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Tax treatment of owner occupied housing and wealth inequality

Sang-Wook (Stanley) Cho [a,*], Johanna L. Francis [b]

[a] School of Economics, University of New South Wales, Sydney, NSW 2052, Australia
[b] Department of Economics, Fordham University, E-507 Dealy Hall, 441 East Fordham Road, Bronx, NY 10458, USA

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ABSTRACT

We construct a quantitative general equilibrium lifecycle model with housing tenure decisions to investigate the degree to which wealth inequality in the United States is affected by the preferential tax treatment of home-ownership. Favorable tax treatment of owner occupied housing in the form of home mortgage interest and property tax deductibility, and the untaxed nature of imputed rents, provides a financial incentive for home-ownership over renting as well as an incentive to "over-consume" housing since houses are not fungible. Since the favorable tax treatment of housing disproportionately creates tax savings for the upper quantiles of the income distribution, we quantify how it contributes to the heavily right skewed distribution of wealth in the United States using data from the Survey of Consumer Finances. We consider a revenue-neutral government response to the counter factual experiments of removing the current tax structure on housing. Our quantitative analysis shows that, in terms of distributional effects, removing all of the preferential tax treatments results in an aggregate increase in welfare. However, we do not find any reduction in inequality. We also find that while some re-allocation toward financial assets occurs, households primarily increase their consumption when imputed housing rents are taxed and the property tax deduction is removed. Thus housing tax policy may be effective at encouraging more overall saving through housing assets.

1. Introduction

Housing equity makes up more than 65% of the average household's wealth. For the majority of US households, home-ownership is their surest means of wealth creation. Housing is also treated differently from other types of assets in terms of tax implications, as there are exemptions on capital gains and deductibility of mortgage interest from federal tax liability. Housing policy, in general, in the US is directed toward increasing home-ownership not only through preferential tax treatment, but also through government sponsored enterprises (Fannie Mae and Freddie Mac) who provide market liquidity, and down payment assistance programs that provide low-income households with the possibility of purchasing a house.[1]

In this paper, we consider whether the public policy goal of increasing home-ownership through the tax system also contributes to wealth inequality and investigate what the aggregate and distributional effects of changing current tax policy would be. We develop an overlapping generations general equilibrium model with explicit tenure choice and life-cycle attributes to determine whether removing some or all of the special tax provisions for housing is welfare improving and whether it reduces the Gini coefficient measure of inequality on overall wealth. We specifically focus on the home mortgage interest

* Corresponding author. Tel.: +61 2 9385 3287; fax: +61 2 9313 6337.
E-mail addresses: s.cho@unsw.edu.au (Sang-Wook (Stanley) Cho), ajofrancis@fordham.edu (J.L. Francis).

[1] The initial purpose of the special tax treatment of housing was not specifically to increase home-ownership. See Congressional Research Service Bulletin, 2008.

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deduction (MID hereafter), the property tax deduction (PTD), and the untaxed nature of imputed rents from owner-occupied housing. We examine these changes under a scenario that maintains revenue neutrality for the government, where increases in taxation revenue are offset through changes in the income tax rate.

Our experiments show that removing each of the tax expenditures for housing generates additional tax revenue for the government which varies across experiments from 0.01% to 0.95% of GDP. When we combine removal of the tax provisions, the additional tax revenue amounts to 1.05% of annual GDP, or approximately $136 billion based on US real GDP for the second quarter of 2009. The implications of our experiments for welfare and aggregate statistics are mixed. We find small but positive welfare gains for all demographic groups and a small reduction in home-ownership ratio when the MID is removed. Quantitatively, the improvement in the aggregate welfare ranges between 0.14% and 0.16%, while the reduction in the home-ownership ratio ranges between 0.05% and 0.07% points. On the other hand, when we impose a tax on imputed rents, the magnitude of welfare gains ranges between 7.79% and 9.48%. Despite overall gains in welfare, these gains are not evenly distributed across different demographic groups nor are they all positive, as some, specifically wealthy and retired households, experience negative changes in welfare. The welfare loss for these sub-groups ranges from 1.46% and 3.15%. Regarding inequality, although it is clear that the preferential tax treatment of housing is a regressive policy, its impact on overall wealth inequality is negligible with no impact on reducing inequality as measured by the Gini coefficient from taxing imputed rent, removing MID or PTD, suggesting it is not as regressive as believed, or at least that it is not a significant factor contributing to the extreme skewness of the wealth distribution.

We also find, predictably, that removing all housing tax provisions leads to a lower home-ownership ratio in all experiments and, in particular, a substantively lower ratio when we impose taxes on imputed rents. Our quantitative experiments show that the home-ownership ratio falls by 23.18–43.35% points when we tax imputed rents at the same rate as wage (and asset) income. We observe significant substitution from housing to financial assets as the costs of owning a home increase, particularly when we implement a tax on imputed rents, but overall net worth falls on average implying that individuals also increase their non-housing consumption as they reduce their housing consumption. This re-allocation from savings (including housing assets) to consumption suggests that current housing tax policy has the additional attribute of encouraging savings. Our model abstracts from home-equity loans, which would reduce the saving through housing that we find in our benchmark.

The tax treatment of housing directly impacts two aspects of the home-ownership decision: whether to own or rent and how much housing to consume. All three of the housing tax policies we highlight make owner-occupied housing more desirable than renting, for those who can afford it, and provide an incentive for individuals to purchase larger houses. These tax policies reduce the real user cost of housing, in general, provide advantages over holding other assets, and allow individuals to carry more debt than they would otherwise be able to.

Our work is most closely related to Gervais (2002), who was the first to model an explicit tenure decision in a general equilibrium framework and consider the impact of these policies on aggregate welfare. Although the general effects of the preferential tax treatment of housing on home-ownership and housing capital have been known since at least the early work of Laidler (1969) and Poterba (1990, 1992), they were not made quantitatively precise until the more recent work of Gervais and Pandey (2008) and Poterba et al. (2008). Gervais (2002) found that taxing imputed rents at the same rate as business capital income increases the stock of business capital while decreasing the stock of housing capital in equilibrium, suggesting that the preferential tax treatment of housing assets causes housing to crowd out other assets. He argues that the interaction of housing tax provisions and tenure choice in an environment where there is a down-payment requirement, creates significant distortions in individuals' lifetime savings and consumption profiles. Removing mortgage interest deductibility or taxing imputed rents reduces these distortions and he finds, at least in some contexts, households would prefer to live in a world where mortgage interest payments are not deductible or imputed rents are taxed. Although we find similar results for mortgage interest deductibility, we also find that the wealthiest retired households do not benefit when imputed rents are taxed. This result comes from the fact that we disaggregate households not only by earnings but also by age.

The rest of the paper is organized as follows: Section 2 presents a snapshot of aggregate wealth and the wealth-transitions of a cross-section of the population and provides some details about home-ownership trends. Section 3 presents the general equilibrium life-cycle model, followed by Section 4 with the calibrated parameterization of the model. In Section 5 we discuss the benchmark results and the results of our policy experiments in Section 6. We conclude in Section 7.

