfare cost of as much as 2.2 percent of GNP in 1990 dollars. An intergenerational aspect of the problem that inflates the welfare cost estimates was identified. In Skinner's two-period model, the taxation of non-housing capital causes the relative price of housing to rise. Higher housing prices bring windfall gains to current homeowners and losses to future owners. This intergenerational distortion caused estimates of the welfare cost of non-taxation of housing to be substantially higher.

Gyourko and Sinai (2003) examined the spatial distribution of tax subsidies to owner-occupied housing in the United States. Their study analyzed spatial patterns both across states and within metropolitan areas using tract-level census data. They found that the mean tax benefit per owned housing unit at the state level in 1990 ranged from a low of $971 in South Dakota to a high of $10,718 in Hawaii. As expected, house owners with high incomes and high house prices benefit the most from tax benefits. They found striking skewness in the distribution of tax subsidies across the states and within metropolitan areas. Their estimates were also used to consider the welfare implications of changes in federal tax policy related to housing.

Recent directions in the housing literature have included study of portfolio adjustments (reshuffling) that would likely be made by households in the face of elimination of the mortgage interest deduction. Follain and Melamed (1998), for example, estimate that portfolio adjustments by households would result in far less additional revenue than has been predicted by static models that assume no adjustment. Replicating the usual static result, Follain and Melamed find that elimination of the mortgage interest deduction would generate an additional $27.2 billion in revenue—a result similar to that of the Joint Committee on Taxation for 1987. Their dynamic simulation, however, allows households to adjust their portfolios and derives a much smaller revenue gain of just $4.8 billion. Dunsky and Follain (2000) also provide evidence that mortgage holders reshuffle their portfolios in response to changes in effective tax rates.

An underlying theme running through many of the above studies is the extent to which deductions affect the demand for housing. Our goal is to offer estimates of those effects for the time span of 1994-2003.

2. A Model of Housing Expenditure

This section describes the model used to assess the effect of mortgage interest and property tax deductions upon housing expenditure. The model's representation of the deductions takes two forms: (i) in an identity that describes the amount of deductions, and (ii) in the net price of housing that contains adjustments representing the deductions. The influence of deductibility is not represented by an estimable parameter and so a two-step approach for simulating the impact of deductibility is pursued. First, an equation for expenditure, based upon a two-category linear expenditure system, is estimated using U.S. time-series data over the period 1976-2003.[2] Second, the estimated coefficients are used to simulate the impacts from the deductions upon expenditure and quantity in a multi-equation framework by varying the degree of deductibility between zero and 100 percent. Following de Leeuw and Struyk (1975), Polinsky and Ellwood (1979), and others in the literature, we assume that the underlying production function of housing exhibits constant returns to scale and so the implied long-run supply curve of housing services is perfectly elastic.[3]

The expenditure equation for a good, x_i, in the linear expenditure system is

$$p_i x_i = p_i\gamma_i + \beta_i [Y_d - \sum_{j=1}^{m} p_j\gamma_j] \ , \tag{1}$$

where p_i is price of the i^{th} good, Y_d is disposable income, β_i is the marginal budget share of the i^{th} good, and the γ_j are minimum required quantities of the respective m goods. Expenditure on good i, $p_i x_i$, is composed of two parts: the first, $p_i\gamma_i$, represents the minimum expenditure on good i required to maintain a minimal subsistence level; the second, $\beta_i[Y_d - \sum p_j\gamma_j]$, is the share of supernumerary income expended upon good i. If needed, the demand equation is available from (1) in the form of

$$x_i = \gamma_i + (\beta_i/p_i) \ [Y_d - \sum_{j=1}^{m} p_j\gamma_j] \ . \tag{2}$$

Our interest is exclusively with housing so only two categories, housing and all other goods, are present in the linear expenditure system. Following the format of (1), the expenditure equation for housing is

$$E_h = \gamma_1 P_{nh} + \beta_1 (Y_d - \gamma_1 P_{nh} - \gamma_2 P_x) \ , \tag{3}$$

where E_h is housing expenditure, P_{nh} is the net price of housing, P_x is a non-housing price index, and Y_d is disposable income. E_h is the product of the net price of housing and the quantity of houses sold, H. The expenditure and income variables are taken to be in per capita terms.

