

The Tax Treatment of Homeowners and Landlords*

Matthew Chambers
Towson University

Carlos Garriga
Florida State University

Don E. Schlagenhauf
Florida State University

December 11, 2006

Abstract

This paper analyzes the effects of the asymmetric tax treatment of homeowners and landlords. We construct a quantitative general equilibrium overlapping generations model with housing and rental markets. The model emphasizes the determinants of tenure choice jointly with asset-housing investment decisions, where property owners decide the amount of housing services to consume and supply to the rental market. We find that the removal of asymmetries in the existing tax code only has positive welfare effects in a revenue neutral environment. In a nonneutral environment, welfare decreases suggest that tax changes play an important role. The rental supply response is critically affected by the interaction of the tax code and the size of the moral hazard effect derived from the higher depreciation of rental housing. The larger the size of the moral hazard effect, the smaller the rental supply response. We show that the policies that are designed to target a specific group, such a tax credit for the downpayment, can have adverse welfare implications for the overall economy and in particular the members of the targeted group who are not able to participate in the new policy. We find that changes in the progressivity of the income tax code can be used as an effective tool to attain sizeable welfare gains and at the same time achieve housing policy goals. This welfare result is larger than that reported in Conesa and Krueger (2006) with respect to income tax reforms. This suggests that changes in the degree of progressivity in the tax code are amplified in the presence of housing.

J.E.L. classification codes: E2, E6, R2

*We acknowledge the useful comments from participants at the 2006 Midwest Macro Conference, 2006 Summer Meetings of the Econometric Society, and the MEA conference on “Overlapping Generation Models and Uncertainty - Theory, Policy Applications and Computation” at the University of Mannheim. Carlos Garriga is grateful to the financial support of Generalitat de Catalunya through grant SGR01-00029 and Ministerio de Ciencia y Tecnología through grant SEC2003-06080. Corresponding author: Don Schlagenhauf, Department of Economics, Florida State University, 246 Bellamy Building, Tallahassee, FL 32306-2180. E-mail: dschlage@mailier.fsu.edu. Tel.: 850-644-3817. Fax: 850-644-4535.

Introduction

The use of the tax code to promote owner-occupied housing dates back to the Civil War era. The most prominent parts of the current tax code that are argued to impact housing are: the deductibility from taxable income of mortgage interest payments and property taxes; the exclusion of the imputed rental value of owner-occupied housing from taxable income; and the special treatment of capital gains upon the sale of the house. As a result, the tax treatment of owner-occupied housing introduces a wedge into the decision to invest in housing relative to real capital and the tenure decision which focuses on homeownership relative to renting. The impact of tax policy on these margins has been studied by many authors. For example, Laidler (1962), Aaron (1972), and Rosen (1972) employ Harberger methods for measuring excess burden to examine the efficiency losses of tax policy.¹ Other authors have used a general equilibrium approach to study these policies. Berkovec and Fullerton (1992) employ a static disaggregated general equilibrium model to study housing and portfolio choices as well as the implications of tax policy. They find that when all the tax advantages to homeownership are disallowed, the total quantity of owner housing decreases by three to six percent while the fraction of owners actually increase. In addition, Berkovec and Fullerton find minimal benefits to homeowners from the mortgage interest rate and property tax deduction. Gervais (2002) examines the taxation of housing in the context of a dynamic life-cycle economy with housing rental services provided by a rental firm. He finds that mortgage interest deductions or the taxing of imputed rents have very small distributional effects from a long-run perspective.

These studies ignore another margin that can have important quantitative implications for policy assessment. The housing investment decision is joint with the decision on how to use the services generated from this investment. Does the household consume all the services or lease some services to another household? Empirical evidence from the *Property Owners and Managers Survey* of the Census Bureau indicates that households or non-institutional proprietors own most of the rental property. In general, existing studies avoid considering this margin which has implications for rental supply responses by either assuming the supply of rental services is exogenous or is determined by a 'stand-in' rental firm. The first approach magnifies rental price effects by eliminating movements in aggregate quantities. In the latter approach, an arbitrage condition ties the rental price to the interest rate and the depreciation rate of rental property, thus implying that in equilibrium, the return on rental investment should be equal to the return on capital. As a result, the stock of rental-occupied housing is entirely determined by the demand for rental property. More importantly, only housing policies that affect maintenance cost will have an impact on the equilibrium rental price. When this decision is explicitly considered, the supply of rental property can not be reduced to a simple arbitrage condition. Since all landlords face different marginal income tax rates, their supply of rental units responds in a non-trivial manner to changes in the rental rate. In addition, the presence of moral hazard, resulting from the higher depreciation rate on rental housing, influences how the supply of rental services adjusts to changes in the rental price.

¹Aaron (1972) estimates the extent to which households' liability would change if the imputed net rent would be taxed. He finds that tax liabilities as a percentage of gross income would increase. While there is some tendency for this to be increasing in income, it is certainly not monotonic. One of the limitations of the approach is that it assumes that gross imputed rents are independent of changes in the tax code.

In this paper we examine the impact of asymmetries introduced by the existing tax code on tenure decisions and on the incentives for landlords to supply rental property. These asymmetries are introduced by allowing mortgage interest payments to be deductible from taxable income, and the exclusion of the imputed rental value of owner-occupied housing from taxable income. This tax treatment is designed to benefit existing homeowners, and may encourage some renters to become homeowners. We also consider policies that can be introduced into the tax code to target a set of renters to become homeowners, such as a tax credit for the downpayment, or a tax sheltered individual housing account (IHA). As an alternative to the above policy strategies, we investigate whether housing goals can be attained by modifying the progressivity of the tax code without targeting specific groups.

In order to analyze the posed issues, we construct a quantitative general equilibrium overlapping generations model. This model has the features that investment in housing is part of the household's portfolio decision; that life-cycle effects play a prominent role; that rental and ownership markets coexist; and that households make the choice of what quantity of housing services to consume. Households face uninsurable labor income, life uncertainty, and borrowing constraints. Decisions are made with respect to consumption of goods and housing services as well as the amount (real) capital and housing investment. The investment in housing requires a downpayment and a mortgage is required. The housing good generates services that can be consumed by the owner or rented to others. The consumption of these housing service flows leads to the depreciation of the housing stock which is dependent on who rents the services. Households make all decision subject to a nonlinear tax code that depends on adjusted gross income.

We begin by examining asymmetric treatments in the existing tax code. We find that welfare increases if the mortgage interest rate deduction is removed and if owner-occupied housing services are taxed. The increase in welfare is relatively small with respect to the mortgage deduction while the welfare increase is much larger with respect to the taxation of housing services. The effect on the overall homeownership rate is small, but we find a larger increase in the homeownership rate for younger households. This analysis is conducted in a revenue neutral environment. When the environment is not revenue neutral, welfare decreases which suggests that tax changes play an important role. In this analysis, the importance of the endogenous rental supply becomes clear, especially for housing policy evaluation. The rental supply response is critically affected by the interaction of the tax code and the size of the moral hazard effect. The larger the size of the moral hazard effect, the smaller the rental supply response. These factors have not been stressed in the literature and are relevant for policy analysis. If prices are not allowed to change, as would happen in a partial equilibrium environment, we find that the homeownership rate would fall 13 percent. If imputed rents from owner-occupied housing are taxable, the decline in the homeownership rate would be even larger. These results illustrates the importance of a general equilibrium analysis in policy research.

Some economists have questioned the efficacy of existing asymmetric tax treatment for increasing homeownership and suggest designing a policy that directly targets low income and younger households who are not owners. We examine two possible policy reforms. The first is the introduction of a tax credit for the downpayment and the other is the introduction of tax sheltered individual savings accounts that exempt interest earnings of households under age 35 from taxation which reduces the difficulty that some families have in accumulating

a downpayment. The tax credit policy results in an increase in the homeownership rate for households under age 35 from 39.1 percent to 41.8 percent, while the other policy actually reduces the homeownership rate for the youngest households. The important result is that a policy designed to target a particular group can have adverse welfare implications for the overall economy and in particular the members of the targeted group who are not able to participate in the new policy. The reason is the implicit revenue change that accompanies the introduction of the new housing programs.

The analysis of the existing tax code under the revenue neutral assumption suggests that progressivity of the tax code may have important implications for attaining housing policy goals. We investigate the importance of the degree of progressivity by examining a proportional income tax structure and a tax code with the optimal progressivity suggested by Conesa and Krueger (2006). We find that both tax code structures result in large welfare improvements and attainment of housing policy goals without the adverse implications for renters found in the prior two policies. Housing policy goals can be achieved without targeting a specific segment of households.

This paper is organized into five sections. In the first section, we present some empirical facts that surround the decision to become an owner of rental property. The next section develops our model economy. In the third section, we explain how we estimate the model using calibration targets from the US economy. The fourth section employs the model economy to evaluate the welfare implications of existing policy, and alternative housing policies, while the fifth section focuses on the implication of income taxation progressivity for housing policy goals. The final section concludes.

1 Empirical Evidence-The Decision to Own Rental Property

The modeling decision on how rental housing services are provided to the marketplace can impact the assessment of current tax policy. We argue that the decision to supply rental property is entwined with the decision to invest in housing and the decision of how much of these housing services to directly consume. Tax policy introduces wedges into these decisions creating implications for the supply of rental property. The rental firm construct that is usually employed in tax analysis ignores these tax implications. In this section, we examine data that pertains to the decision to supply rental property.

In 1996, the Census Bureau conducted a survey, the *Property Owners and Managers Survey* (POMS), designed to learn more about the rental housing stock and the providers of rental housing. The POMS sample size includes 16,300 units which were rented or vacant for rent with 90 percent of these properties being inside metropolitan areas. Among all units, 79 percent are residential with the remaining being commercial. A rental unit is defined as a property rented for cash, and either occupied by someone other than the owner or vacant but available for rent. Two types of rental properties are included. The first type is the single-unit rental property which includes single-family detached or attached houses, condominium units, cooperative units, or mobile homes. The second type is multi-unit rental property which includes units in apartment complexes of various forms and sizes. We use this survey to assemble facts for model development and evaluation.

We want to investigate whether households or firms are the main holders of rental property. This determines whether the landlord decision should be modeled from the point of view of a dynamic firm, or as part of a household portfolio decision. If a household is defined as noninstitutional investors, trustees for an estate, limited partnership, Table 1 shows that households own over 90 percent of rental units.² While this data indicates that households play an important role in the provision of rental housing services, it does not tell us whether a few noninstitutional firms account for a large percent of units rented. Such a finding would suggest the rental firm paradigm would be appropriate. In order to investigate this possibility, we examine ownership by the number of units owned. As can be seen, the noninstitutional investor still dominates rental ownership.

Table 1: Ownership and Rental Property

Type of Owner	Total Units	Less than 5 Units	5 to 49 Units	50 or more Units
Individual Investor, husband/wife	86.3	89.9	74.4	30.6
Trustee for Estate	2.0	1.9	2.6	1.0
Limited Partnership	2.8	1.7	5.5	25.4
General Partnership	2.9	2.2	5.2	12.9
Real Estate Investment Trust	0.7	0.6	1.2	2.6
Real Estate Corporation	1.6	1.0	3.7	10.9
Other Corporation	1.3	0.9	3.0	5.7
Non-profit or Church	0.7	0.3	2.0	6.1

Source: Property Owners and Managers Survey (POMS)

Although not presented in a table, we examine data on how owners acquire rental property and finance these acquisitions. POMS reports that 85.3 percent of the rental units were explicitly purchased while only 6.6 percent were inherited (or gifted). This indicates that the bequest does not play an important role in the decision to become a landlord.