2. Some evidence about wealth inequality and housing

The preferential tax treatment of owner-occupied housing has a variety of impacts on capital accumulation in general and the wealth distribution specifically which we explore below. In this section, we set out some facts about the US wealth distribution and home-ownership.

The main source of microeconomic data on wealth for the US is the Survey of Consumer Finances (SCF) which collects detailed information every three years about wealth and portfolio composition for a cross-section of households.[2] Table 1

[2] The SCF was explicitly designed to measure the balance sheet of households and the distribution of wealth. It over-samples wealthy households by including a representative population sample and a list sample drawn from tax records. It is the most accurate representation available of the right tail of the US wealth distribution, while retaining evidence from the remainder of the distribution.

Table 1
Share of net worth held by net worth percentile groups.

Percentile	1992	1995	1998	2001	2004	2007
Top 1%	30.2	34.6	33.9	32.7	33.4	33.8
Top 5%	54.6	55.9	57.2	57.7	57.5	60.4
Top 10%	67.1	67.8	68.6	69.8	69.5	71.5
Top 50%	96.7	96.4	97.0	97.2	97.4	97.5
Bottom 50%	3.3	3.6	3.0	2.8	2.5	2.5
Gini	0.78	0.78	0.79	0.80	0.80	0.81

Note: Survey of Consumer Finances (SCF) data from reported years. Based on calculations from Kennickell (2009), Table 4.

Table 2
Share of income held by percentiles of the income distribution.

Percentile	1992	1995	1998	2001	2004	2007
Top 1%	11.7	14.3	16.8	20.4	17.2	21.4
Top 5%	26.4	28.7	31.2	35.7	31.9	37.2
Top 10%	37.6	39.3	41.3	45.7	42.7	47.2
Top 50%	82.9	83.2	83.8	85.1	84.1	85.4
Bottom 50%	17.1	16.8	16.2	14.9	15.8	14.6
Gini	0.50	0.51	0.53	0.56	0.54	0.57

Note: The share of income data is from the Survey of Consumer Finances. The calculations of shares are based on data from Kennickell (2009), Table 4.

displays the wealth distribution from six waves of the SCF, where the amount of wealth held by individuals in the top percentiles of the wealth distribution is contrasted with the amount held by those in the bottom 50 percentiles (Kennickell, 2009). The bottom 50% of the wealth distribution holds only 3% of aggregate wealth whereas the top 1% holds roughly 30%. The average of the Gini coefficient for the wealth distribution (0.79) over the last decade confirms this skewness, where values of the Gini coefficient close to one signify more inequality compared to values closer to zero.

In comparison to these wealth statistics, Table 2 depicts the distribution of income for the same six most recent waves of the SCF. Income, while fairly unequal, is distributed much more equally than wealth. Households in the top percentile of the income distribution earn between 12% and 21% of aggregate income, depending on the year of the survey. The Gini coefficient for income, which averages 0.54, is also much lower than the Gini for the wealth distribution. The data in these tables demonstrates that wealth in the US is much more concentrated than income and that this phenomenon has been persistent over at least the most recent two decades. The fact that income is less concentrated than wealth implies income heterogeneity alone cannot explain the concentration of wealth.

Taking a closer look at the housing portion of household portfolios, over the last 14 years there has been a 4% increase in home-ownership, which represents the largest increase in ownership since the housing boom that occurred between 1945 and 1965 (see Garriga et al. (2006)). It coincides with the introduction of new mortgage products and the securitization of mortgages as well as with the aging of the population (see Chambers et al. (2009a)). Currently 68% of households own their own home, up from 64% in the early 1990's, see Fig. 1. Home-ownership displays a concave relationship with age, peaking between ages 70 and 74 and then declining slightly. Young households, with a head under 35, have the lowest rate of home-ownership (42%) although home-ownership among younger households has increased since the mid-1990s, see Fig. 2.

The increase in home-ownership has not substantially flattened the distribution of housing assets, however. In Table 3, we look at the share of housing assets held by different percentiles of the wealth distribution using data from the most recent six waves of the SCF. We find that the top 1% of the wealth distribution holds approximately 9% of housing assets, where housing assets are measured as the market value of the households' principle residence. Although this is a significantly lower concentration than we observed for either the wealth or income distribution, it is still fairly concentrated, particularly when we consider that the top 10% of the distribution holds almost 40% of housing assets and that the bottom 50% holds approximately 12% of housing assets. Thus the gains in housing have not been evenly spread across the distribution, even with the increase in the number of young households who purchase a home.

3. Benchmark model

We consider a general equilibrium overlapping generations model populated by *ex ante* heterogeneous agents. We explicitly model the tenure decision where individuals who wish to purchase a home must meet a down-payment requirement and pay a transaction cost that is proportional to the size of the house. We consider the benchmark case and each of our experiments keeping in mind the concept of a ''normal'' tax code. A normal tax code is one in which expenses accrued in order to earn income are deductible from that income for tax purposes. Our benchmark model considers the current tax treatment of housing in the US, where imputed rents are not taxed and mortgage interest payments and property tax are deductible from federal tax liability.

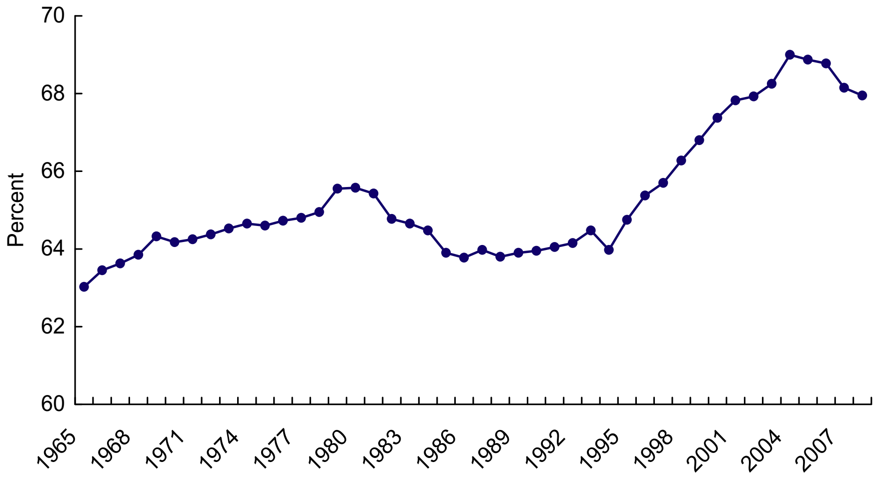

Fig. 1. Home-ownership rate, average in US.