The net price of housing, P_{nh}, is the price of housing adjusted according to:

$$P_{nh} = r(1 - \lambda)P_h + r\lambda P_h + \tau P_h - t\theta(\lambda m P_h + \tau P_h) \ , \tag{4}$$

where P_h is the (purchase) price of housing, λ is the loan-to-value ratio, r is the real rate of interest, t is the marginal income tax rate, τ is the property tax rate, and m is the mortgage interest rate. θ is the deductibility proportion that ranges from zero for no deductibility to one for full deductibility. The first term on the right-hand-side of (4) is the equity portion of the house price, as discounted by the real rate of interest, and reflects the opportunity cost of capital. The second term is the interest cost of the debt portion of the house price. The first and second terms will be combined in later uses. The third term captures the property tax cost of owning the house when assuming that the tax rate is expressed as the effective rate applied to the price of the house. Finally, the fourth term reflects the reduction in price due to the deductibility of the sum of mortgage interest and property taxes.

Data for the variables involved in calculating the net price of housing are shown in Table 1 for selected years. Expenditures and prices in Table 1 were deflated by a non-housing price index, P_x, having a base year of 2000. For illustration, the purchase price of housing in 2000 was \$180,680 but the net price of housing was considerably less, as calculated by:

$$\begin{aligned} P_{nh} &= (.0587)(.236)(180{,}680) + (.0587)(.774)(180{,}680) + (.0085)(180{,}680) \\ &\quad - (.0887)((.774)(.0805)\,(180{,}680) + (.0085)(180{,}680)) \\ &= \$2{,}503 + 8{,}111 + 1{,}536 - \$1{,}135 = \$11{,}015\ . \end{aligned}$$

The net price of housing varied substantially over the time span shown in Table 1 with wide swings in interest rates having been a primary reason. Also contributing to the variability in net price was variability in the (purchase) price of housing. Prices dropped during the early 1980s, then rose during the late 1980s before falling again through the mid-1990s. From the mid-1990s onward through 2003, the price of housing resumed a pattern of increases. Net price is also partially determined by the marginal income tax rate. The rate fell by about one and one-half percentage points from 1985 to 2003, amounting to a relative decline of about 15%, but most of the decline over that span occurred as an abrupt drop between 1986 and 1987 resulting from the Tax Reform Act of 1986.

The marginal income tax rate, t, plays a prominent role in the net price of housing and will be modeled by the specification:

$$t = \delta_0 + \delta_1 Z + \delta_2 Z^2 + \delta_3 TRA\ , \tag{5}$$

where

$$Z = Y_p - D\ , \tag{6}$$

the difference between per capita personal income, Y_p, and per capita total itemized deductions including exemptions, D.[4] A dummy variable, TRA, for the years 1987 and onward is included to allow for the abrupt drop in the tax rate due to the Tax Reform Act of 1986. The δ_1 parameter should be positive and the δ_2 parameter should be negative due to the bounded progressivity of the U.S. income tax system. Total itemized deductions including exemptions, D, is defined as the identity:

$$D = D_x + \theta(\lambda m P_h + \tau P_h)H \quad , \tag{7}$$

where the variable D_x is non-housing deductions including exemptions and H is the quantity of housing. The term $\theta(\lambda m P_h + \tau P_h)H$ in (7) represents the portion of total itemized deductions that are in the form of housing deductions. The deductions and housing quantity variables appearing in (7) are in per-capita terms so as to match the scaling of per capita personal income in (6). A comprehensive list of variable names, definitions, and data sources is available in the Appendix.