Table 2 details how the purchase of rental property is financed. As can be seen, the vast majority (75 percent) of rental property is financed through a mortgage type loan. This suggests that in modelling the landlord decision the financing aspect of the decision is similar to the financing decision for an owner occupied unit. POMS also indicates that a downpayment is part of the landlord's financing package.

²POMS defines a noninstitutional owner to be individual investor (husband and wife), trustee for estate, limited partnership, and general partnership.

Table 2: Financing of Acquired Rental Property

Financing Method	Frequency	Percent
Mortgage Financed	4,046	75.5
Collateralized Borrowing	186	3.5
Cash	784	14.6
Some other manner	343	6.4
Total	5,359	100

Source: Property Owners and Managers Survey (POMS)

The sources of the downpayment are bank cash deposits (61.6 percent), collateralized non property borrowing (8.3 percent), sale of other real estate (7.8 percent), and the sale of stocks and other savings vehicles (9.8 percent). Only 10 percent of the real estate acquisitions are not financed with a downpayment.³ These facts suggest that the landlord and owner occupied decisions should be modeled in a similar manner.

We are also interested in the characteristics of individual landlords along several dimensions for model evaluation purposes. We would like to know how the provision of rental services varies with age of the household and/or the income (wealth) position. In Table 3 we report the probability of being a landlord by age for single and multiple unit properties

Table 3: Structure of Ownership of Rental Property by Age

Age Cohort	Percent who Own
25 and under	0.2
26 to 35	5.1
36 to 45	16.9
46 to 55	25.5
56 to 65	25.8
66 to 75	17.5
76 and older	9.0

Source: Property Owners and Managers Survey (POMS)

We also examine how the number of units vary by age. We find that the average number of units exhibits a hump over the life-cycle with the peak occurring in the 56-65 age cohort. For our purposes, the major findings are that all age cohorts are represented in the landlord market, and the probability of being a landlord increases with age up to age 60.

³It is interesting to note that the American Housing Survey (1995) reports that 9.97 percent of first-time buyers do not use a downpayment.

Table 4 focuses on the ownership of rental property by income.

Table 4: Structure of Ownership of Rental Property by Income

Income Range	Percent who Own
Under \$10,000	6.0
\$10,000 to \$30,000	19.5
\$30,000 to \$50,000	20.5
\$50,000 to \$75,000	16.1
\$75,000 to \$100,000	8.9
Over \$100,000	29.0

Source: Property Owners and Managers Survey (POMS)

As would be expected, households with income over \$100,000 account for the largest ownership percentage. A more interesting finding is the number of households that have rental property positions in the income range between \$10,000 and \$50,000. This indicates that our model should find the provision of rental services at all income levels.

In sum, some of the important facts pertaining to the rental market are:

- Households or non-institutional proprietors own most of the rental property.
- The size distribution of landlords is skewed with more than fifty percent of the landlords owning less than five units.
- Most of rental properties are acquired and financed through a mortgage type loan.
- The probability of being a landlord increases with age and income.
- A primary reason to own rental property is for the income from the rents.

These findings suggests that a theory that ignores the presence of the rental market as part of the housing investment decision could miss an important channel through which tax policy impacts decisions.

2 The Model

The economy is comprised of households, firms, a financial intermediary, and a government sector. Households are indexed by their age, $j \in \mathcal{J} = \{1, 2, \dots, J\}$ and live a maximum of J periods. Survival each period is uncertain. The probability of surviving from age j to age $j + 1$ is denoted by $\psi_{j+1} \in (0, 1)$, with $\psi_1 = 1$. Consumers have preferences defined over consumption, c , and housing services, s , and are subject to labor earnings shocks $\epsilon \in \mathcal{E}$. Households can invest in two assets to smooth out uncertainties; a riskless financial asset and housing. This financial asset is denoted by $a' \in \mathcal{A}$ and offers a net return r . Housing is denoted by $h' \in \mathcal{H}$ and has a market price p per unit. The housing asset generates shelter services according to the a linear function technology $s = g(h') = h'$. Shelter services may be sold in a rental market, in which case rental income is generated at the rate R per unit of shelter. Because of the relative size of the cost of the housing asset, mortgages are required

and are available from a financial institution who receives deposits from the household. The financial intermediary also makes loans in form of capital investment to firms.

Firms use a constant returns to scale Cobb-Douglas technology with capital and labor as inputs to produce a good that can be used for consumption, capital or housing purposes. A government provides social security benefits to the retired by taxing the income of working households. In this section we describe the main elements of the quantitative model. The formal definition of the model is presented in the appendix.

2.1 The Financial Intermediary

The financial intermediary is a zero profit firm. The firm receives the deposits of the households, a' and offers mortgages to the homeowners-landlords as well as loans of capital to firms. These mortgages generate revenue each period.⁴ Financial intermediaries receive principal payments from those individuals who sell their home with an outstanding mortgage position as well as the outstanding principle of individuals who unexpectedly die. These payments are used to pay a net interest rate, r , on deposits.

The financial institution offers a uniform mortgage instrument to all households that want to invest housing. The decision to purchase a house of size h at price p requires a downpayment equal to $\chi \in [0, 1]$ percent of the value of the house. Consequently, households need to take on debt equal to $D_0 = (1 - \chi)ph$. Let r^m be the interest rate of a mortgage contract with maturity length N . We denote the mortgage contract by $M(x)$ where x is defined by the set (p, h', χ, N, r^m) . The mortgage contract specifies a mortgage payment, $m(x)$, interest payment, $I(x)$, and the laws of motion for the remaining debt, $D(x)$, and equity position, $H(x)$.⁵

⁴The spread between the mortgage rate and the return on capital is assumed to cover fixed costs.

⁵According to American Housing Survey (AHS) and POMS, 91 percent of homeowners and 87 percent of landlords use fixed rate mortgages (FRM). This mortgage contract is comprised of an increasing amortization schedule of the principal, and a decreasing schedule for interest payments, so that the payment schedule is constant. That is,

$$m(x) = A_t + I_t,$$

and satisfies

$$m(x) = \frac{r^m}{[1 - (1 + r^m)^{-N}]} D_0.$$

The contract front loads the interest rate payments and back loads the principle payments where

$$A_t = m(x) - r^m D_t.$$

The laws of motion for debt and home equity are

$$D_{t+1} = (1 + r^m)D_t - m(x), \quad \forall t,$$

and

$$H_{t+1} = H_t + [m(x) - r^m D_t], \quad \forall t,$$

where $H_0 = 0$ denotes the home equity in the initial period.

2.2 Households

A household's income depends on labor, interest, and rental income. Each household is endowed with a fixed amount of time each period and they supply this endowment to the labor market inelastically until retirement at age $j^* < J$. Households differ in their productivity for two reasons - age and period specific productivity shocks. We define v_j as the labor productivity of an age j individual. The age profile of average labor productivity is $\{\nu_j\}_{j=1}^{j^*}$. A household also draws a period specific earnings component, ϵ , from a probability space, where $\epsilon \in \mathcal{E}$. The realization of the current period productivity component evolves according to the transition law $\Pi_{\epsilon, \epsilon'}$. Thus, a worker's labor earnings in a given period is $w\epsilon v_j$ where w is the market wage rate. Additional sources of income are interest earnings, ra , and rental income from services generated from the investment in housing. Tax law may treat service income differently depending on who consumes the service flow. Let κ_r be the fraction of taxable housing services rented to other households that is taxable while κ_o if the fraction of owner-occupied services that is taxable. The rental income from the housing investment that is taxable can be written as $[\kappa_r \max(h' - s, 0) + \kappa_o s]$. Hence, gross income is defined as:

$$gy(a, h', s, \epsilon, v_j, j; q) = \begin{cases} w\epsilon v_j + (1+r)a + R[\kappa_r \max(h' - s, 0) + \kappa_o s], & \text{if } j < j^*, \\ \theta + (1+r)a + R[\kappa_r \max(h' - s, s) + \kappa_o s], & \text{if } j \geq j^*. \end{cases} \quad (1)$$

where θ is the social security retirement benefit, and $q = \{p, R, r, r^m\}$ is the vector of prices.⁶

A tax function T determines the tax obligation as well as the marginal tax rate, τ_y , after allowances are made for adjustments. Examples of adjustments could be a deduction for mortgage interest rate payments, maintenance expense, and/or property taxes. We will denote adjustments generally by Ξ .⁷ Adjusted gross income is defined as

$$ay(a, h', s, \epsilon, j; q) = gy(a, h', s, \epsilon, j; q) - \Xi$$

Income taxes are based on adjusted gross income. We represent the tax payment as $T[ay(a, h', s, \epsilon, j; q)]$. In addition, labor earnings are subject to a retirement (or social security) tax which is denoted by τ_p . After tax income is defined as:

$$y(a, h', s, \epsilon, v_j, j; q) = \begin{cases} (1 - \tau_p)w\epsilon v_j + (1+r)a + \\ R[\kappa_r \max(h' - s, 0) + \kappa_o s] - T(ay), & \text{if } j < j^*, \\ \theta + (1+r)a + \\ R[\kappa_r \max(h' - s, s) + \kappa_o s] - T(ay), & \text{if } j \geq j^*. \end{cases} \quad (2)$$

The household's current period budget constraint depends on the household's asset holdings, the current housing investment, the remaining length of the mortgage, labor income shock, and households age. Individuals make decisions over consumption goods, housing services, and the investment in assets and housing. We assume that households are born with initial wealth that is dependent on the initial income shock.

⁶Following the existing tax code, we assume the capital gains from the housing investment are not taxable.

⁷If mortgage interest rate payments are deductible, then Φ would be equal to the mortgage interest payments of $I(x) = I(p, h', \chi, N, r^m)$.

We can isolate five possible optimization problems that the household solves. We focus on the housing tenure decision. The value function for a household is described by the state vector which depends the entering asset position, a , the prior period housing position, h , the number of periods remaining on an existing mortgage, n , the value of the current period idiosyncratic shock, ϵ , and age, j . We will always characterize the value function by the order of state variables $v(a, h, n, \epsilon, j)$.

1. **Renter today ($h = 0$) and renter tomorrow ($h' = 0$)**

Consider a household that does not own a house at the start of the period, $h = 0$, and decides to continue renting housing services in the current period, $h' = 0$. The value function and decision problem can be expressed as:

$$v(a, 0, 0, \epsilon, j) = \max_{(c, s, a') \in \Omega_j} \left\{ u(c, s) + \beta \psi_{j+1} \sum_{\epsilon' \in \mathcal{E}} \pi(\epsilon, \epsilon') v(a', 0, 0, \epsilon', j + 1) \right\}$$

$$s.t. \quad c + a' + Rs = y(a, 0, s, \epsilon, v_j, j; q) + tr, \quad (3)$$

$$c, s, a' \geq 0 \quad (4)$$

where Rs denote the cost of the housing services purchased in the rental market and tr is the lump sum transfer from the government. Equation (3) indicates that asset markets are incomplete as short-selling is precluded.