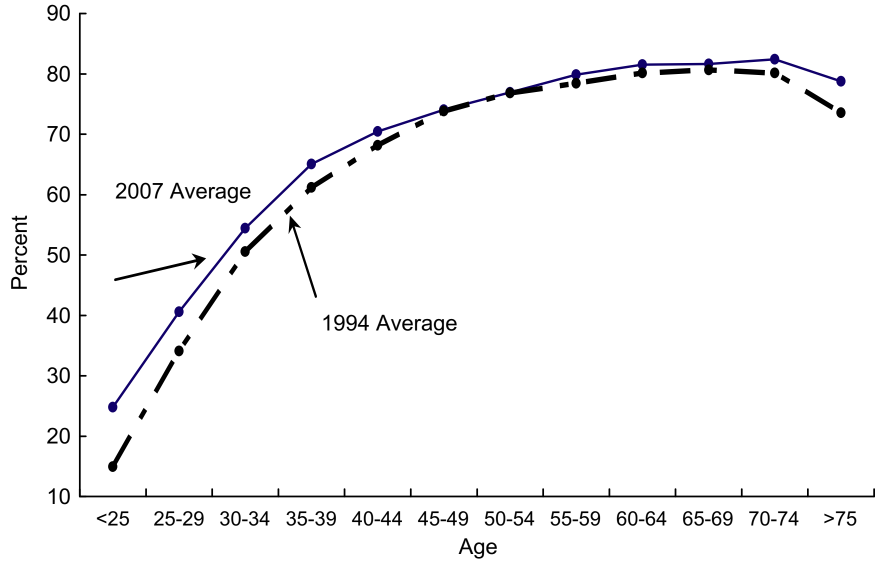

Fig. 2. Home-ownership by age, average in US.

Table 3
Share of housing held by percentiles of the net worth distribution.

Percentile	1992	1995	1998	2001	2004	2007
Top 1%	7.1	7.1	8.0	9.0	9.9	9.4
Top 5%	22.5	20.4	23.1	25.0	26.3	27.5
Top 10%	34.7	31.8	34.6	37.1	38.2	38.5
Top 50%	87.5	85.3	85.9	87.7	88.3	87.4
Bottom 50%	12.4	14.8	14.2	12.3	11.7	12.6

Note: The share of housing data is from the Survey of Consumer Finances. Housing is defined as the market value of principle residences. The calculations shares are based on data from Kennickell (2009), Fig. A3a–f.

3.1. Demographics

Each model period is calibrated to correspond to three years. Agents or households enter into working life at age 20 (denoted as $j = 1$ in the model) and may live until 86 (denoted as $J = 23$), when they die for certain. All agents enter their working life with zero financial assets and some positive transfers. Initially an exogenous fraction o of the agents enter as home-owners and the remaining $1 - o$ as renters. Agents work and receive earnings until the age of mandatory retirement denoted as j^*. In each period after retirement, agents face a positive probability of dying. The probability of dying is denoted by v_j, which is the exogenously given survival probability at age $j+1$ conditional on being alive at age j. The unconditional survival probability for an agent aged j is thus given by $\prod_{t=1}^{j} v_t$. Since death is certain after age J, $v_J = 0$. Upon death, the household's net worth is wholly taxed by the government which reduces the skewness of the model wealth distribution since it prevents the build-up of wealth across generations. For simplicity there is no population growth and the measure of the households is normalized to one. Therefore, the fraction of new agents entering into the lifecycle model is constant and replaces the number of agents dying each period. In addition, the model abstracts from fertility choice and changes in family size over the life cycle.

3.2. Technology

There is a representative firm producing an aggregate output good Y under the aggregate production function using the physical capital stock K and aggregate labor input L:

$$Y = F(K, L) \tag{1}$$

The production function has a standard Cobb–Douglas form. Aggregate output can be either consumed or invested into business capital or housing capital. Let I^k and I^h denote the aggregate investment in business capital and housing capital, respectively. The aggregate resource constraint is:

$$Y = C + I^k + I^h + G + \Pi \tag{2}$$

where C denotes aggregate consumption of non-housing goods, G is fixed government expenditure, and Π denotes the transaction costs incurred from the housing transactions. In addition, business capital and housing capital depreciate at rates δ^k and δ^h, respectively.

3.3. Preferences

Agents derive utility from consumption of non-housing goods, c, and from the flow of services from their housing stock, $f(h)$, as well as from bequests, q, left upon death. Assuming agents derive utility from leaving a bequest (or a 'warm glow' bequest motive) is a simple way to incorporate bequests into the model without introducing the complexities of strategies between parents and children. The service flow from housing, $f(h)$, is proportional to the housing stock, h.

The instantaneous utility function reflects the empirical evidence on the non-linearity of the housing to non-housing consumption ratio as suggested by Jeske (2005) and employed in Chambers et al. (2009a), given as follows:

$$U(c, f(h)) = \omega \frac{c^{1-\sigma_1}}{1-\sigma_1} + (1-\omega)\frac{f(h)^{1-\sigma_2}}{1-\sigma_2} \tag{3}$$

The parameter ω measures the relative importance of non-housing consumption to housing expenditures, while σ_1 and σ_2 are the curvature parameters with respect to non-housing and housing consumption.

For the utility derived from leaving bequests, q, we incorporate a nonhomothetic bequest motive and follow the specification by DeNardi (2004) denoted as:

$$\varphi(q) = \varphi_1 \left[1 + \frac{q}{\varphi_2}\right]^{1-\sigma_q}$$

The term φ_1 reflects the parent's concern about leaving bequests to children, while φ_2 measures the extent to which a bequest is a luxury good. The curvature parameter σ_q governs the relative risk aversion for the bequest in the utility function.

3.4. Labor income dynamics

Agents enter into the lifecycle either as renters or home-owners. Renters have zero financial or housing assets, whereas home-owners have zero financial assets but a positive housing endowment when they enter the life cycle. During each period prior to the mandatory retirement age, agents are endowed with one unit of time which they supply inelastically. Agents also face an exogenous age-efficiency profile, ϵ_j, during their working years. This profile is estimated from the data and recovers the fact that productive ability changes over the life cycle. Each unit of effective labor is paid the wage rate w. Workers are also subject to stochastic shocks to their productivity level, υ_j. These shocks are represented by a finite-state Markov process with a transition function Q_υ. This Markov process is the same for all households. The total productivity of a worker of age j is given by the product of the worker's stochastic productivity in that period and the worker's deterministic efficiency index at the same age: $\upsilon_j \epsilon_j$. Working agents also pay taxes τ_y on their labor earnings and asset income. Upon retirement, retirees receive social security benefits b, which are based on the productivity shock received in the last working period.

Let y denote the sum of after-tax income and holding of the financial asset expressed as a function of age (j), financial net worth (a), and productivity shock (υ):

$$y(j,a,\upsilon)=\begin{cases}(1-\tau_y)w\epsilon\upsilon+(1+r(1-\tau_y))a & \text{if } j<j^*\\ (1-\tau_y)b(\upsilon_{j^*-1})+(1+r(1-\tau_y))a & \text{if } j\geqslant j^*\end{cases} \quad (4)$$

3.5. Housing and tenure choice

In every period, households decide whether to become a renter or a home-owner. If the household decides to rent, a rental payment of p is paid per unit of housing service to the rental agency. The renter may also decide to become a home-owner and purchase a house with size h.

We assume a minimum housing size, $\underline{H}$, for owner-occupied housing, to capture the lumpiness and indivisibility of housing investment. This constraint was previously introduced in Gervais (2002) and Cocco (2005), among others. The constraint on minimum owner-occupied housing size is as follows:

$$h_j \geqslant \underline{H} \quad \forall j \quad (5)$$

Households that rent, on the other hand, may choose to rent houses that are smaller than $\underline{H}$.