A five-equation system is formed by collecting equations (3) through (7). Expenditure, prices, and disposable income in (3) and (4) are converted to real terms with a non-housing price index, P_x. The system is as follows:

Expenditure

$$\frac{E_h}{P_x} = \alpha_0 + \alpha_1 \frac{P_{nh}}{P_x} + \alpha_1 \frac{Y_d}{P_x} + \varepsilon_1 \tag{8}$$

Marginal income tax rate

$$t = \delta_0 + \delta_1 Z + \delta_2 Z^2 + \delta_3 TRA + \varepsilon_2 \tag{9}$$

Net price of housing

$$\frac{P_{nh}}{P_x} = (r + \tau)\frac{P_h}{P_x} - t\theta(\lambda m \frac{P_h}{P_x} + \tau \frac{P_h}{P_x}) \tag{10}$$

Deductions (Total itemized deductions including exemptions)

$$D = D_x + \theta(\lambda m P_h + \tau P_h)H \tag{11}$$

Income less deductions

$$Z = Y_p - D \quad . \tag{12}$$

ε_1 and ε_2 are stochastic error terms with zero mean and finite variance. Equations (8) and (9) are stochastic while (10), (11), and (12) are identities.

We highlight the linkages in the system beginning with the first equation and moving downward. Expenditure, E_h/P_x, in (8) depends upon the net price of housing, P_{nh}/P_x, in (10) which in turn depends upon the marginal income tax rate, t, in (9). Thus, the marginal income tax rate affects expenditures through the net price of housing. The marginal income tax rate, t, in (9) depends upon the nominal value of income less deductions, Z, in (12) which in turn depends upon deductions in (11).[5] The system is recursive and not simultaneous since there is no bidirectional relationship between dependent and independent variables in the stochastic equations. However, equation (8) may contain the problem of contemporaneous correlation since the net price of housing, P_{nh}/P_x, being partially determined by the marginal income tax rate, t, may co-vary with the error term ε_1. A Hausman (1978) test failed to reject the null hypothesis of no contemporaneous correlation.

Variables appearing in the stochastic equations (8) and (9) may be non-stationary over time. Prior to estimation of the equations, the prospect of non-stationary variables is examined with unit root tests. Two types of tests are chosen from opposite perspectives, one based upon the presence of a stochastic trend and the other based upon the presence of a deterministic trend. The tests of Phillips and Perron (1988) and Kwiatkowski, et. al. (1992), designated here as PP and KPSS, respectively, are used to examine the trend behavior of the continuous variables in equations (8) and (9). The PP test maintains the null hypothesis of a unit root in a variable while the KPSS test maintains the null hypothesis of no unit root. Both tests are used so that modeling directions are not inclined toward accepting one type of trend over the other. Table 2 reports the results from the tests.

The PP and KPSS tests each indicate that a unit root is present in E_h/P_x, P_{nh}/P_x, t, Z, and Z^2. Only one variable, Y_d/P_x, showed conflicting results from the tests. The PP test indicates a unit root in Y_d/P_x, but the KPSS test does not. We opt for the recommendation from the PP test.[6] A common method of dealing with the presence of unit roots is to take first differences of the variables prior to estimating an equation containing them and we do so here. The first difference of Y_d/P_x was analyzed with the PP and KPSS tests and it is stationary according to both. Thus, differencing Y_d/P_x does not induce non-stationary behavior. Tests for cointegrating relationships among the variables in the respective equations did not reveal the presence of such relationships so error-correction forms for the stochastic equations were not pursued.

Equations (8) and (9) were estimated in differenced form by ordinary least squares using annual data covering the 1976-2003 span. The coefficient estimates, with t-ratios in parentheses, are

$$\Delta\left(\frac{E_h}{P_x}\right) = \underset{(-1.198)}{-4.82} + \underset{(4.749)^{**}}{.010}\cdot\Delta\left(\frac{P_{nh}}{P_x}\right) + \underset{(2.969)^{**}}{.023}\cdot\Delta\left(\frac{Y_d}{P_x}\right) \qquad R^2 = .565 \tag{13}$$

$$\Delta t = \underset{(-1.352)}{-.00278} + \underset{(1.646)^{*}}{.618\text{E-}05}\cdot\Delta Z - \underset{(-1.189)}{.737\text{E-}10}\cdot\Delta Z^2 - \underset{(-4.918)^{**}}{.0172}\cdot\Delta TRA \qquad R^2 = .516 \tag{14}$$