2. **Renter today ($h = 0$) and homeowner tomorrow ($h' > 0$)**

In this case, we have a household who rented in the previous period, $h = 0$, but decides to take a positive position in housing, $h' > 0$. The purchase of a house requires a downpayment χ . Hence, households must make an initial expenditure $\chi p h'$ to take a position in the housing market. The remaining value of the house is financed with a mortgage requiring payments each period of $m(p, h, \chi, N, r^m)$ for a total length of N periods. Formally:

$$v(a, 0, 0, \epsilon, j) = \max_{(c, s, a', h')} \left\{ u(c, s) + \beta \psi_{j+1} \sum_{\epsilon' \in \mathcal{E}} \pi(\epsilon, \epsilon') v(a', h', N - 1, \epsilon', j + 1) \right\}$$

$$s.t. \quad c + a' + \chi p h' + m(p, h, \chi, N, r^m) + x(h', h_c) = y(a, h', s, \epsilon, v_j, j; q) + tr + R(g(h') - s). \quad (5)$$

The decision to take an investment position in housing provides the household with the opportunity to earn another source of income. This source of income occurs if part of the housing services generated by the investment are leased to other households. This possibility is captured by the term $R(g(h') - s)$ where the housing investment generates $g(h')$ services. Owning a house leads to a maintenance expense. The actual maintenance expense depends on whether some housing services are rented to other households. There is an implicit moral hazard problem in renting housing services to other households as renters decide on how intensely to utilize a house, but may not actually pay the resulting costs creating an incentive to overutilize the property. The

result is higher maintenance costs for rental occupied housing. In order to calculate the appropriate amount of maintenance investment, the amount of housing that is subject to owner depreciation, δ_o , and the amount of housing that is subject to renter depreciation, δ_r , must be known. Let $h_c(s)$ correspond to the amount of housing required so that housing services of s can be generated. If this amount is equal or exceeds the amount of services generated by h' , the depreciation costs are determined by the depreciation rate δ_o . If the household decides to consume less than the amount of services generated from the housing position, the part of the housing position that the household lives in, $h_c(s)$, depreciates at the rate δ_o while the remaining part of the house, $(h' - h_c(s))$, depreciates at the rate δ_r . Hence, the maintenance cost function can be defined as:

$$x(h', h_c) = \begin{cases} \delta_o p h', & \text{if } h_c(s) \geq h' \\ \delta_o p h_c(s) + \delta_r p [h' - h_c(s)], & \text{if } h_c(s) < h'. \end{cases}$$

Clearly, the magnitude of moral hazard effect, measured by the spread in the two depreciation rates $\Delta\delta = \delta_r - \delta_o > 0$, directly influences how the supply of rental services adjusts to changes in price.

3. Homeowner today ($h > 0$) and renter tomorrow ($h' = 0$)

A third case has the household entering a period with a positive housing investment position, $h > 0$, and decides to become a renter, $h' = 0$.⁸ The optimization problem for this situation is:

$$v(a, h, n, \epsilon, j) = \max_{(c, s, a')} \left\{ u(c, s) + \beta \psi_{j+1} \sum_{\epsilon' \in \mathcal{E}} \pi(\epsilon, \epsilon') v(a', 0, 0, \epsilon', j+1) \right\}$$

$$s.t. \quad c + a' + Rs = y(a, 0, s, \epsilon, v_j, j; q) + tr + [(1 - \phi_s)ph - D(n)]. \quad (6)$$

In this specific case, the sale of the house generates income, ph , net of selling costs, ϕ_s , and remaining principle $D(n)$ which depends on whether the mortgage has been paid off or not.⁹

4. Homeowner today ($h > 0$) and homeowner tomorrow ($h' > 0$)

The last two cases deal with a household that enters the period with a housing investment position, $h > 0$, and decides to continue to have some housing investment position, $h' > 0$. The critical issue is whether the household decides to change their housing investment which is referred to as the duration decision.

(a) Homeowner maintains housing size

⁸In the last period, all households must sell h , rent housing services and consume all their assets, a , as a bequest motive is not in the model. In the last period, $h' = a' = 0$.

⁹As our analysis will be conducted at the steady state, other than transaction costs, there are no differences in the purchase and selling prices of housing.

If the household decides to maintain their housing investment, $h = h'$, then the problem is described by:

$$v(a, h, n, \epsilon, j) = \max_{(c, s, a', h') \in \Omega_j} \left\{ u(c, s) + \beta \psi_{j+1} \sum_{\epsilon' \in \mathcal{E}} \pi(\epsilon, \epsilon') v(a', h, n', \epsilon', j + 1) \right\}$$

$$s.t. \quad c + a' + m(p, h, \chi, n, r^m) + x(h, h_c) = y(a, h, s, \epsilon, v_j, j; q) + tr + R(g(h) - s). \quad (7)$$

where $n' = \max\{N - 1, 0\}$. In this situation, the household must make a mortgage payment if $n > 0$.

(b) **Homeowner changes housing size**

If the household decides to either up-size or down-size their housing investment position, (i.e., $h \neq h'$, $h > 0, h' > 0$), the optimization problem is more cumbersome:

$$v(a, h, n, \epsilon, j) = \max_{(c, s, a', h') \in \Omega_j} \left\{ u(c, s) + \beta \psi_{j+1} \sum_{\epsilon' \in \mathcal{E}} \pi(\epsilon, \epsilon') v(a', h', N - 1, \epsilon', j + 1) \right\}$$

$$\begin{aligned} s.t. \quad & c + a' + (\phi_b + \chi)ph' + m(p, h', \chi, N, r^m) + x(h', h_c) \\ & = y(a, h', s, \epsilon, v_j, j; q) + tr + R(g(h') - s) + [(1 - \phi_s)ph - D(n)], \end{aligned} \quad (8)$$

This constraint accounts for the additional income from selling their home (net of transaction costs, $\phi_s ph$, and remaining principle, $D(n)$), as well as the cost of buying a new home.

We can combine the various budget correspondences into one general budget constraint if we define several indicator variables. Let I_b be a indicator function that is equal to 1 if the household decides to invest in housing, and zero otherwise. Let I_d be a indicator function that is equal to 1 if the household decides to sell the current position h and is zero otherwise. If the household has a nonzero investment position in housing, it must decide whether to rent out some of the shelter services generated by the housing investment. We will define an indicator function I_L that takes on a value of 1 if the household decides to rent out (or lease) some of the shelter services generated by the housing investment, and zero otherwise. Given these definitions, the general budget constraint is

$$\begin{aligned} & c + a' + I_b [\chi ph' + m(p, h', \chi, N, r^m)] \\ & + (1 - I_b)m(p, h, \chi, N, r^m) + [(1 - I_L)\delta_o ph' + I_L p(\delta_o s + \delta_r(h' - s))] \\ & = y(a, h', s, \epsilon, v_j, j; q) + tr + I_R R(g(h') - s) + I_d [(1 - \varphi_s)ph - D_n]. \end{aligned} \quad (9)$$

2.3 Firms

In this economy, a representative firm produces a good in a competitive environment that can be used either for consumption, capital purposes, or housing purposes. The representative firm produces goods using a constant returns to scale Cobb-Douglas technology $F(K, L)$

where K and L denote the amount of capital and labor utilized. The aggregate resource constraint is given by

$$C + K' + I_H + G + \Upsilon = F(K, L) + (1 - \delta_K)K \quad (10)$$

where C, K, G, I_H and Υ represent aggregate consumption, the aggregate capital stock at the beginning of the next period, aggregate housing investment, aggregate government spending, and transactions costs, respectively. The parameter δ_K denotes the depreciation rate for physical capital.

2.4 Government

In addition to gathering income taxes from all households to fund expenditures, the government provides retirement benefits, θ . These benefits are financed by taxing employed individuals at the tax rate τ_p . Since this policy is self-financing, the tax rate depends on the retirement benefit or replacement ratio. This relationship can be written as:

$$\tau_p = \frac{\theta \left[\sum_{j=1}^{j^*-1} \sum_i (\mu_j w v_j \epsilon) / \sum_{j=j^*}^J \mu_j \right]}{\sum_{j=1}^{j^*-1} \sum_i (\mu_j w v_j \epsilon)}$$

where μ_j is the size of the age j cohort.

In addition, the government collects the physical assets and housing assets of those who unexpectedly die. Both of these assets are sold and any outstanding debt on housing is paid off. The remaining value of these assets are distributed to the surviving households as a lump sum payment, tr , to avoid distortions. This transfer can be defined as

$$tr = \frac{Tr}{1 - \mu_1}$$

where Tr is the aggregate (net) value of assets accumulated over the state space from unexpected death and is defined as¹⁰

$$Tr = \int \mu_j (1 - \psi_j) a(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times \{2, \dots, J\}) + \int \mu_j (1 - \psi_j) [p * h(a, h, n, \epsilon, j) - D(a, h, n, \epsilon, j)] \Phi(da \times dh \times dn \times d\epsilon \times \{2, \dots, J\}).$$

Income tax collections are used for government spending which plays no direct role in the model.

¹⁰In the formulation, the new born generation does receive a lump sum transfer as we endow these individuals with capital assets as observed in data.

2.5 Market Equilibrium

This economy has three markets: the goods market, the asset market, and the rental of housing services market. The goods market clearing condition is defined by equation (10). In the asset market the market clearing condition is complicated by mortgages and unexpected death. The total amount of capital available to firms, K , can be written as

$$\begin{aligned}
K' = & \int \mu_j a'(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times dj) \\
& - \int \mu_j (1 - \chi) p h'(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times dj) \\
& + \int \mu_j m(p, h, \chi, N, r^m) \Phi(da \times dh \times dn \times d\epsilon \times dj) \\
& + \int_{h'(a, h, n, \epsilon, j) \neq h} \mu_j D(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times dj) \\
& + \int \mu_j (1 - \psi_j) D(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times dj)
\end{aligned}$$

The first term on the right hand side of the equation captures the savings of households over the state space. From this amount, new mortgages must be subtracted. This amount is captured by the second term on the right side. The remaining three terms represent additional assets that are available to firms. These are mortgage payments, the payment of outstanding mortgage debt from those households who sell their housing investment, and the payment of outstanding debt of households who unexpectedly die with a positive housing position.

The last market determines the rental values of housing services which depends on the aggregate amount of housing services made available by individuals who own housing services and the aggregate amount of housing services demanded for rent. This market clearing equation can be written as:

$$\begin{aligned}
& \int_{h'(a, h, n, \epsilon, j) > 0} \mu_j [h'(a, h, n, \epsilon, j) - s(a, h, n, \epsilon, j)] \Phi(da \times dh \times dn \times d\epsilon \times dj) \\
= & \int_{h'(a, h, n, \epsilon, j) = 0} \mu_j s(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times dj)
\end{aligned}$$

A formal definition of the recursive equilibrium is provided in the appendix.

3 Parameterization of Model

In order to evaluate the model, parameters and functional forms must be specified. We estimate most of the parameters using an exactly-identified Method of Moments approach. That is, we solve for the parameters that are consistent with some key properties of the U. S. economy observed in 1994. This estimation problem is embedded with the general solution

of the model. It is important to note that our model is estimated to aggregate variables and not distributions.