A home-owner can decide whether to keep their current house or to sell and move either to a new house or become a renter. Home-owners also pay a maintenance cost equal to the level of depreciation, δ^h, in the period during which the house was owner-occupied. In addition, buying or selling a house incurs a transaction cost, which is a fraction ϕ^s of its selling value and ϕ^b of its purchase value. The housing transaction cost, expressed as a function of housing value this period (h_j) and next period (h_{j+1}), is written as follows:

$$\phi(h_j,h_{j+1})=\begin{cases}\phi^s h_j+\phi^b h_{j+1} & \text{if } h_{j+1}\neq h_j\\ 0 & \text{if } h_{j+1}=h_j\end{cases} \quad (6)$$

Owning a house provides several benefits. First, the house can be used as collateral for home-owners to borrow up to a fraction, κ, of next period's housing value. As such, κ is the loan-to-value (LTV) ratio, and $1-\kappa$ is commonly known as the down payment ratio. The collateral constraint for a household of age j is as follows:

$$a_{j+1} \geqslant -\kappa h_{j+1} \quad \forall j \quad (7)$$

where a_{j+1} is the financial net worth. On the other hand, renters are not allowed to borrow since they do not own a collateral asset.

Second, we assume that home-owners derive higher utility from housing services than renters. This assumption captures the fact that home-owners can modify their housing unit to suit their tastes whereas renters are restricted in the modifications they can make. Following Platania and Schlagenhauf (2002) and Ortalo-Magné and Rady (2006), we assume that renters derive only a fraction $\lambda < 1$ of the utility that home-owners do from the same housing services. Thus, $f(h)=Ih+(1-I)\lambda h$, where I is an indicator denoting whether the household is a home-owner $(I=1)$ or a renter $(I=0)$. Third, housing assets can also add to the level of the bequest, from which agents also derive utility.

3.5.1. Rental agency

The rental market in the economy is operated by a rental agency. Following Gervais (2002), this rental agency is a two-period lived institution which takes deposits, D_t, in the first period and buys rental properties, S_t, as well as issues loans B_t to households. Unlike business capital, which must satisfy a one period time-to-build constraint, residential capital can be rented immediately upon purchase. In the second period, the agency receives payments for rental units, pS_{t+1}, and interest from loans extended to households, rB_{t+1}, and pays for the depreciation costs of the rental properties $(\delta^h S_{t+1})$, the interest on the deposits (rD_{t+1}), and the property tax on the rental units $(\tau_p S_{t+1})$. At the end of the second period, the existing institution sells the undepreciated part of the residential stock to a new institution. The problem of the rental agency is formulated as follows:

$$\max_{S_{t+1},B_{t+1},D_{t+1}} \quad pS_{t+1}+rB_{t+1}-\delta^h S_{t+1}-rD_{t+1}-\tau_p S_{t+1} \quad (8)$$

$$\text{subject to} \quad S_{t+1}+B_{t+1}\leqslant D_{t+1} \quad (9)$$

For this maximization problem to be well defined, the following no-arbitrage condition needs to be satisfied in a stationary equilibrium with constant prices:

$$p=\delta^h+r+\tau_p \quad (10)$$

This implies that renting out a property, receiving the rental payment and paying the maintenance costs and property tax yield the same profit as receiving interest income. In other words, in a stationary equilibrium with constant prices, the rental rate on housing is uniquely determined given the interest rate and the depreciation rate.

3.6. Government and taxation

The government has a set of different tax instruments at its employ, denoted as $\tau = \{\tau_y, \tau_m, \tau_r, \tau_p\}$. First, the government collects income tax from households at a rate τ_y proportional to labor earnings and interest earnings from their net financial assets. Retired households also pay income tax on their pension benefit, b. Under the US tax code, we allow the mortgage interest payment to be tax deductible.[3] We use an indicator $\tau_m = 1$ to denote full mortgage deductibility on the tax paid on asset income. Housing assets also generate implicit income in the form of imputed rents based on the flow of services per period. We allow for the taxation of imputed rents at rate τ_r. The US tax system does not currently tax imputed rents so we set $\tau_r = 0$ in the benchmark. Finally, home-owners can deduct the total amount of property taxes on their primary residence. Denoting τ_p as the property tax rate, the payment of property tax inclusive of the deduction can be written as $\tau_p(1-\tau_y)h$, where property taxes are paid based on the market value of housing.

We use Z to denote all housing-related tax payments for home-owners, where

$$Z(\tau, a, h) = \begin{cases} \tau_r h + \tau_p(1-\tau_y)h & \text{if } a \geqslant 0 \\ (\tau_m - 1)\tau_y r a + \tau_r(a+h) + \tau_p(1-\tau_y)h & \text{if } a < 0 \end{cases} \tag{11}$$

In addition to income and housing taxes, the government fully taxes away bequests left by the deceased. All tax revenues from labor and asset income, housing, and bequests are used to finance pension benefits, b, a fixed level of government expenditures denoted as G, and a housing endowment for the initial cohorts (who have high income draws). The government maintains a balanced budget every period.

3.7. The household's recursive problem

The state space is a set $x = \{j, a, h, I, \upsilon\}$, where j is the age of the household, h is the stock of housing, a is financial net worth (financial assets less all liabilities), I is a housing tenure status indicator, and υ is the productivity shock. Households choose next period housing tenure by comparing the value of home-ownership against the value of renting. The value function $V(j, a, h, I, \upsilon)$ is given as $V(j, a, h, I, \upsilon) = \max\{V^o, V^r\}$, where V^o and V^r denote the value of owning and renting, respectively.

If agents choose to own ($I' = 1$), then the value function V^o is given by:

$$V^o(j, a, h, I, \upsilon) = \max_{c, a', h'} \left[U(c, f(h')) + \nu\beta \mathbb{E} V(j+1, a', h', 1, \upsilon') + (1-\nu)\varphi(a'+h') \right]$$

s.t.

$$c + a' + h' + \phi(Ih, h') \leqslant y(j, a, \upsilon) + I(1-\delta^h)h - IZ(\tau, a, h) \tag{12}$$

$$h' \geqslant \underline{H} \tag{13}$$

$$a' \geqslant -\kappa h' \tag{14}$$

$$c \geqslant 0 \tag{15}$$

If agents choose to rent ($I' = 0$), then the value function V^r is as follows:

$$V^r(j, a, h, I, \upsilon) = \max_{c, a', h'} \left[U(c, f(h')) + \nu\beta \mathbb{E} V(j+1, a', 0, 0, \upsilon') + (1-\nu)\varphi(a') \right]$$

s.t.

$$c + a' + ph' + \phi(Ih, 0) \leqslant y(j, a, \upsilon) + I(1-\delta^h)h - IZ(\tau, a, h) \tag{16}$$

$$c, a', h' \geqslant 0$$

3.8. Definition of a stationary equilibrium

A stationary equilibrium is given by a set of government policy arrangements $\{\tau, b, G\}$; a set of prices $\{p, r, w\}$; value functions $V(x)$; allocations $c(x), a'(x), h'(x)$; a time-invariant distribution of agents over the state variables $x = \{j, a, h, I, \upsilon\}$, $m^*(x)$; and aggregate quantities $\{Y, C, H, K, L, S, D, B\}$ such that given prices and the government policies:

(i) the functions $V(x), c(x), a'(x), h'(x)$ solve the dynamic maximization problem of the households given in section (3.7).
(ii) factor prices are equal to their marginal products:

$$r = F_K(K, L) - \delta^k$$
$$w = F_L(K, L)$$

(iii) $\{S, B, D\}$ solves the rental agency's problem given in (8).