**significant at $\alpha = .05$ level; *significant at the $\alpha = .10$ level (one-tailed test).

E indicates scientific notation. The small values of the estimated coefficients for ΔZ and ΔZ^2 are largely due to the scale of the marginal income tax rate and the use of first differences. Tests for serial correlation did not reveal the presence of the problem in either equation. In the expenditure equation, the net price of housing and disposable income both have positive and significant coefficients. In the equation for the marginal income tax rate, the coefficient on ΔZ is positive and significant at the $\alpha = .10$ level while the coefficient on ΔZ^2 is negative, as expected, but falls short of significance at the $\alpha = .10$ level.[7] The dummy variable for the Tax Reform Act of 1986 is negative and significant at the $\alpha = .05$ level. All three variables in the marginal income tax rate equation have the expected sign.

3. Simulation Results

This section describes the process that was followed to simulate the effect of mortgage interest and property tax deductions upon housing expenditures by varying the deductibility parameter, θ. Collecting the estimated equations (13) and (14), now rewritten in terms of levels, along with the identities of equations (10), (11), and (12) gives the following system, written for year i:

$$\left(\frac{E_h}{P_x}\right)_i = a_0 + a_1\left(\frac{P_{nh}}{P_x}\right)_i + a_2\left(\frac{Y_d}{P_x}\right)_i - a_1\left(\frac{P_{nh}}{P_x}\right)_{i-1} - a_2\left(\frac{Y_d}{P_x}\right)_{i-1} - \left(\frac{E_h}{P_x}\right)_{i-1} \tag{15}$$

$$t_i = d_0 + d_1 (Z_i - Z_{i-1}) + d_2 (Z_i^2 - Z_{i-1}^2) + d_3 (TRA_i - TRA_{i-1}) - t_{i-1} \tag{16}$$

$$\left(\frac{P_{nh}}{P_x}\right)_i = (r+\tau)\left(\frac{P_h}{P_x}\right)_i - t\theta\left(\lambda m\frac{P_h}{P_x} + \tau\frac{P_h}{P_x}\right)_i \tag{17}$$

$$D_i = (D_x)_i + \theta((\lambda m P_h + \tau P_h)H)_i \,. \tag{18}$$

$$Z_i = (Y_p)_i - D_i \,. \tag{19}$$

Expenditure, E_h/P_x, in (15) responds to the deductibility proportion, θ, through the net price of housing, P_{nh}/P_x, from (17). The deductibility proportion also affects the net price of housing by affecting deductions, D, in (18) which in turn affects the marginal income tax rate, t, in (16). Thus, there are two routes for the deductibility proportion to affect expenditure and, as shown below, the routes may be counterbalancing. Substitution of (18) into (19), (19) into (16), (17) into (15), and, finally, (16) into (15) creates the final form of the system to be used for simulating the impacts of mortgage interest and property tax deductions upon expenditure. Three values of θ are used: one (full deductibility), .5, and zero (no deductibility). At each value, expenditures were simulated for years through the time span of 1994-2003.

Table 3 reports the simulation results. The table should be read by row to compare expenditures across the values of the deductibility proportion. Using 1994 as an example, when θ falls from one (full deductibility) to .5 (half deductibility), and then to zero (no deductibility), expenditure measured in the real terms of the non-housing price index falls from \$174.87 to \$173.75 and, finally, to \$172.63. The effects upon expenditure from changes in the deductibility proportion are small, but the small declines need not be considered as unusual. A decrease in the deductibility proportion, θ, has two opposing effects on expenditure, E_h/P_x. First, a decrease in θ creates an increase in the net price of housing, P_{nh}/P_x, in turn causing a rise in expenditure as dictated by the estimated positive coefficient on P_{nh}/P_x in (13). Second, the marginal income tax rate is a decreasing function of deductions, D, so a fall in θ boosts the marginal income tax rate which in turn decreases P_{nh}/P_x, thereby promoting a decrease in expenditure. Therefore, the direct effect from a reduction in θ will be an increase in expenditure while the indirect effect of θ through the marginal tax rate will be a decrease in expenditure. As the deductibility proportion decreases, the expenditure for housing will decrease, remain constant, or perhaps even increase according to the relative strengths of the two opposing effects.