3.1 Demographics

Each period in the model is taken to be three years. A individual enters the labor force at age 20 (model period 1) and lives till age 83 (model period 23). Retirement is assumed to be mandatory at age 65 (model period 16). Individuals survive to the next period with probability ψ_{j+1} . These probabilities are set at survival rates observed in 1994 using data from the National Center for Health Statistics, *United States Life Tables*, 1994.

The size of the age specific cohorts, μ_j , need to be specified. Because of our focus on steady state equilibrium, these shares must be consistent with the stationary population distribution. As a result, these shares are determined from $\mu_j = \psi_j \mu_{j-1} / (1 + \rho)$ for $j = 2, 3, \dots, j$ and $\sum_{j=1}^J \mu_j = 1$, where ρ denotes the rate of growth of population. Using resident population as the measure of the population, we set this the three year growth rate to 3.643 percent.

3.2 Preferences

We assume that preferences over the consumption of goods and housing services can be represented by a period utility function of the form:

$$U(c, s) = \frac{1}{1 - \sigma} [c^\gamma s^{1-\gamma}]^{1-\sigma}$$

The coefficient determining the curvature of the utility function, σ , is set to the value two. The other preference parameters, γ and β , will be estimated.

3.3 Endowments

Each household is born with an initial asset position. The distribution of initial assets is based on the asset distribution observed in the *Panel Study on Income Dynamics* (PSID). Each income state was given their corresponding level of assets to match the nonhousing wealth to earnings ratio.

Workers are assumed to have an inelastic labor supply, but the effective quality of their supplied labor depends on two components. One component is age-specific which we denote as v_j and is designed to capture the "hump" in life cycle earnings. We use data from U.S. Bureau of the Census, "Money, Income of Households, Families, and Persons in the United States, 1994," *Current Population Reports*, Series P-60 to construct this variable. The other component captures the stochastic component of earnings and is based on Storesletten, Telmer and Yaron (2004). We discretize this income process into a five state Markov chain using the methodology presented in Tauchen (1986). The values we report reflect the three year horizon employed in the model. As a result, the efficiency values associated with each possible productivity value ϵ are

$$\epsilon \in \mathcal{E} = \{4.41, 3.51, 2.88, 2.37, 1.89\}$$

and the transition matrix is:

$$\pi = \begin{bmatrix} 0.47 & 0.33 & 0.14 & 0.05 & 0.01 \\ 0.29 & 0.33 & 0.23 & 0.11 & 0.03 \\ 0.12 & 0.23 & 0.29 & 0.24 & 0.12 \\ 0.03 & 0.11 & 0.23 & 0.33 & 0.29 \\ 0.01 & 0.05 & 0.14 & 0.33 & 0.47 \end{bmatrix}.$$

3.4 Technology

In this model a representative profit maximizing competitive firm produces a good that can be used either for consumption, housing investment, or capital good investment. We assume that the aggregate production function is of the Cobb-Douglas form:

$$F(K, L) = K^\alpha L^{1-\alpha}$$

The capital share parameter is set to 0.29. This value is calculated by dividing private fixed assets plus the stock of consumer durables less the stock of residential structures by output plus the service flows from consumer durables less the service flow from housing.¹¹

3.5 Housing

The housing market introduces a number of parameters. The purchase of a house requires a mortgage with a downpayment. In this paper we focus on 30 year fixed rate mortgages. As a result of the assumption that a period is three years, we set the mortgage length, N , to ten periods. The downpayment requirement, χ , is set to twenty percent.¹² We allow for a wedge between the rate of return on capital and the mortgage interest rate. We set this wedge to six percent for a three year period which is approximately two percent annually. This value is close to the observed difference between the 30 year Treasury Bond rate and the average rate for a 30 year fixed rate mortgage.

Transactions in the housing market cause transactions costs to be incurred. We set a selling transaction cost to 0.005. We set this parameter so that the model would capture the observed buying and selling patterns.

Because of the lumpy nature of housing, the specification of the second point in the housing grid determines the minimum house size. The specification of this grid point has implications for the timing of the homeownership decision and thus wealth portfolio decisions. To avoid having the choice of this variable having inadvertent implications for the results, we estimate this value to match the aggregate ownership rate.

As previously explained, housing depreciates at rates which depend on whether the property is owner occupied or rented. The value for δ_o and δ_r are estimated.

We allow mortgage interest payments to be deductible. Maintenance expenses for rental property are deductible. As in the existing code, the services generated from owner-occupied housing does not generate a tax obligation.

¹¹A data appendix is available the details the calculation of this parameter as well as other parameters used in the paper.

¹²The American Housing Survey in 1993 presents data that shows that the average downpayment is approximately twenty percent.

3.6 Government Policies and the Income Tax Function

The government enters the model in a number of ways. Income is provided to retired individuals. We assume the retirement program is self-financed through a payroll tax on the earnings of workers. After retirement, households receive a transfer based on some fraction of the average value labor income. The replacement ratio is set at thirty percent which results in a payroll tax on the worker of 5.25 percent.

Government spending is financed through a tax on income and property taxes. In order to get a more accurate assessment of housing policy wedges, we want the income tax code to be a good approximation of the actual tax code for the US. Gouveia and Strauss (1994) estimated a functional form for the US income tax code that is theoretically motivated by the equal sacrifice principle. The actual taxes paid by a household, $T(ay)$, is based on adjusted gross income, and is determined by the functional form

$$T(ay) = \xi_0(ay - (ay^{-\xi_1} + \xi_2)^{\frac{-1}{\xi_1}})$$

where (ξ_0, ξ_1, ξ_2) . If $\xi_1 > 0$ the tax code is progressive and the marginal income tax rate is:

$$T'(ay) = \xi_0(1 - (1 + \xi_2 y^{\xi_1})^{-\frac{1}{\xi_1} - 1})$$

Gouveia and Strauss estimate the parameters and find that $\xi_0 = 0.258$ and $\xi_1 = 0.768$. The parameter ξ_2 is dependent on units of measurement. We maintain the value of ξ_1 and set ξ_2 to 0.3710. However, we will calibrate the parameter ξ_0 . so that the revenue from is tax generates a federal government expenditure-GDP ratio of 7.4 percent. This is the ratio observed in 1994. The calibration of this parameter does not impact the curvature of the marginal tax function.¹³

The government receives the assets - capital and housing- from individuals who unexpectedly die. These assets are sold and any remaining mortgage debt is paid to the financial intermediary. The remaining value of these assets are distributed to the living individuals in the form of a lump sum transfer.

The entire set of parameters that we set are presented in Table 5.

¹³The Gouveia and Strauss tax function was estimated for the period 1979-1989. As our model is calibrated for the period 1994-1996, we acknowledge some inconsistency. However, since our focus is on the importance of various margins impacted by housing policy, we do not feel this inconsistency is a major problem.

Table 5: Calibrated Parameter Value
(annualized values)

Parameter	Value
Demographics:	
J	83
J^*	65
ρ	0.012
Preferences:	
σ	2.00
Technology:	
α	0.0290
Housing:	
χ	0.20
M	10
ϕ	0.06
prem	0.02
Government	
ξ_1	0.7680
ξ_2	0.3710

3.7 Estimation

We estimate seven parameters using an exactly-identified Method of Moments approach. The parameters that need to be estimated are the depreciation rate for the capital stock, δ , the depreciation rate for rental units, δ_r , the depreciation rate for ownership units, δ_o , the relative importance of consumption goods to housing services, γ , and the individual discount rate, β , the minimum size of the smallest housing investment position, \underline{h} , and the tax function parameter ξ_0 . We identify these parameter values so that the resulting aggregate statistics in the model economy are equal to seven targets observed in the U.S. economy.

We use the following targets based on NIPA. We find the target is the ratio of capital to gross domestic product which is about 2.541, (annualized value) for the period 1958-2001 where we define the capital stock as private fixed assets plus the stock of consumer durables less the stock of residential structures so as to be consistent with capital in the model. Output is GDP plus service flows from consumer durables less the service flow from housing.¹⁴ A second target is the ratio of the housing capital stock to the nonhousing capital stock. The housing capital stock is defined as the value of fixed assets in owner and tenant residential property. We find ratio of the housing stock to nonhousing capital stock to be 0.43. The third target is the investment in capital goods to output ratio which is 0.135. The ratio of the investment in residential structures to housing capital stock is the fourth target and is set at 0.121. The final target using NIPA data is the government expenditure-output ratio. Defining government expenditure as federal government expenditures, we find this ratio for 1994 to be 7.4 percent. The remaining two targets are based on data from the *American Housing Survey*. The homeownership rate in the period 1994-1996 is 64.2 percent. We want our model to be consistent with this fact. In addition, we target the ratio of the number of square feet in owner-occupied housing to the number of square feet in rental housing. We

¹⁴We estimated services flows using procedures outlines in Cooley and Prescott (1995).

find this ratio is 4.25.

Given these targets (along with the market clearing equations), the estimated parameters are presented in Table 8. The implied targets generated by the model solution are within one percent error for all the observed targets.

Table 6: Estimation of Model (In Annualized Values)

Statistic	Target	Model
Ratio of wealth to gross domestic product (K/Y)	2.541	2.5625
Ratio of housing stock to Fixed capital stock (H/K)	0.430	0.4264
Housing Investment to Housing Stock ratio (x_H/H)	0.040	0.040
Ratio owner-occupied to rental housing square feet	4.250	4.0899
Ratio fixed capital investment to GDP($\delta K/Y$)	0.045	0.0449
Homeownership Ratio	0.642	0.6419
Government expenditure to output ($T(ay)/Y$)	0.074	0.0742
Variable	Parameter	Estimated Value
Individual Discount Rate	β	0.9653
Share of consumption goods in the utility function	γ	0.8769
Tax Function Coefficient	ξ_0	0.2003
Depreciation rate of owner occupied housing	δ_o	0.0341
Depreciation rate of rental housing	δ_r	0.0594
Depreciation rate of capital stock	δ_K	0.0599
Minimum Housing Size	\underline{h}	1.5025

4 Asymmetries in the existing tax code

In this section, we examine the quantitative implications of asymmetries between owner and rental occupied housing. In the existing tax code, asymmetries are introduced by allowing mortgage interest payments to be deductible from taxable income, and the exclusion of the imputed rental value of owner-occupied housing from taxable income. These sources of asymmetry are designed to benefit existing homeowners, and may encourage some renters to own the home they occupy. Other policies can be introduced in the tax code to target a set of renters to become homeowners, such as a tax credit for the downpayment, or a tax sheltered individual housing account (IHA).

4.1 The home mortgage interest deduction

One of the hallmarks of U.S. policy towards housing appears in the tax code where mortgage interest payments are deductible for those households who itemize. This deduction creates an incentive to both own and consume more housing. The view among practitioners is that the removal of the interest deduction would result in less owner occupied housing consumption and thus smaller home sizes. Homeownership would be lower since the incentives to own have been reduced. Not surprising, the effect of the removal of this deduction has been studied in the literature. Rosen (1979) and Rosen and Rosen (1980) are two of the first to examine this deduction. They argue that the removal of this deduction would reduce the homeownership rate four basis points. They point out that their results could be biased

in their formulation as housing only serves as a consumption good and has no investment role. More recently, Gervais (2002) employs a general equilibrium life-cycle model where housing is both a consumption and investment good. In his model, the tax system introduces a wedge that makes owning preferable to renting. He finds that the elimination of the mortgage interest deduction would reduce the aggregate homeownership by 4.2 basis points. These results contrast with the findings by Berkovec and Fullerton (1992), and Glaeser and Shapiro (2002). They find the mortgage interest deduction has a small impact on homeownership. The aforementioned papers are a sample of the literature on this issue. Obviously, disagreement exists over the effects of this policy.