[3] Since 1997, households can deduct up to $1 million in mortgage interest for primary and secondary residences.

(iv) the government policies satisfy:

$$\int [\tau_y(wL + rK) + Z(\tau, a, h) + q]m^*(dx) = \int_{j \geqslant j^*} b_j m^*(dx) + G + \int_{j=1} Ih_j m^*(dx)$$

where

$$b_j = \frac{\chi w \epsilon_{j^*-1} \upsilon_{j^*-1}}{\int_{j<j^*} m^*(dx)} \tag{17}$$

(v) m^* is the invariant distribution of households over the state variables.
(vi) all markets clear.

$$C = \int cm^*(dx) \tag{18}$$

$$H = \int_{l=1} hm^*(dx) \tag{19}$$

$$S = \int_{l=0} hm^*(dx) \tag{20}$$

$$L = \int \epsilon \upsilon m^*(dx) \tag{21}$$

$$K = \int am^*(dx) - S \tag{22}$$

$$Y = C + \delta^k K + \delta^h H + \delta^h S + \Pi + G \tag{23}$$

where

$$\Pi = \int \phi(h, h')m^*(dx)$$

4. Calibration

The set of parameters are divided into those that can be estimated independently of the model or are based on the estimates provided by other literature and data, and those that are chosen such that the predictions generated by the model can match a given set of targets. All parameters were adjusted to the three year time span that each period in the model represents. For the first group of calibrated parameters, Table 4 lists the parameters provided by other literature and data.

Regarding the preference parameters, while in a standard separable CRRA-type utility function with two types of goods it is assumed that $\sigma_1 = \sigma_2$, this assumption is not consistent with the data on consumer behavior when one of the goods is housing. Jeske (2005) observes an increasing ratio of housing services to consumption with age, where, as income rises he finds a larger fraction goes to housing. Different values for σ_1 and σ_2 can take into account the non-linearity of the housing to non-housing consumption ratio. Several other studies, such as Chambers et al. (2009a), assume the coefficient of relative risk aversion on housing services is less than that on non-housing consumption, which allows them to match the increasing ratio of housing to non-housing consumption as income increases. We assume $\sigma_1 = 3$ and $\sigma_2 = 1.5$ thus allowing the marginal utility from an increase in housing services to decline more slowly than the marginal utility of non-housing consumption which implies individuals will allocate a larger fraction of a given increase in income to housing (assuming a threshold level of consumption has been reached). For the bequest parameters, σ_q and ϕ_2 are taken from DeNardi (2004), while ϕ_1 is chosen to account for the slow run-down of wealth during retirement. We pin down the value of ϕ_1 such that the average wealth of cohorts aged 70+ is approximately 70% of the wealth of cohorts aged 60–69.[4] For λ, which measures the degree of households' preference for home-ownership over renting, we choose a value of 0.9.[5]

In the aggregate production function, we use the National Income and Product Accounts (NIPA) and Fixed Assets Tables (FAT) from 1959 to 2007 to calibrate α, the share of income attributed to physical capital, as well as the annual depreciation rates of the capital and housing stock. For the transaction cost parameters, ϕ^s and ϕ^b, Gruber and Martin (2003) estimate the relocation and agency costs from the US Consumer Expenditure Survey (CEX), and find that the median household pays costs on the order of 7% whenever selling a house and 2.5% to purchase. We set the transaction cost parameters to $\phi^s = 0.07$ and $\phi^b = 0.025$ accordingly. We take the maximum loan-to-value ratio, κ, to be 80%, with an implied maximum down-payment requirement of 20%, which has been the average down-payment requirement over the last 20 years according to the American Housing Survey.

[4] The average net worth of cohorts aged 60–69 and 70+ from the SCF (2007) was $1,053,000 and $728,000, respectively.

[5] The parameter λ is a critical parameter since it strongly influences the desire to be a home-owner versus a renter. Smaller values of λ should result in more home-ownership, ceterus paribus, and thus higher tax revenues from housing. In order not to bias our results, we choose a value for λ that is consistent with several recent studies, Gervais and Pandey (2008) and Kiyotaki et al. (2008).

Table 4
Parameter definitions and values.

Preference		
σ_1	Risk-aversion coefficient (non-housing)	3
σ_2	Risk-aversion coefficient (housing)	1.5
σ_q	Risk-aversion coefficient (bequest)	1.5
ϕ_1	Bequest parameter	−34.0
ϕ_2	Bequest parameter	11.6
λ	Utility premium	0.9
Technology		
α	Capital income share	0.237
δ^h	Housing depreciation rate	0.042
δ^k	Business capital depreciation rate	0.073
ϕ^s	Selling transaction cost	0.07
ϕ^b	Buying transaction cost	0.025
κ	Loan-to-value ratio	0.8
Stochastic process		
ρ	Persistence of annual income process	0.97
σ_υ^2	Innovation of annual income process	0.06
Housing tax and replacement ratio		
τ_m	Mortgage interest deductibility	1
τ_r	Tax on imputed rent	0
τ_p	Tax on housing property	1%
χ	Replacement ratio	40%
Demographics		
j^*	Retirement age	$65 (j^* = 16)$
ν_j	Survival probability	Bell and Miller (2005)
ϵ_j	Age-efficiency profile	Hansen (1993)
o	Home-ownership ratio for 21–25 year old	25%

The logarithm of the stochastic productivity process is assumed to be an AR(1) process following Huggett (1996),

$$\ln \upsilon_j = \rho \ln \upsilon_{j-1} + \mu_j$$

The disturbance term μ_j is normally distributed with mean zero and variance σ_υ^2. The persistence parameter ρ is taken from DeNardi (2004), while the variance, σ_υ^2, is chosen to match the Gini coefficient for earnings.[6] Productivity shocks are discretized into a four-state Markov chain according to Tauchen and Hussey (1991), with values given by $\{0.2667, 0.7135, 1.4015, 3.7495\}$, and the transition matrix Q_υ given by:

$$\begin{Bmatrix} 0.7203 & 0.2352 & 0.0424 & 0.0020 \\ 0.2352 & 0.4560 & 0.2664 & 0.0424 \\ 0.0424 & 0.2664 & 0.4560 & 0.2352 \\ 0.0020 & 0.0424 & 0.2352 & 0.7203 \end{Bmatrix} \tag{24}$$

For housing taxes, since the benchmark case simulates the current tax system in the United States, mortgage interest is fully deductible thus we set $\tau_m = 1$. The average property tax rate is taken from the 2007 American Community Survey conducted by the US Census Bureau, which we set at $\tau_p = 0.01$ and allow property taxes to be fully deductible from the income base used in calculating income tax liability. Imputed rent on owner-occupied housing is untaxed in the benchmark ($\tau_r = 0$).