With expenditures falling slightly and the net price rising, quantity is falling as the deductibility proportion decreases. Percentage decreases in the quantity of single-family housing units sold are shown in Table 3. Again using 1994, the decrease is 5.2 percent in response to a drop in the deductibility proportion from one to .5. When the deductions are eliminated, the decrease is 10.0 percent. All years in the 1994-2003 span show a pattern of slight declines in expenditure in response to decreases in the deductibility proportion. Decreases in quantities are moderate in scale and similar across the years, ranging from 9.7 to a high of 12.2 percent in response to elimination of the deductions. For comparison, Rosen (1979) found using 1970 data that elimination of housing deductions would, on average, reduce housing demand by 4.4 percent. The importance of housing tax deductions as a factor in determining housing demand has definitely increased since Rosen's study of a quarter-century ago.

4. Summary

We have prepared estimates of the effect of mortgage interest and property tax deductions upon single-family housing expenditures and the quantity of single-family housing purchased in the U.S. A two-step approach was used. First, equations for housing expenditure and the marginal income tax rate were estimated using U.S. time series data. Second, the estimated equations were combined with others describing the net price of housing and the level of tax deductions. The full model was then used to simulate effects from the deductions by varying the degree of deductibility from full to none.

A change in the deductibility proportion has two opposing effects on housing expenditure. First, a reduction in deductibility directly reduces deductions and creates an increase in the ratio of the net price of housing to the non-housing price index, thereby promoting an increase in expenditure. Second, there is an indirect effect since the marginal tax rate is a decreasing function of deductions including exemptions. A reduction in deductibility boosts the marginal income tax rate, thereby decreasing the relative price of housing and producing a reduction in expenditure. As the deductibility proportion decreases, expenditure upon housing may decrease, remain constant, or perhaps even increase according to the relative strengths of the direct and indirect effects. Our analysis reveals that with expenditures falling slightly and net price rising, the quantity of housing purchased falls moderately as the deductibility proportion decreases. All years in the 1994-2003 span of our simulation show decreases in expenditure in response to decreased deductibility. Annual decreases in quantities range from approximately 10 to 12 percent as the deductions are eliminated. Thus, our results show that eliminating the deductions would have a moderate negative effect upon housing demand. A variety of other policy options have been put forth that would temper the negative effects of rescinding deductions and perhaps prove even more effective in providing stimulus to housing demand. Examples include progressive tax credits for homeowners (with allowances for regional price differentials) and programs to heavily subsidize down payments. Our results indicate that positive impacts from such programs would have to be substantial to overcome the prospective negative effects from decreasing or eliminating the deductions of mortgage interest and property taxes.

Endnotes

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1. Policy discussions of fundamental tax reform in recent years has stimulated a wide range of research on housing topics, including the work of Bruce and Holtz-Eakin (1999), Capozza, Green, and Hendershott (1996), Folain and Ling (1991), Follain, Ling, and McGill (1993), and Hendershott and White (2000).

2. The linear expenditure system was used by MacRae and Turner (1981) in their study of the consumption of owner-occupied housing services. More recently, Wilhelmsson (2002) used the linear expenditure system as a base for analyzing the importance of housing attributes in a hedonic price framework.

3. Rosen (1985, p. 384) states that "The assumption of a horizontal supply curve is quite common..... Of course to the extent that input prices change with the size of the housing industry, the long-run supply curve will have a non-zero slope."