We use our model to reexamine the implications of the mortgage interest rate deduction. In order to highlight the insights drawn from the model and to illustrate the impact of the existing tax treatment for homeowners and renters, we report the performance of our model along several key dimensions. Table 7 summarizes the impact of the elimination of the deduction on mortgage interest payments in the tax code when compared with the benchmark model.¹⁵

The equilibrium for the benchmark economy incorporated a mortgage interest rate deduction and a deduction of landlord maintenance expenses. Since the aggregate homeownership rate has been estimated, we report the homeownership rate for households under age 35. We find that this rate is 39.1 percent compared to 39.7 percent observed in the data. The model predicts an average house size of 1,983 square feet for owner-occupied housing while the average apartment size is 1,005 square feet. Data from the American Housing Survey (1995) report the average size of an owner-occupied house 2,137 square feet, the average apartment size 1,199 square feet.¹⁶

What happens when mortgage interest payments are no longer deductible? We find that this policy change has a very small impact on the interest rate, but a larger effect on the rental price of housing. Specifically, the percentage change in the interest rate is -0.1 percent. The rental price increases 1.43 percent. For the homeownership rate, the elimination of this deduction increases the homeownership for younger households, but essentially leaves the aggregate homeownership rate unchanged. The small impact on the ownership rate is a consequence of the revenue neutral assumption which means the gain in revenue accompanying the removal of the deduction is offset by a tax reduction.¹⁷ For the marginal household, the reduction in their tax bracket essentially keeps their after tax income unchanged. For younger households, the increase in the price of rental housing makes owning a relatively more attractive option. When combined with the income effect accompanying the tax reduction, the homeownership rate for younger households increases.

¹⁵Our analysis in this paper is a steady state comparison of two equilibrium.

¹⁶A more formal evaluation of the model can be found in Chambers, Garriga, and Schlagenhaut (2004).

¹⁷More precisely, we make the policy change revenue neutral by allowing the tax function parameter ξ_0 to change so that the government expenditure to output ratio remains unchanged. However, this assumption is not innocuous as the income compensation has a direct impact on the new equilibrium.

Table 7: Elimination Mortgage Deduction

	Interest Rate	Percent Change Interest Rate	Percent Change Rental Price	Welfare Eq. Cons.
Benchmark	4.62%	-	-	-
Revenue Neutral	4.61%	-0.1	1.43	0.64
Nonrevenue Neutral	4.65%	0.7	2.14	-0.46
Partial Equilibrium	4.58%	-	-	-0.22

	Ownership Rate	Ownership Rate (under 35)	Average Owner Size	Average Rental Size
Data	64.0	39.7	2,137	1,199
Benchmark	64.0	39.1	1,983	1,005
Revenue Neutral	63.8	40.6	1,991	1,029
Nonrevenue Neutral	63.1	39.9	2,005	1,013
Partial Equilibrium	55.5	28.7	2,093	1,070

Another issue is whether the mortgage deduction allows wealthier households to purchase larger houses. After the elimination of the home mortgage deduction, the average house size of homeowners remains essentially unchanged, but the size of the average apartment increases slightly from 1,005 square feet to 1,029 square feet. Again, the reason for this change is partially a result of the revenue neutral assumption. In addition, the increase in the rental rate brings forth an increase in supply from the investors in housing.

The elimination of the mortgage interest rate deduction has important implications for tenure and duration decisions. Some facts related to these decisions are presented in Table 8. We find the desire to upsize or downsize a house is substantially reduced. That is, the percent of households who upsize falls by nearly fifty percent. Downsizing declines almost twenty-five percent. Renters mobility is slightly increased as the fractions of renter who move is 23.32 percent in the benchmark economy. After removal of the mortgage interest deduction, the fraction of renters who move increases to 25.12 percent.

Table 8: Tenure and Duration Decisions

	Benchmark % Individuals	No Deduction % Individuals
Households move (Homeowners & Renters)	27.81	21.45
Less than 35 (% average)	13.11	14.25
Between 35 and 65 (% average)	34.60	29.89
Between 66 and 85 (% average)	40.63	41.87
Homeowners Upsize	3.74	1.79
Homeowners Downsize	12.87	9.48
Homeowners do not move	48.85	53.42
Renters do not move	23.32	25.12

Further understanding of this policy is obtained from an analysis of the distributional effects. These are presented in Table 9. When examining house size by age cohorts, the

average house size only decreases for the first age cohorts. If we look at the average size of owner-occupied house by income quintal, the model generates a reduction in size in the third and fourth income quintals. The first and second income quintals includes many older households who have saving income, and have either paid off or nearly paid off their house. For these households the reduction in the marginal tax rate compensates them for the removal of the mortgage deduction. As a result, larger houses are purchased. However, for the third and fourth income quintals the redefinition of taxable income places them in a higher tax bracket. Hence, these households buy smaller homes. If age cohorts are examined, house size declines only in the youngest cohort. We find that the average apartment size increases for the first three income quintals and the first four age cohorts. For the supply of rental services, we find that in general more housing services are provided when the interest rate deduction is removed. This response is directly related to the increase in the rental price. In sum, the effect of the deduction is asymmetric from a distributional perspective.

Table 9: Distributional Effects: Elimination Mortgage Deduction

Variable	Quintals					Age Cohorts				
	Q1	Q2	Q3	Q4	Q5	20-34	35-49	50-64	65-74	75-89
Sqft. Owners by Income										
Benchmark	2,031	2,055	1,884	1,918	2,271	1,657	1,927	2,164	2,216	2,042
Revenue Neutral	2,040	2,133	1,827	1,908	2,280	1,649	1,935	2,167	2,226	2,083
Nonrevenue Neutral	2,056	2,143	1,848	1,914	2,300	1,657	1,948	2,186	2,240	2,099
Partial Equilibrium	2,130	2,201	2,017	1,986	2,354	1,752	2,038	2,253	2,300	2,159
Sqft. Renters by Income										
Benchmark	874	932	991	1,118	1,272	762	991	1,134	1,131	1,172
Revenue Neutral	886	936	1,033	1,109	1,290	769	992	1,136	1,171	1,170
Nonrevenue Neutral	881	923	1,025	1,105	1,275	769	990	1,123	1,150	1,153
Partial Equilibrium	907	990	1,054	1,144	1,381	827	1,031	1,173	1,184	1,186
Rental Supply by Income										
Benchmark	436	416	588	557	203	810	545	309	258	431
Revenue Neutral	469	377	685	602	232	858	575	344	286	429
Nonrevenue Neutral	476	392	687	620	236	874	585	349	296	437
Partial Equilibrium	412	346	530	558	191	789	506	292	248	387
Welfare by Income										
Revenue Neutral	2.65	8.76	-9.29	0.61	1.94	0.70	0.92	0.88	0.80	0.77
Nonrevenue Neutral	1.23	6.88	-9.69	-0.15	0.28	-0.42	-0.29	-0.35	-0.52	-0.63
Partial Equilibrium	1.71	4.57	-10.32	3.24	0.48	-0.16	-0.08	-0.32	-0.86	-1.39

A formal approach to evaluate the removal of mortgage interest rate deduction is to conduct a welfare analysis. In order to measure changes in aggregate welfare associated with a change in policy, we employ a consumption equivalent approach. Given the form of utility, the steady state welfare consequences of switching from a consumption allocation under the existing policy, (c_B), to a policy without the mortgage deduction, (c), is given by

$$CEV = \left[\frac{W(c)}{W(c_B)} \right]^{\frac{1}{\gamma(1-\sigma)}} - 1$$

where $W(c)$ represents the expected lifetime welfare of an agent being born into a stationary equilibrium implied by the policy.¹⁸ From an aggregate perspective, welfare increases by

¹⁸More formally, the social welfare function W is defined as

$$W(c) = \sum_s \pi_s v(0, 0, 0, \epsilon, 1)$$

0.64 percent. We also examine the welfare implications of this policy change from an age cohort and income perspective. Again, we use a consumption equivalent approach where we integrate over the value functions weighted by the respective measure over the defined subclass. These results are presented in Table 9. This policy change leads to larger changes in welfare by income quintal. Welfare decreases for households who fall in the third income quintal, but increase in the other quintals. The reason is that even though all the marginal tax rates are scaled down, the change in the definition of taxable income places some households in a higher tax bracket; those households that have high mortgage interest payments. For those households where the home is paid off, or the mortgage interest payments are a small fraction of income, welfare can increase. In addition, income from rental property is especially pronounced in the third income quintal which magnifies the tax effect, and explains why welfare decreases in this quintal. When examining by age cohorts, welfare effects are much smaller and relatively similar over all cohorts.

At this point, it is important to stress that the supply of rental services is a decision that has implications for the price elasticity in the rental market. If the supply of rental property is very elastic, a small change in the price of rental housing will increase supply along two dimensions. First, more households will find it beneficial to become landlords and supply rental property. Second, existing landlords could choose to increase the supply of rental housing. This could occur by either decreasing their consumption of the existing housing investment position, or increasing their housing investment position. Consequently, to study the implications of different housing policies for equilibrium prices, it is important to understand this supply response. In addition, a clear understanding of this response is important for understanding differences in the literature.

Gervais (2002), for example, assumes the rental market is determined by a 'stand-in' rental firm. This firm takes deposits from investors and gives mortgage loans to homeowners. The maximization problem of this firm results in an arbitrage condition that ties the rental price, R , to the interest rate and the depreciation rate of rental property, $r + \delta_r$. This condition implies that in equilibrium, the return on rental investment should be equal to the return on capital. Consequently, in this context the stock of rental-occupied housing is entirely determined by the demand for rental property. Only housing policies that reduce the maintenance cost via subsidies have an impact on the equilibrium rental rate. In contrast, Ríos-Rull and Sánchez-Marcos (2005) consider an endowment economy with a fixed supply of owner-occupied housing. The role of this assumption is to magnify price effects by eliminating movements in aggregate quantities. In our model, the rental market is endogenously modeled at the household level. In this formulation, the supply of rental property can not be reduced to a simple arbitrage condition, or determined by an arbitrary stock of housing that is available for renters. A household makes a choice to become a landlord and rent some fraction of their housing investment. Since all landlords face different marginal income tax rates, their individual supply of rental units responds in a non-trivial manner to changes in the rental rate.