The deterministic age-efficiency profile ϵ_j, is calculated from the estimate of the mean age-income profile from Hansen (1993). For lifetime uncertainty, the conditional survival probabilities are taken from Bell and Miller (2005). We base the fraction of home-owners among households entering into the lifecycle on the average home-ownership ratio reported in Survey of Consumer Finances between 1994 and 2007 for young households.[7]

The next three parameters, β, ω, and $\underline{H}$, are jointly chosen such that the predictions generated by the model can match a given set of aggregate target ratios from the National Income and Product Account tables. The first aggregate target is the physical capital to output ratio, $\frac{K}{Y}$. The physical capital stock is the sum of private and government non-residential fixed assets and inventories, while output is defined as the gross domestic product minus the expenditure on housing services. For the US, using the NIPA tables, the average over the period 1959–2007 was 1.95 for the capital output ratio.[8] The second target

[6] The Gini coefficient for earnings in the age group between 26 and 60 is 0.45 according to the SCF data. Our choice of σ_υ^2 gives a value of 0.455 in the simulation. Our simulation also generates an income percentile ratio $\frac{p90}{p10} = 14.0$, which matches the US data well.

[7] We assume that the houses for these young households are endowed by the government from the funds left as bequests. We endow these individuals with houses rather than assets, with which to purchase a house, so that there can be home-ownership among the first cohort, otherwise individuals would have to wait one period during which they purchased the house.

[8] Given the capital–output ratio, the implied interest rate in stationary equilibrium is derived as $r = \alpha\frac{Y}{K} - \delta^k$, which is 4.9% annually.

Table 5
Parameters to match target ratios.

Parameters	Definition	Value
β	Discount factor (annual)	0.918
$\underline{H}$	Minimum housing (fraction of average income)	0.645
ω	Share of non-housing consumption	0.731
τ_y	Tax rate on income	23.98%

Table 6
Aggregate Statistics-Benchmark Simulation.

	Benchmark Simulation	US data
Capital-output ratio $\left(\frac{K}{Y}\right)$	1.9512	1.95
Housing-output ratio $\left(\frac{H}{Y}\right)$	1.2189	1.22
Home-ownership ratio (%)	64.47	64.5
Consumption-output ratio$\left(\frac{C}{Y}\right)$	0.5823	0.607

is the housing capital to output ratio, $\frac{H}{Y}$. Housing capital corresponds to the stock of owner-occupied and rental properties. This ratio is 1.22 in the United States over the period 1959–2007. The third aggregate target is the aggregate home-ownership ratio. The average home-ownership ratio from 1965 to 2007 in the US was approximately 64.5%. We use these three data targets to tie down three parameters, $\beta, \underline{H}$, and ω. The income tax rate τ_y is chosen to balance the government budget, where tax revenues are used to finance social security benefits and fixed government expenditures, G, which are 17% of GDP. The calibrated parameter values are shown in Table 5.

5. Benchmark results

5.1. Aggregate and lifecycle profiles

In this section, the results from the benchmark simulation are presented and the fit of the model is evaluated. The aggregate statistics for the benchmark simulation as well as the empirical counterparts for the US are presented in Table 6. We find that the benchmark achieves a close match for all targets as well as the consumption to GDP ratio.

In Fig. 3 we construct the lifecycle profiles of net worth and the composition of the asset portfolio (housing vs. financial assets) for an average household from the simulation. Net worth is defined as the sum of financial net worth (financial assets less debt)[9] and housing assets, $a + h$. Our model captures the profile of housing assets observed in the data; with rapid accumulation of housing occurring early in life and almost no downsizing following retirement. The former is attributed to the role of housing as collateral and the latter is explained by the existence of transaction costs and the fact that some older households take on a reverse mortgage and debts. Fig. 4 shows the average home-ownership ratio by age from the simulation. The age profile of home-ownership follows a hump-shaped pattern, which matches the data shown in Fig. 2.

5.2. Distribution of wealth

In Table 7, we look at the model implied summary statistics on the distribution of wealth. Assuming a bequest motive allows the model to generate sufficient wealth (and financial assets) during retirement periods to match the data. Lifecycle models without bequest motives, or some other reason to continue saving once buffer-stock and retirement targets have been reached, generate a relatively low concentration of wealth. Considering first the skewness of the wealth distribution, the upper tail of the distribution generated by the model is too thin to match the data counterpart; for example, the wealthiest 5% of households hold only 24% of total wealth in the model compared with 57.5% in the data. This is a well-known problem in the standard lifecycle model that even with inclusion of bequest motives, the model is unable to generate households with higher saving rates.[10] However, the model generates a close fit in terms of the wealth held by the top quintile as well as the various percentile ratios. Given our attention to housing in the portfolio, our model does a fairly good job in matching the majority of the distribution of housing with a close fit in terms of the housing wealth held by the top two deciles as well as the bottom 50% of the distribution.

The model matches the Gini coefficient for housing assets well and captures the fact that the Gini coefficient for financial net worth is greater than the Gini for housing assets. However, the model under-predicts the pronounced skewness of the

[9] Financial net worth, denoted as a in the model, can take negative values for households with a mortgage payment. However, the average profiles are positive for all age cohorts due to the fact that there is significant saving by some households in each of the cohorts which outweighs the negative asset positions.

[10] Modeling entrepreneurs would help to generate the top tail of the wealth distribution. See Cagetti and DeNardi (2006).

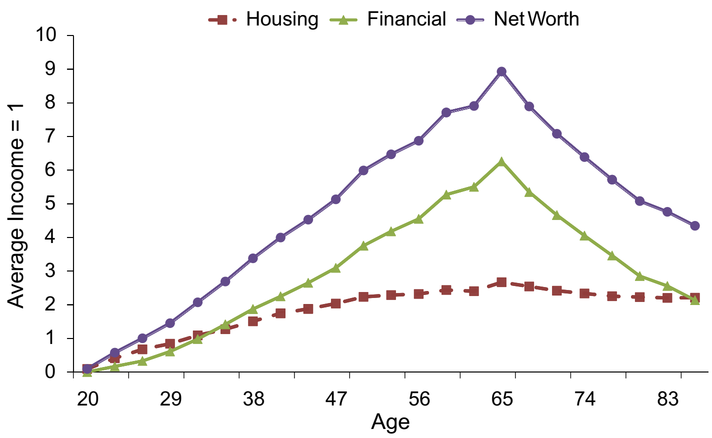

Fig. 3. Net worth and assets by age.

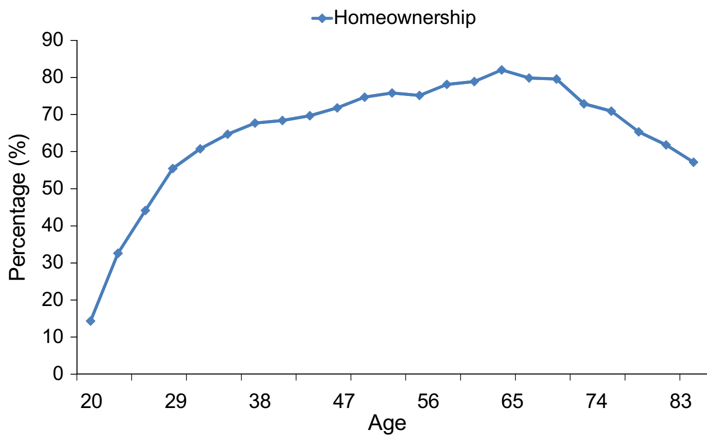

Fig. 4. Home-ownership by age.