4. The marginal income tax rate is actually the average marginal income tax rate.

5. Expected inflation is implicitly incorporated in the model through the mortgage interest rate that appears in the equations for total deductions, D, and the net price of housing, P_{nh}/P_x. Changes in the expected inflation rate generally will prompt changes of like direction in the mortgage interest rate although the magnitudes of change may not match due to the possibility of contemporaneous changes in the real rate of interest. A rise in the mortgage interest rate due to an increase in expected inflation will prompt an increase in mortgage deductions. If income less deductions responds by decreasing, then the marginal income tax rate will decrease, thereby making the effects upon the net price of housing and expenditure ambiguous. Another possible influence upon housing expenditure, but not explicitly represented in the model, is consumer sentiment. However, links between measures of consumer sentiment and measures of activities in the real economy are not strong, as has recently been demonstrated by Ludvigson (2004).

6. The Augmented Dickey-Fuller (1981) test also indicated the presence of a unit root in each of the variables.

7. Use of a one-tailed test for assessing the coefficients of ΔZ and ΔZ^2 is appropriate since a negative coefficient on ΔZ and a positive coefficient on ΔZ^2 are impossible under the present income tax rate structure.

Appendix: Variable List and Data Sources

D Itemized deductions including exemptions - *Statistics of Income Bulletin*, Summer 2005, Vol. 22, No. 1.

D_x Non-housing deductions including exemptions - derived (see text).

E_h Expenditure on single-family houses - derived (see text).

H Total unit sales of single-family houses - *U.S. Housing Market Conditions*, May 2005; U.S. Department of Housing and Urban Development.

m Mortgage interest rate - *U.S. Housing Market Conditions*, May 2005; U.S. Department of Housing and Urban Development.

λ Loan-to-value ratio - *Federal Reserve Bulletin*, various issues; Board of Governors of the Federal Reserve System.

P_h Price of housing - *U.S. Housing Market Conditions*, May 2005; U.S. Department of Housing and Urban Development. P_h is the weighted average of new and existing home prices with the quantities of new and existing homes purchased serving as weights.

P_{nh} Net price of housing - derived (see text).

P_x Non-housing price index (base year 2000 = 100) - Bureau of Labor Statistics (BLS).

Pop Population - Bureau of Economics Analysis (BEA).

r Real mortgage interest rate (mortgage interest rate minus inflation rate) - Calculated by subtracting the inflation rate from the mortgage interest rate. Inflation rates are based on the Consumer Price Index from BLS.

t Marginal income tax rate - Average marginal rates are from the U.S. Department of the Treasury, Office of Tax Analysis for the years 1974-1985 for joint filers, the U.S. Bureau of the Census, Population Reports, Series P-60, various years; and Steuerle's (1991) calculation of average marginal rates for 1986-1990. For 1991-2003, Steuerle's method is used.

τ Property tax rate per owner-occupied unit - Property tax rates per owner-occupied unit are calculated by dividing the residential portion of property taxes by the number of owner-occupied units. The residential portion of property taxes is calculated by multiplying total property tax payments by the ratio of the total value of residential property to the total value of private property. Total property tax payments are from the U.S. Bureau of the Census. Total value of private property and residential property is from BEA. The number of owner-occupied housing units is from various issues of the *Current Housing Report*, U.S. Bureau of the Census.

TRA Dummy variable for Tax Reform Act of 1986.

Y_d Per capita disposable personal income - BEA.

Y_p Per capita personal income - BEA.

References

Bourassa, S. C. and W. G. Grigsby. 2000. "Income Tax Concessions for Owner-occupied Housing," *Housing Policy Debate*, 11(3), 521-546.

Bruce, D. and D. Holtz-Eakin. 1999. "Fundamental Tax Reform and Residential Housing," *Journal of Housing Economics* 8(4), 249-271.

Capozza. D., R. Green, and P. Hendershott. 1996. "Taxes, Mortgage Borrowing, and Residential Land Prices," in H. Aaron and W. Gale, eds., Economic Effects of Fundamental Tax Reform. Washington, D.C.: The Brookings Institution.