The presence of moral hazard is another important factor that determines the supply response. We find that the price elasticity of rental supply depends on the size of the spread in maintenance costs measured by $\Delta\delta = \delta_r - \delta_o$. When the spread is large, landlords have a

where the value function of a new born with no asset or mortgage holding obligation is weighted by the unconditional probability of the idiosyncratic productivity shock.

smaller response to price changes since the price effect may not compensate for the additional increase in maintenance costs. In this case, the supply of rental property is relatively inelastic and all adjustment comes via price changes. However, when the moral hazard effect is small, the supply of rental property is more elastic and hence larger quantity adjustments occurs. In Table 10, we illustrate the effect of moral hazard by calculating equilibrium for various spreads in maintenance costs while maintaining the mortgage interest rate deduction. In the baseline estimation, the spread in depreciation rates is approximately 7 percent. We find the interest rate falls by 0.1 percent, and the rental price increases by 1.4 percent. As the moral hazard effect lessens, the percentage response in the rental price monotonically declines. Clearly, the endogenous decision to supply rental services is complex and can have impact for housing policy conclusions.

Table 10: Impact of Moral Hazard

	Interest Rate	Percent Change Interest Rate	Percent Change Rental Price
Benchmark ($\Delta\delta = 2.5\%$)	4.618%		
Revenue Neutral ($\Delta\delta = 2.5\%$)	4.614%	-0.1	1.4
Revenue Neutral ($\Delta\delta = 1.1\%$)	4.642%	0.5	-3.0
Revenue Neutral ($\Delta\delta = 0.4\%$)	4.613%	-0.1	-8.2

Because the revenue neutral assumption seems to blur the various incentive effects associated with the policy change, we investigate the importance of this assumption by setting the tax coefficient ξ_o at the benchmark value and recalculating a new steady state equilibrium. Essentially, the additional revenue is treated in a manner where it is thrown away. These results also appear in Tables 7 and 9. We now find the interest rate increase is 1.5 percent and the rental rate increase is 2.74 percent. The marginal household prefers to rent. The increase in the rental rate tends to encourage an increase in the rental supply. Offsetting this factor is the increase in the interest rate which makes investment in capital more attractive. Overall, the homeownership rate is reduced by almost one basis point at the aggregate level. The increasing demand pressure in the rental market seems to dominate the supply response. Surprisingly, the ownership rate of the younger cohorts increases. Despite the elimination of this deduction, the higher rental rates cause some of the wealthier younger households to prefer owner-occupied housing. In addition, we find that the size of average owner-occupied house and the average size of the rental apartment increases. This is a consequence of the lower aggregate ownership rate. The elimination of the home mortgage interest deduction causes the marginal buyer to have higher income and wealth thus allowing somewhat larger house purchases. On the other hand, the marginal household that is forced into rental property has more income and wealth as compared to the household who was a renter in the revenue neutral reform. As a consequence, they can afford larger apartments.

In terms of the distributional impact of these policies, we find that the average house is larger for all quintals except the third and fourth. That result may appear counterintuitive as house sizes are increasing in some quintals without tax compensation effects. This is a result of the large increase in the rental price that makes owner-occupied housing more attractive. This also explains why apartment size in general falls and rental supply increases by income quintal. Overall, welfare falls by 0.46 percent when the mortgage interest rate deduction is

eliminated, and we find small welfare losses in each age cohort. When income quintals are the examined, we again find that welfare decreases at the third and fourth quintal. This is not surprising because consumption of housing services fell for these households.

In principle, one would think that the relatively small price movements would make partial equilibrium analysis appropriate. In order to examine this possibility, we fixed the equilibrium prices at the benchmark level and calculate allocations under the assumption of no revenue compensation. We refer to this exercise as "partial equilibrium" in Table 7 and 9. We find very large effects in ownership rates. In particular, the aggregate ownership rate falls from 64 percent in the benchmark case to 55.5 percent when the deduction is removed. The homeownership rate for younger households falls from 39.1 percent to 28.7 percent. We find that approximately 13 percent of the homeowners in the economy own because of the existence of the mortgage deduction. Rosen and Rosen's (1980) partial equilibrium analysis implies a 6 percent change. However, we have already seen that when general equilibrium effects are included, our number is no larger than 1.5 percent for the nonrevenue neutral case.

4.2 Taxation of Housing Service Income

Many economists argue that the primary distortion in the current tax code is the treatment of housing service income. Under the current tax code, income from the rental of housing services is taxable income, but the implicit income from owner-occupied housing is not taxable. This policy introduces an asymmetry between the tax treatment of owners and landlords. The implications of this tax distortion has been studied in the literature. For instance, Berkovic and Fullerton (1992) find that if the service flow from owner-occupied housing is taxable income, high bracket households would desire to own less housing, and lower bracket households would want more. They find this policy reduces housing consumption between 3 and 6 percent. Gervais (2002) uses his model and finds that taxing imputed rents of owner-occupied housing would increase the stock of business capital over six percent as well as decrease the stock of housing eight percent. The effect on homeownership is not addressed.

If the first-order conditions of the household's optimization problem are examined, the distortions introduced by the asymmetric treatment between rental and owner-occupied housing is:

$$\frac{U_s}{U_c} = R(1 + T'(ay)(\kappa_o - \kappa_r)) + p[T'(ay)(\iota_r\delta_r - \iota_o\delta_o) - (\delta_r - \delta_o)]$$

where U_i represents the marginal utility with respect consumption c , and housing services flows s . The additional terms of the right hand side capture the asymmetric treatment of the taxation of housing services and the deduction of maintenance expenses. The terms κ_o and κ_r represent the fraction of owner and rental occupied housing that is respectively taxed. The terms ι_o and ι_r represent the fraction of maintenance expense from owner and rental occupied housing that is tax deductible. The current tax code assumes that $\kappa_o = \iota_o = 0$, and $\kappa_r = \iota_r = 1$ which reduces the first-order condition to

$$\frac{U_s}{U_c} = R(1 - T'(ay)) + p[T'(ay)\delta_r - \Delta\delta].$$

Under this scenario the first term on the right hand side indicates that the failure to tax housing services reduces the effective cost of owner-occupied housing. This wedge introduces a bias towards owner-occupied housing. When the imputed rental income from owner-occupied housing is taxed at the same rate as rental housing, $\kappa_o = \kappa_r$, then the asymmetry in the tax code is eliminated. The second term on the right hand side focuses on the wedge related to the presence of moral hazard in the rental market. Under the current tax code the failure to deduct maintenance expense for owner-occupied housing but not for rental housing affects this first-order condition in a nontrivial manner. Under the tax code where imputed rental services are taxed the implied first-order condition becomes

$$\frac{U_s}{U_c} = R - \Delta\delta + T'(ay)\delta_r.$$

Ignoring taxes for a moment, the moral hazard effect reduces the opportunity cost of owner-occupied housing, and reduces the incentives to supply rental housing. However, the tax effect increases the opportunity cost since landlords give up the deduction for rental maintenance expenses. This expression not only shows the role of the asymmetric treatment of housing, but also the importance of moral hazard for supplying rental housing services.

We construct a set of experiments to examine the asymmetric tax treatment of housing service income. We assume that the imputed income of the service flows from owner-occupied housing, (measured as Rs), is fully taxable so that $\kappa_o = \kappa_r = 1$. We maintain the deduction for mortgage interest rate payments. In Table 10, we summarize the aggregate implications of this policy change relative to the the benchmark economy. We begin by examining this policy change under the assumption of revenue neutrality. In terms of prices, the taxation of owner-occupied housing services results in a 1.6 percent decline in the rental rate and a 7.7 percent decline in the interest rate. The interest rate impact indicates that households are redirecting investment funds from housing and into capital. As would be expected, the average size of an owner-occupied house declines about 1 percent. The apartment size increases ten percent and this is attributable to two factors - the rental price decline and the decline in taxes due to the revenue neutral assumption. The aggregate ownership rate and the ownership rate for households under age 35 increases 1.0 percent and 5.56 percent, respectively. Not surprisingly, aggregate welfare increase 4.38 percent.

Table 10: Taxation Of Owner-Occupied Housing Services

	Interest Rate	Percent Change Interest Rate	Percent Change Rental Price	Welfare Eq. Cons.
Benchmark	4.62%	-	-	-
Revenue Neutral	4.24%	-8.1	-2.1	4.38
Nonrevenue Neutral	4.49%	-2.6	1.4	-0.10
Partial Equilibrium	4.58%	-	-	-0.32

	Ownership Rate	Ownership Rate (under 35)	Average Owner Size	Average Rental Size
Benchmark	64.0	39.1	1,991	1,029
Revenue Neutral	64.5	41.4	1,958	1,107
Nonrevenue Neutral	60.6	38.1	1,940	998
Partial Equilibrium	38.1	11.8	2,245	1,232

The distributional implications of the taxation of owner-occupied housing services are presented in Table 11. By income and age, average owned house size in general declines. Average apartment size in each income quintal is larger. When we examine apartment size by age cohort, we find that they are larger in the second and fourth income quintals. When apartment size is examined by age cohort, we find that only in the youngest age cohort does apartment size decline. The increase in apartment size is a consequence of investors in housing decreasing own consumption and increasing the amount of square feet made available to the rental market. Welfare is increased in each age cohort with the greatest increases occurring in the younger age cohorts. From an income distribution perspective, all quintals show an increase in welfare except the second quintal. In the first quintal includes many older households who are wealthy, but have little or no income. This accounts for the increase in welfare in the lowest quintal. The number of these older households is less in the second quintal. The loss in welfare is thus a result of low income households with little wealth being worse off. The largest welfare increases occur with younger cohorts and lower income quintals. Of course, these results raise the question of whether the welfare results are due to the housing policy change or the tax reduction effect due to the revenue neutral assumption.

In an attempt to address this question, we recalculate equilibrium when the tax parameter ξ_o is fixed at the benchmark value - the nonrevenue neutral case. Now, the interest rate decline is mitigated and the rental rate increases. Without the endogenous tax cut, both homeowners and renters live in smaller accommodations. The aggregate homeownership rate falls 5.0 percent and the homeownership for households under age 35 falls three percent. Overall welfare falls slightly.

Table 11 Distributional Effects: Taxation of Owner-Occupied Housing Services

Variable	Quintals					Age Cohorts				
Sqft. Owners by Income	Q1	Q2	Q3	Q4	Q5	20-34	35-49	50-64	65-74	75-89
Benchmark	2,031	2,055	1,884	1,918	2,271	1,657	1,927	2,164	2,216	2,042
Revenue Neutral	2,033	2,007	1,864	1,890	2,246	1,639	1,877	2,135	2,221	2,021
Nonrevenue Neutral	1,850	2,068	1,867	1,868	2,238	1,650	1,897	2,137	2,191	1,866
Partial Equilibrium	2,299	2,297	2,365	2,175	2,505	1,850	2,166	2,430	2,486	2,334
Sqft. Renters by Income										
Benchmark	874	932	991	1,118	1,272	886	936	1,033	1,109	1,290
Revenue Neutral	916	1,015	1,134	1,199	1,372	814	1,078	1,243	1,231	1,226
Nonrevenue Neutral	912	952	1,022	1,190	1,297	810	1,032	1,113	1,092	1,214
Partial Equilibrium	993	1,153	1,208	1,305	1,536	954	1,201	1,373	1,382	1,315
Rental Supply by Income										
Benchmark	436	416	588	557	203	810	545	309	258	431
Revenue Neutral	446	486	626	593	241	836	605	349	270	480
Nonrevenue Neutral	774	556	762	761	395	972	732	494	437	761
Partial Equilibrium	458	469	420	593	264	907	600	335	298	429
Welfare by Income										
Revenue Neutral	5.80	-2.10	7.76	2.73	2.30	4.04	3.47	2.74	1.94	1.23
Nonrevenue Neutral	-1.70	-2.97	2.38	-0.66	-1.98	-0.34	-0.88	-1.32	-2.32	-3.20
Partial Equilibrium	-5.20	-2.52	4.70	0.98	0.58	-0.42	-0.61	-0.38	-0.86	-1.60

The distributional implications mirror the aggregate results. House and apartment sizes are in general smaller in each age cohort and in each income quintal as compared to the benchmark case. The rental supply response is interesting. Households with housing investment appear to consume less and offer more on the rental market which is consistent with the first order condition. In general this seems to occur over all income quintals and age cohorts. With more households seeking to rent instead of owning, the increased supply response to the rental market seems to lessen the rental price increase. Welfare falls over all age cohorts and income quintals. The one exception is the third income quintal where welfare increase. This is the income quintal where the largest supply to the rental market occurs. In all likelihood, the additional rental income is the reason for the increase in welfare in this quintal.