Table 7
Distribution of net worth and assets.

	Net worth		Financial		Housing	
	Model	SCF 01	Model	SCF 01	Model	SCF 01
Gini coefficient	0.632	0.806	0.661	0.849	0.624	0.645
Total net worth/asset held by						
Top 5%	24.3	57.5	25.9	61.7	13.8	30.7
Top 10%	40.8	69.7	41.8	75.4	29.2	41.3
Top 20%	63.4	82.6	64.5	88.1	55.0	63.6
Bottom 50%	6.8	2.8	5.9	1.3	6.7	6.9
Percentile ratios						
p90/p25	50.6	57.5	31.2	185.0	–[†]	–[†]
p90/p50	5.9	8.5	6.2	16.9	7.9	4.0
p75/p25	26.3	22.2	16.0	55.1	–	–

[†] Households in the 25th percentile in the model and data are renters with zero housing wealth.

distribution financial assets, which results in under-prediction of overall wealth inequality. We also report the Gini coefficients by different age cohorts in Table 8. As shown in Silos (2007), the generally decreasing trend of financial wealth inequality between youth and middle age, broadly defined, is due to a larger number of borrowers among younger households while the decreasing trend of housing wealth inequality is due to a large number of renters among younger cohorts. Our model is able to match the fact that the inequality is highest among the youngest cohorts aged 20-34 and the fact that inequality is reduced as households become middle-aged. However, the model is not able to match the exact pattern of increases and decreases that occur after middle-age.

Table 8
Gini coefficients-by assets and age.

	Net worth		Financial		Housing	
	Model	SCF 01	Model	SCF 01	Model	SCF 01
20–34	0.729	0.866	0.782	0.861	0.712	0.766
35–49	0.575	0.763	0.581	0.790	0.591	0.617
50–64	0.497	0.788	0.489	0.835	0.539	0.599
65–86	0.569	0.753	0.613	0.827	0.548	0.579

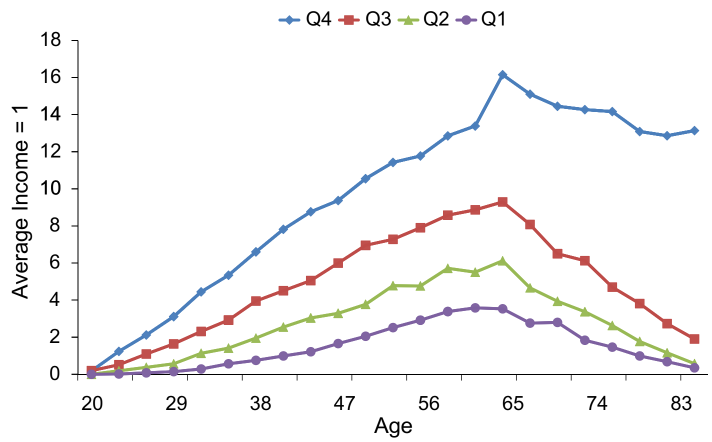

Fig. 5. Decomposition of lifecycle profile of wealth.

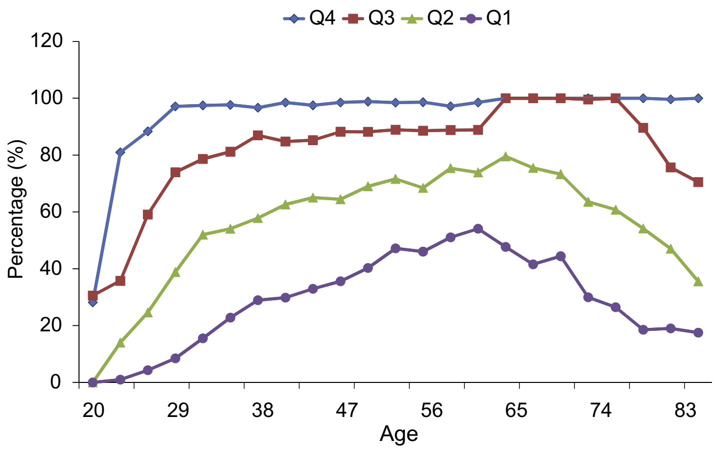

Fig. 6. Decomposition of lifecycle profile of home-ownership.

5.3. Lifecycle profiles of disaggregated households

We track the cross-sectional profiles of households in terms of their net worth and home-ownership ratios by disaggregating each age cohort in terms of earnings quartiles as shown in Figs. 5 and 6, respectively. All four lifecycle profiles of wealth exhibit the classic concave shape which characterizes the data, where asset accumulation peaks upon reaching retirement age. Since bequests are modeled as a luxury good, only the households in the highest quartile retain enough wealth during retirement to leave bequests. The remaining households mostly run down their assets to finance retirement consumption. Home-ownership is also increasing over the majority of the lifecycle for all four groups. For the highest two quartiles, home-ownership reaches 100% by the age of approximately 65, whereas for poorer households, the transition to home-ownership is more gradual with (lower) peaks reached between 60 and 65 years old.

6. Policy experiments

In order to answer our central question – whether the preferential tax treatment of housing has an impact on wealth inequality – we conduct a set of policy experiments and compare the outcomes to the benchmark case. We specifically focus

Table 9
Policy experiments-parameter values.

	Change in parameters		
(1) Removal of MID	$\tau_m = 1$	→	$\tau_m = 0$
(2) Taxing imputed rent	$\tau_r = 0$	→	$\tau_r = \tau_y$
(3) Removal of PTD	$\tau_p(1 - \tau_y)$	→	τ_p
(4) = (2) + (3)			

on the following counter-factual experiments: (1) eliminating mortgage interest deductibility (MID), (2) taxing imputed rents, (3) eliminating property tax deductibility (PTD), and (4) combining the taxation of imputed rents with an elimination of property tax deductibility. We consider these experiments, keeping in mind what a 'normal tax code' would imply, that is, that expenses incurred to earn income ought to be deductible. Thus, when we tax imputed rent we maintain mortgage interest deductibility. We analyze the results of these experiments assuming that the government maintains a balanced budget. The government responds to any increases in revenue resulting from removing preferential tax treatment by adjusting the income tax rate to maintain revenue neutrality. For the case of removing PTD, the government lowers the property tax rate to keep revenues constant. Table 9 summarizes the relevant parameter values associated with the policy experiments.

6.1. Aggregate and lifecycle profiles

In this section we consider the effect of changing the tax treatment of housing on home-ownership as well as the distributional and welfare impact of such changes. For the mortgage interest deduction (labeled as (1)) and the property tax deduction (labeled as (3)), we consider a full removal of deductibility. In order to determine the tax rate to implement on imputed rent (labeled as (2)), we treat housing equity like other asset interest income and apply the income tax rate to the imputed rent. For all experiments, we look at one scenario where the interest rate is fixed to the benchmark case and a second scenario where the interest rate is fully flexible.