Congressional Budget Office. 1996. "Reducing the Deficit: Spending and Revenue Options," Washington, D.C.: The Congress of the United States.

de Leeuw, F. and R. J. Struyk. 1975. *The Web of Urban Housing*. Washington, D.C.: The Urban Institute.

Dickey, D. A. and W. A. Fuller. 1981. "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root," *Econometrica* 49(4), 1057-1072.

Dunsky, R. M. and J. R. Follain. 2000. "Tax-Induced Portfolio Reshuffling: The Case of the Mortgage Interest Deduction," *Real Estate Economics*, 28(4), 683-718.

Follain, J. R. and D. C. Ling. 1991. "The Federal Tax Subsidy to Housing and the Reduced Value of the Mortgage Interest Deduction," *National Tax Journal*, 44(2), 147-168.

Follain, J. R. and L. S. Melamed. 1998. "The False Messiah of Tax Policy: What Elimination of the Home Mortgage Interest Deduction Promises and A Careful Look At What It Delivers," *Journal of Housing Research*, 9(2), 179-199.

Follain, J. R., D. C. Ling, and G. McGill. 1993. "The Preferential Income Tax Treatment of Owner-occupied Housing: Who Really Benefits?" *Housing Policy Debate*, 4(1), 1-24.

Goulder, L. H. 1989. "Tax Policy, Housing Prices, and Housing Investment," *Regional Science and Urban Economics*, 19(2), 281-304.

Gyourko, J. and T. Sinai. 2003. "The Spatial Distribution of Housing-related Ordinary Income Tax Benefits," *Real Estate Economics*, 31(4), 527-575.

Joint Committee on Taxation. 1986. "Estimates of Federal Tax Expenditures for Fiscal Years 1987-1991, Table 1," Washington, D.C.: U.S. Government Printing Office.

Joint Committee on Taxation. 1989. "Estimates of Federal Tax expenditures for Fiscal Years 1990-1994,Table 1," Washington, D.C.: U.S. Government Printing Office.

Hausman, J. A. 1978. "Specification Tests in Econometrics," *Econometrica*, 46(6), 1251-1271.

Hendershott, P. H. and M. White. 2000. "The Rise and Fall of Housing's Favored Investment Status," *Journal of Housing Research*, 11(2), 257-275.

Kwiatkowski, D., P. C .B. Phillips, P. Schmidt, and Y. Shin. 1992. "Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root," *Journal of Econometrics*, 54(1-3), 159-78.

Ludvigson, S. C. 2004. "Consumer Confidence and Consumer Spending," *Journal of Economic Perspectives*, 18(2), 29-50.

MacRae, C. D. and M. A. Turner. 1981. "Estimating Demand for Owner-occupied Housing Subject to the Income Tax," *Journal of Urban Economics*, 10(3), 338-356.

Office of Management and Budget. 1998. "Tax expenditures," in *Analytical Perspectives, Budget of the United States Government, Fiscal Year 1999*, Washington, D.C.: U.S. Government Printing Office.

Perron, P. 1988. "Trends and Random Walks in Macroeconomic Time Series: Further Evidence From a New Approach," *Journal of Economic Dynamics and Control*, 12(2/3), 297-332.

Polinsky A. M. and D. T. Ellwood. 1979. "An Empirical Reconciliation of Micro and Grouped Estimates of the Demand for Housing," *Review of Economics and Statistics*, 61(2), 199-205.

President's Advisory Panel on Federal Tax Reform. 2005. "Simple, Fair, and Pro-Growth: Proposals to Fix America's Tax System", Washington, D.C.: www.taxreformpanel.gov/final-report/

Rosen, H. S. 1979. "Housing Decisions and the U.S. Income Tax," *Journal of Public Economics*, 11(1), 1-23.

Rosen, H. S. 1985. "Housing Subsidies: Effects on Housing Decisions, Efficiency, and Equity," in D.T. Auerbach and M. Feldstein, eds., Handbook of Public Economics. New York, NY: North-Holland.