A partial equilibrium analysis leads to some different conclusions with respect to the taxation of owner occupied housing services. The interest rate and the rental price are set at values that exceed the either the revenue neutral or revenue nonneutral analysis. In addition, we hold the tax coefficient, ξ_o , so the analysis is not revenue neutral. The incentives of the marginal household to become a homeowner are obviously reduced. The aggregate homeownership rate falls from 64 percent to 31 percent. The ownership rate for households under age 35 falls to 11 percent. Welfare falls relative to the benchmark economy.

4.3 Alternative Policies and Housing Goals

Some urban economists have questioned the efficacy of existing housing policy, especially as it pertains to the treatment of housing under the current tax code, for increasing homeownership. In this section, we use our quantitative model to examine the implications of a housing policy that is designed to increase participation of a particular segment of the population in owner-occupied housing. We consider two policy reforms. Olsen (2006) has argued that a housing voucher program for low income households would increase the homeownership rate. Although we do not directly evaluate his proposal, we consider a tax credit

that covers some percentage of the downpayment requirement. Another policy change is motivated by policies in Europe where individuals who are not homeowners have access to tax sheltered savings accounts that are intended to be savings vehicles for the accumulation of the downpayment. We consider a policy where renters under a certain age are not taxed on their interest earnings.

We begin by considering a policy where a household receives a tax credit for one-half the downpayment on the purchase of a housing investment. Some proponents argue that homeownership among lower-income households would increase if such credits are introduced independently of the issues surrounding mortgage interest deductions. The subsidy is the same for all homeowners and is independent of the size of the dwelling. In this experiment, we maintain the existing tax code. The tax coefficient ξ_0 is allowed to change so that the government expenditure-income ratio is held at the target value.

Table 12: Aggregate Effects of Alternative Housing Policies

	Interest Rate	Percent Change Interest Rate	Percent Change Rental Price	Welfare Eq. Cons.
Benchmark	4.62%	-	-	-
Tax Credit for Downpayment	4.66%	0.85	2.44	-0.58
Income Tax Credit for Renters	4.65%	0.76	4.42	-1.53

	Ownership Rate	Ownership Rate (under 35)	Average Owner Size	Average Rental Size
Benchmark	64.0	39.1	1,983	1,005
Tax Credit for Downpayment	65.3	41.8	2,047	933
Income Tax Credit for Renters	63.5	24.4	2,075	918

We find that the aggregate homeownership rate increases to 65.3 percent. More importantly, the homeownership rate for households under age 35 increases from 39.2 percent to 41.8 percent, or a 7 percent increase. As can be seen in Table 12, the tax credit for the downpayment is not welfare enhancing. The explanation is clear once Table 12 is considered along with the distributional results presented in Table 13. Aggregate average house size increases three percent. Most of this increase is due the increase in home size for household in the 20-34 age cohort, or households in the second and third income quintal. However, the welfare measure for either the youngest age cohort or the second and third income quintal does not increase. The reason is the impact on renters. From an aggregate perspective, the aggregate average size of an apartment declines. This is a result of the reduced supply of rental square feet which leads to an increase in the rental rate. Since our distributional welfare measures are not conditioned on being a homeowner, the loss in welfare of renters dominated any welfare increases from homeownership leading to the overall drop in welfare. In sum, a policy that is targeted to move households into the homeowner state from the renter state can have adverse consequences for those households who are not able to participate.

Table 13 Distributional Effects of Alternative Housing Policies

Variable	Quintals					Age Cohorts				
Sqft. Owners by Income	Q1	Q2	Q3	Q4	Q5	20-34	35-49	50-64	65-74	75-89
Benchmark	2,031	2,055	1,884	1,918	2,271	1,657	1,927	2,164	2,216	2,042
Tax Credit for Downpayment	1,957	2,169	1,916	1,918	2,268	1,896	1,904	2,158	2,177	2,087
Income Tax Credit for Renters	1,940	2,187	1,922	1,914	2,263	2,084	1,932	2,112	2,129	2,052
Sqft. Renters by Income										
Benchmark	874	932	991	1,118	1,272	886	936	1,033	1,109	1,290
Tax Credit for Downpayment	836	868	934	1,040	1,181	732	935	1,006	1,039	1,084
Income Tax Credit for Renters	833	857	943	1,066	1,156	810	886	945	979	1,084
Rental Supply by Income										
Benchmark	436	416	588	557	203	810	545	309	258	431
Tax Credit for Downpayment	483	272	527	524	175	544	537	284	266	355
Income Tax Credit for Renters	558	311	576	585	236	414	566	387	370	447
Welfare by Income										
Tax Credit for Downpayment	-1.94	-0.84	-0.04	-0.34	0.32	-0.49	-0.40	-0.73	-1.15	-2.28
Income Tax Credit for Renters	-0.19	-1.75	-2.81	-0.80	0.18	-1.04	-0.53	-1.28	-2.08	-3.20

In many European countries, individuals who are not homeowners have access to special savings accounts that are intended to help households accumulate a downpayment. In this experiment, we evaluate the homeownership implications of the introduction of tax sheltered individual savings accounts, (IHA's). We limit the IHA option to rental households under the age of 35 for illustrative purposes. The results from this experiment are also presented in Table 12 and 13. This policy results in a slight decrease in the aggregate homeownership rate. More importantly, the homeownership rate for households under age 35 falls from 39.1 percent to 24.4 percent. Overall, welfare falls under this policy reform. The loss of welfare is larger than under a downpayment credit policy. What accounts for this result? The introduction of IHA's creates an incentive to save rather than invest in housing. At the same time, this policy results in a loss of tax revenue which leads to an increase in the tax parameter, ξ_0 , so that the government expenditure-output target is maintained. Younger, higher income households can take advantage of this policy and purchase larger houses. This can be seen in Table 12, as the average house size for household's under age 35 increases approximately twenty-five percent. Household in the second and third income quintal also buy larger houses. The combined incentive to save and the tax response cause an increased demand for rental apartments. The result is an increase in the rental price which indicates the demand response exceeds an endogenous supply response in the rental market. Apartment size declines, especially for households under age 35. Welfare calculation either by age cohort or income quintal further support this conclusion. Again, we find that a policy designed to target a particular group can have adverse welfare implications for the economy and members of the targeted group who are not able to participate in the policy.

5 Income Taxation Progressivity and Housing Goals

The analysis of the existing tax code under the revenue neutral assumption suggests that tax policy by itself may have important implications for housing policy design. In this section, we explore the implications of varying the degree of progressivity in the income tax code for housing policy goals. Why might changes in the progressivity of the tax code have

implications for housing goals? The answer is suggested by the first order conditions for renters and homeowners. For renters, the condition is:

$$\frac{U_s}{U_c} = R.$$

The tax code does not effect their decision. For homeowners, the relevant condition is:

$$\frac{U_s}{U_c} = R - \Delta\delta + T'(ay)\delta_r.$$

A reduction in the progressivity of the income tax code reduces the opportunity cost of owner-occupied housing, and as a result could lead to a larger participation in housing. We investigate the quantitative importance of the degree of progressivity in the tax code. We consider a proportional (or nonprogressive) tax code and a tax code with optimal progressivity as suggested by Conesa and Krueger (2006).¹⁹

Table 14: Tax Policy and Housing

	Interest Rate	Percent Change Interest Rate	Percent Change Rental Price	Welfare Eq. Cons.
Benchmark	4.62%	-	-	-
Proportional Tax	3.91%	-15.3	-5.72	7.26
C-K Optimal Tax	4.05%	-12.3	-5.05	6.05
	Ownership Rate	Ownership Rate (under 35)	Average Owner Size	Average Rental Size
Benchmark	64.0	39.1	1,983	1,005
Proportional Tax	69.5	44.5	1,922	1,049
C-K Optimal Tax	68.8	43.6	1,926	1,033

In Tables 14 and 15, we present the results from changing from the current tax system to either a proportional or an optimal progressive tax structure. We maintain the existing treatment of housing in the tax code. The change to a proportional tax system reduces the marginal tax rate for higher income households. However, the incentive to purchase larger homes is smaller since the mortgage deduction can not be used to reduced the marginal tax rate. As a result, these households increase their saving, which results in a decline in the interest rate from 4.62 percent to 3.91 percent. The lower mortgage rate allows a larger fraction of households to participate in the owner-occupied market generating a large increase in the aggregate ownership and the ownership for younger households. For lower income households the marginal tax rate increases. For those that can afford to enter in the housing market, they purchase smaller homes.

The implications for the rental market are more complex as renters now face lower rental prices and higher marginal income taxes. The average apartment size increases indicating that the taxation effect dominates the price effect. The distributional results indicate that the taxation effect is not always dominant. If apartment sizes are examined from an age cohort perspective, we find the youngest age cohort consume smaller units. The remaining cohorts rent larger unit. For this latter group, the price decline dominates the marginal tax rate change. From an income distribution perspective, apartment size increases.

¹⁹Conesa and Krueger formulation abstracts from housing and rental markets. Consequently, their tax code might not be optimal in our context.

Overall the change in the tax structure results in a large increase in welfare. The tax code change enables the homeownership goal to be achieved without making renters worse off.

Table 15 Distributional Effects of Alternative Tax Policies for Housing

Variable	Quintals					Age Cohorts				
Sqft. Owners by Income	Q1	Q2	Q3	Q4	Q5	20-34	35-49	50-64	65-74	75-89
Benchmark	2,031	2,055	1,884	1,918	2,271	1,657	1,927	2,164	2,216	2,042
Proportional Tax	1,991	1,989	1,834	1,857	2,153	1,643	1,843	2,056	2,148	2,028
C-K Optimal Tax	2,007	2,010	1,832	1,858	2,158	1,649	1,846	2,065	2,158	2,025
Sqft. Renters by Income										
Benchmark	874	932	991	1,118	1,272	886	936	1,033	1,109	1,290
Proportional Tax	886	989	1,090	1,169	1,412	784	1,019	1,225	1,188	1,205
C-K Optimal Tax	880	960	1,079	1,157	1,355	780	1,017	1,200	1,159	1,193
Rental Supply by Income										
Benchmark	436	416	588	557	203	810	545	309	258	431
Proportional Tax	299	327	487	452	164	658	466	259	170	286
C-K Optimal Tax	308	325	504	469	178	670	482	268	177	309
Welfare by Income										
Revenue Neutral	5.80	-2.10	7.76	2.73	2.30	4.04	3.47	2.74	1.94	1.23
Proportional Tax	8.72	2.59	10.64	5.28	6.57	7.41	7.15	6.25	5.12	4.59
C-K Optimal Tax	2.74	6.17	10.23	4.68	5.10	6.18	5.99	5.33	4.66	3.89

Conesa and Krueger (2006) have calculated the coefficients for the Gouveia and Strauss tax function that determines the optimal progressivity of the income tax code in an economy with heterogeneous consumers and uninsurable mortality and labor income risk. Their tax coefficients imply that the optimal income tax structure should be less regressive. When compared to the proportional tax system this means marginal tax rates are somewhat higher for higher income households and somewhat lower for lower income households.

From an aggregate perspective the changes are in the same direction that we found when a proportional income tax is adopted. The magnitude of this change is smaller. The welfare gains associated with this tax code change are sizeable, but smaller than the gains calculated under proportional tax system. This is a consequence of the distributional effects implied by the nature of the this tax system. The distributional implications are in general consistent with the proportional tax results. However, they clearly indicate the impact that "optimal progressivity" has in tenure and investment decisions. House size at the third, fourth, and fifth income quintals is essentially the same. For these income quintals the marginal tax rate is effectively constant, and the average home size is essentially the same as observed under the proportional income tax. For the lowest two income quintals average house size increases. This is a result of the fact that the marginal tax rate is lower for this set of households compared to the corresponding rate under a proportional tax code.

We conclude that a change in the tax structure can result in an increase in the homeownership rate without harming lower income renters. Housing policy goals can be achieved without targeting a specific segment of households. It is important to stress that our welfare gains are much larger than the gains reported in Conesa and Krueger (2006). This suggests that changes in the degree of progressivity in the tax code are amplified in the presence of housing.

6 Conclusions

In this paper, we analyze the effects of the asymmetric tax treatment of homeowners and landlords. We construct a quantitative general equilibrium overlapping generations model that stresses tenure choice (renting vs. owning), housing investment decisions (financial assets vs. housing), and the decision to supply rental housing services. We present empirical evidence from the *Property Owners and Managers Survey* that indicate that household or noninstitutional proprietors own most the rental property. This justifies modeling the rental supply decision at the household level. We also show that this modeling strategy eliminates the possibility of reducing the rental supply to an arbitrage condition. As a result, the rental supply response is critically affected by the interaction of the tax code and the size of the moral hazard effect which can be measured by the spread in the maintenance cost of owner and rental occupied housing. The larger the size of the moral hazard effect, the smaller the rental supply response.

We find that the removal of asymmetries in the existing tax code only has positive welfare effects in a revenue neutral environment. In a nonrevenue neutral environment, welfare decreases which suggests that tax changes are playing an important role. In addition, we show that the policies that are designed to target a specific groups such as a tax credits for downpayments, or tax sheltered individual housing savings accounts, can have adverse welfare implications for the overall economy. In fact, we find that both policies have negative unintended consequences for members of the targeted group who are not able to participate in the new policy.

Given our findings with respect to asymmetries in the existing tax code in revenue neutral and nonrevenue neutral environments we consider the implications of changes in the progressivity of the income tax code. In particular, we examine a proportional income tax code and in a tax code that incorporates the optimal degree of progressivity as in Conesa and Krueger (2006). It is important to stress that our welfare gains are much larger than their gains. This suggests that changes in the degree of progressivity in the tax code are amplified in the presence of housing. More importantly, our results indicate that taxation and savings issues should not be considered in an environment that abstracts from housing.

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7 Appendices

7.1 Stationary Equilibrium

In the model economy, we restrict ourselves to stationary equilibria. The individual state variables are asset holdings, a , housing investment holdings, h , mortgage status, n , labor productivity status, ϵ , and age j . The aggregate state of the economy at time t is completely described by the joint measure Φ over asset positions, housing investment positions, mortgage status, productivity state, and age where $\Lambda = (a, h, n, \epsilon, j)$. Let $a \in \mathbb{R}_+$, $h \in \mathbb{R}_+$, $n \in \mathcal{N} = (1, 2, \dots, N)$, $\epsilon \in \mathcal{E} = \{\epsilon_1, \epsilon_2, \epsilon_3, \epsilon_4, \epsilon_5\}$, $j \in \mathcal{J} = (1, 2, \dots, J)$, and let $\mathcal{S} = \mathbb{R}_+ \times \mathbb{R}_+ \times \mathcal{N} \times \mathcal{E} \times \mathcal{J}$. Let $B(\mathbb{R}_+)$ be the Borel σ -algebra of \mathbb{R}_+ , and $P(\mathcal{N})$, $P(\mathcal{E})$, $P(\mathcal{J})$ the power sets of \mathcal{N} , \mathcal{E} , and \mathcal{J} , respectively. Let \mathcal{M} be the set of all finite measures over the measurable space $(\mathcal{S}, B(\mathbb{R}_+) \times B(\mathbb{R}_+) \times P(\mathcal{N}) \times P(\mathcal{E}) \times P(\mathcal{J}))$.

Definition 1 (Stationary Equilibrium): Given a set of time-invariant fiscal policy arrangements $\{G, \tau_y(\xi_0, \xi_1, \xi_2), \tau_p(\theta), \kappa_o, \kappa_r, \iota_o, \iota_r, \Xi\}$, and initial conditions, a *stationary equilibrium* is a collection of value functions and decision rules for the household, $\{v, a', h', c, s : S \rightarrow \mathbb{R}_+\}$ $c(\Lambda) : A \times H \times N \times E \times J \rightarrow \mathbb{R}_+$, $s(\Lambda) : A \times H \times M \times E \times J \rightarrow \mathbb{R}_+$; prices $\{r, p, R\}$; and invariant distribution $\Gamma(x)$ such that

1. Given prices, $\{r, p, R\}$, policies, transfers, and initial conditions, the value function v and decision rules c , s , a' , and h' solve the consumer's problem;

$$v(a, h, n, \epsilon, j) = \max_{(c, s, a', h') \in \Omega_j} \left\{ u(c, s) + \beta \psi_{j+1} \sum_{\epsilon' \in \mathcal{E}} \pi(\epsilon, \epsilon') v(a', h', \max(0, n-1), \epsilon', j+1) \right\}$$

subject to:

$$\begin{aligned} & c + a' + I_b [\chi p h' + m(p, h', \chi, N, r^m)] \\ & + (1 - I_b) m(p, h, \chi, N, r^m) + [(1 - I_L) \delta_o p h' + I_L p (\delta_o s + \delta_r (h' - s))] \\ & = y(a, h', s, \epsilon, v_j, j; q) + tr + I_R R (g(h') - s) + I_d [(1 - \varphi_s) p h - D_n]. \end{aligned}$$

$$y(a, h', s, \epsilon, v_j, j; q) = \begin{cases} (1 - \tau_p) w \epsilon v_j + (1 + r) a + \\ R[\kappa_r \max(h' - s, 0) + \kappa_o s] - T(ay), & \text{if } j < j^*, \\ \theta + (1 + r) a + \\ R[\kappa_r \max(h' - s, s) + \kappa_o s] - T(ay), & \text{if } j \geq j^*. \end{cases}$$

and

$$c > 0, s > 0, a' \geq 0, h' \geq 0.$$

2. The prices r and w are consistent with the zero-profit condition

$$r = F_1(K, N) - \delta,$$

$$w = F_2(K, N).$$

3. Transfers are given by:

$$Tr = \int \mu_j(1 - \psi_j)a(a, h, n, \epsilon, j)\Phi(da \times dh \times dn \times d\epsilon \times \{2, \dots, J\}) + \int \mu_j(1 - \psi_j)[p * h(a, h, n, \epsilon, j) - D(a, h, n, \epsilon, j)]\Phi(da \times dh \times dn \times d\epsilon \times \{2, \dots, J\})$$

and

$$tr = \frac{Tr}{1 - \mu_1}$$

4. The retirement program is self-financing

$$\tau_p = \frac{\theta \left[\sum_{j=1}^{j^*-1} \sum_i (\mu_j w v_j \epsilon) / \sum_{j=j^*}^J \mu_j \right]}{\sum_{j=1}^{j^*-1} \sum_i (\mu_j w v_j \epsilon)}$$

5. The government budget balances:

$$G = \int \mu_j T(a, h, n, \epsilon, j)\Phi(da \times dh \times dn \times d\epsilon \times dj)$$

6. The goods market condition is satisfied

$$\int \mu_j c(a, h, n, \epsilon, j)\Phi(da \times dh \times dn \times d\epsilon \times dj) + K' + I_H + G + \Upsilon = F(K, N) + (1 - \delta)K$$

where I_H represents the investment housing goods,

$$\begin{aligned} I_H &= \int \mu_j h'(a, h, n, \epsilon, j)\Phi(da \times dh \times dn \times d\epsilon \times dj) \\ &\quad - \left[\int \mu_j h(a, h, n, \epsilon, j)\Phi(da \times dh \times dn \times d\epsilon \times dj) - \right. \\ &\quad - \delta_o \int_{s(\Lambda) \geq h'(\Lambda)} \mu_j h'(a, h, n, \epsilon, j)\Phi(da \times dh \times dn \times d\epsilon \times dj) \\ &\quad \left. - \delta_r \int_{s(\Lambda) < h'(\Lambda)} \mu_j h'(a, h, n, \epsilon, j)\Phi(da \times dh \times dn \times d\epsilon \times dj) \right], \end{aligned}$$

and Υ denotes total transaction costs,

$$\Upsilon = \int_{h'(\Lambda) \neq h(\Lambda) > 0} \mu_j \varphi s h(a, h, n, \epsilon, j)\Phi(da \times dh \times dn \times d\epsilon \times dj)$$

7. *The labor market clears*

$$L = \int \mu_j \epsilon v_j \Phi(da \times dh \times dn \times d\epsilon \times \{1, 2, \dots, j^* - 1\})$$

8. *The asset market clears*

$$\begin{aligned} K' &= \int \mu_j a'(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times dj) \\ &\quad - \int \mu_j (1 - \chi) p h'(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times dj) \\ &\quad + \int \mu_j m(p, h, \chi, N, r^m) \Phi(da \times dh \times dn \times d\epsilon \times dj) \\ &\quad + \int_{h'(\Lambda) \neq h > 0} \mu_j D(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times dj) \\ &\quad + \int \mu_j (1 - \psi_j) D(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times dj) \end{aligned}$$

9. *The rental market clears*

$$\begin{aligned} &\int_{h'(\Lambda) > 0} \mu_j [h'(a, h, n, \epsilon, j) - s(a, h, n, \epsilon, j)] \Phi(da \times dh \times dn \times d\epsilon \times dj) \\ &= \int_{h'(\Lambda) = 0} \mu_j s(a, h, n, \epsilon, j) \Phi(da \times dh \times dn \times d\epsilon \times dj) \end{aligned}$$

10. The law of motion for the measure is:

$$\Phi' = T(\Phi)$$

where the function $T : \mathcal{M} \rightarrow \mathcal{M}$. We will restrict ourselves to equilibria which satisfy $T(\Phi) = \Phi$.