Rosen, H. S. and K. T. Rosen. 1980. "Federal Taxes and Homeownership: Evidence from Time Series," *Journal of Political Economy*, 88(1), 59-75.

Skinner, J. 1996. "The Dynamic Efficiency Cost of Not Taxing Housing," *Journal of Public Economics*, 59(3), 397-417.

Steuerle, C. E. 1991. *The Tax Decade*. Washington, D.C.: The Urban Institute Press.

Wilhelmsson, M. 2002. "Household Expenditure Patterns for Housing Attributes: A Linear Expenditure System with Hedonic Prices," *Journal of Housing Economics*, 11(1), 75-93.

Table 1. Selected Variables and Data

Year	E_h/P_x	H(000's)	P_{nh}/P_x	P_h/P_x	λ	r	τ	t	m
1980	$95.24	3,518	$6,174	$146,626	.732	4.70%	.74%	11.42%	13.77%
1985	213.55	3,902	13,053	143,343	.771	9.38	.80	10.34	12.42
1990	152.63	3,745	10,197	159,042	.748	6.27	.87	8.58	10.13
1995	166.03	4,479	9,882	158,361	.786	5.90	.95	8.53	7.95
2000	235.04	6,029	11,015	180,680	.774	5.87	.85	8.87	8.05
2003	218.48	7,269	8,749	208,479	.779	3.80	.87	8.74	5.83

Notes: E_h/P_x is per capita expenditure on purchases of single-family homes (in 2000$) based on the net price of housing, P_{nh}/P_x. H is the number of new and existing single-family homes purchased, in thousands of units. P_h/P_x is the weighted average price of new and existing single-family homes (in 2000$). λ is the loan-to-value ratio for home mortgages. r is the real mortgage interest rate (mortgage interest rate minus inflation rate). t is the marginal income tax rate. τ is the property tax rate per owner-occupied housing unit. m is the mortgage interest rate. Data sources are given in the Appendix.

Table 2. Stationarity Tests

	Variables	PP Test	KPSS Test
E_h/P_x	(housing expenditure)	-1.884	0.122*
P_{nh}/P_x	(net price of housing)	-1.501	0.171*
Y_d/P_x	(disposable income)	-1.983	0.080
t	(marginal income tax rate)	-2.186	0.131*
Z	(income less all deductions)	-2.325	0.146*
Z^2		-1.017	0.250*

Notes: *significant at the $\alpha = .10$ level. The critical value at the $\alpha = .10$ level for the PP test with constant and trend is -3.132. The presence of a unit root is the null hypothesis in the PP test. The critical value at the $\alpha = .10$ level for the KPSS test with constant and trend is .119. The absence of a unit root is the null hypothesis in the KPSS test.

Table 3. Expenditure and Quantity Effects from Changes in the Deductibility of Mortgage Interest and Property Taxes

	Per Capita Expenditure			Percent Decrease in Quantity	
Year	**θ = 1 (full)**	**θ = .5**	**θ = 0 (no)**	**θ = 1 to .5**	**θ = 1 to 0**
1994	174.87	173.75	172.63	5.2%	10.0%
1995	170.11	168.71	167.30	5.5	10.5
1996	170.96	169.43	167.89	5.5	10.5
1997	186.61	185.54	184.47	5.1	9.8
1998	204.03	202.47	200.90	5.1	9.7
1999	214.34	213.00	211.62	5.1	9.8
2000	224.19	222.93	221.67	5.4	10.4
2001	203.09	201.09	199.08	6.3	11.9
2002	226.94	224.86	222.78	5.7	10.8
2003	214.75	212.29	209.85	6.4	12.2

Notes: Per capita expenditure is per capita single-family housing expenditure, based on the net price of housing, in 2000 dollars. Percent decreases in quantity pertain to the quantity of single-family housing units purchased. θ is the deductibility proportion, equaling one for full deductibility and zero for no deductibility of mortgage interest and property taxes.