Table 10 reports the aggregate statistics for each of the experiments as well as the adjusted income tax rate, interest rate, and the change in aggregate welfare as a result of each policy experiment. In order to measure changes in aggregate welfare, we calculate the change in the average discounted lifetime utility across the population of households that results from each experiment. We use this measure of welfare to be consistent with Gervais (2002).

We consider the results of two sets of experiments at the aggregate level. First, we examine a partial equilibrium case where the interest rate is fixed. This could be thought of, alternatively, as the short run response to the change in the tax implications of housing. We examine this case to isolate the effects of the change in tax treatment from other changes, such as a reduction in the interest rate. We find that the income tax rate falls by between 0.04% (in the case of removing the MID) and 3.87% (for taxing imputed rents and removing PTD). We find that for all experiments except for MID removal, there is a re-allocation from housing towards financial assets at the aggregate level, as the capital output ratio increases and the housing output ratio falls. For the removal of MID, the changes in the aggregate ratios are small suggesting that the MID has little impact on re-allocation between housing and financial assets and that those individuals who delay home-ownership only increase their non-housing consumption. The increase in non-housing consumption is also reflected in a small but positive increase in aggregate welfare. When we remove PTD, we find a small increase in aggregate welfare and a small drop in home-ownership. For this experiment, rather than using the excess revenues from removing PTD to reduce taxes for all individuals (via lowering the income tax rate), we use it to lower the property tax rate, which falls from 1% to 0.8%.

The experiments where imputed housing rents are taxed have stronger implications for re-allocation, resulting in a significant increase in the capital output ratio and a reduction in the housing output ratio. We also find a substantive decline in

Table 10
Aggregate statistics.

	Benchmark	(1)	(2)	(3)	(4)
Fixed interest rate					
Capital output ratio	1.9512	1.9518	2.0703	1.9764	2.0577
Housing output ratio	1.2189	1.2204	1.1502	1.2012	1.1580
Home-ownership ratio (%)	64.47	64.42	41.29	63.57	36.02
Income tax rate (%)	23.98	23.94	20.31	–	20.11
Aggregate welfare change (%)		0.14	7.79	1.00	8.18
Variable interest rate					
Capital output ratio	1.9512	1.9509	1.9215	1.9575	1.9287
Housing output ratio	1.2189	1.2207	1.2402	1.2078	1.2492
Home-ownership ratio (%)	64.47	64.40	29.74	63.35	26.41
Income tax rate (%)	23.98	23.96	21.12	–	20.84
Interest rate (%)	4.87	4.86	4.23	4.73	4.29
Aggregate welfare change (%)		0.16	9.48	1.36	9.69

home-ownership in the two experiments where imputed rents are taxed. Interestingly however, we find the largest increase in aggregate welfare occurs in the two experiments where we implement a tax on imputed rent. Likely if the utility derived from rental housing was substantively lower than owner-occupied housing, we would not observe such a substantial improvement in aggregate welfare. But in our case, since the utility from rental housing services is close to that derived from owning your own house, households use the extra income freed up from the reduction in the income tax rate primarily to consume more non-housing goods and services as well as to purchase financial assets.

In our second set of experiments, we consider the general equilibrium response, where the interest rate is allowed to vary (this could be considered a long-run case). Some of our aggregate results change since a reduction in owner-occupied housing will reduce the demand for loans, causing the interest rate to fall. For all experiments, removing the preferential tax treatment on home-owners, implies tax savings for the government, which subsequently results in a lower income tax rate as we assume the government continues to balance its budget. The reduction in the tax rate ranges from 0.02% (in the case of removing MID) to 3.14%. The interest rate also falls between 0.01% and 0.64%. Income tax rates fall by a smaller percentage in the general equilibrium case because individuals hold fewer financial assets and therefore government revenue from all asset income is lower.

Quantitatively, when we remove MID, we find a small decrease in home-ownership (0.07% points) and a modest increase in aggregate welfare (0.16%). Aggregate welfare improves even though there is no significant reduction in the tax rate. This is likely due to the lower interest rate which allows households to finance their housing purchases more cheaply even though interest is no longer deductible. Removing PTD increases the capital output ratio, lowers the housing output ratio and results in a small decrease in home-ownership. It also results in a welfare improvement that is small but more substantial than in the case of removing MID. In the general equilibrium scenario, taxing imputed rents continues to have the largest effect on home-ownership and welfare, where the gains in welfare are 22% greater than in the partial equilibrium case while home-ownership falls by 35% points. For the case without PTD and with a tax on imputed rent, we find that since discounted average lifetime utility is higher, aggregate welfare increases by 9.69%. The removal of the preferential tax treatment of housing leads to better consumption smoothing over the lifecycle, however it significantly reduces homeownership, which falls to 26.4% from 64.5%.

We report average lifecycle profiles under the different policy experiments in Table 11, which shows the lifecycle profiles of net worth, housing wealth, and home-ownership. It also shows the percentage change in aggregate welfare for different age cohorts. The profile of net worth over the lifecycle changes significantly only for experiments which include taxes on imputed rents, which is consistent with the fact that the aggregate capital output ratio remains mostly unchanged when MID or PTD are removed. In the two cases where imputed rents are taxed, net worth falls for all age cohorts compared to the benchmark case. The majority of this loss is due to a sharp decrease in housing wealth across all age cohorts when imputed rents are taxed (experiments 2 and 4), which is not fully replaced by additional financial wealth. As the households age, home-ownership increases even in the cases with taxation on imputed rents so that after retirement (ages 65–86), approximately 64% of households are homeowners versus 74% in the benchmark case.

The welfare gains from removing MID or PTD are small and decrease with age, while the gains from taxing imputed rents are large but also decrease with age. Thus the preferential housing tax policies are the most welfare reducing for the youngest households or removal of the tax benefits the youngest cohort the most.

Table 11
Average Lifecycle Profiles - Variable interest rate.

	Benchmark	(1)	(2)	(3)	(4)
Net worth					
20–34	0.98	0.98	0.84	0.98	0.85
35–49	3.86	3.86	3.49	3.86	3.45
50–64	6.90	6.90	6.72	6.90	6.74
65–86	6.62	6.62	6.37	6.57	6.43
Housing wealth					
20–34	0.56	0.56	0.04	0.55	0.02
35–49	1.62	1.63	0.47	1.61	0.28
50–64	2.28	2.28	1.62	2.25	1.52
65–86	2.32	2.32	1.97	2.28	1.96
Home-ownership (%)					
20–34	41.5	41.5	5.5	39.4	2.9
35–49	68.4	68.4	12.3	67.8	7.3
50–64	76.5	76.5	40.5	75.7	36.6
65–86	73.8	73.6	64.8	72.9	63.1
Welfare (% change)					
20–34		0.16	9.74	1.43	9.89
35–49		0.16	7.39	0.75	8.13
50–64		0.10	5.26	0.51	6.14
65–86		0.11	6.08	0.18	6.87

6.2. Wealth distribution and welfare changes

Turning to the distributional effect of each of the experiments summarized in Table 12, we find that for all experiments the Gini coefficient for financial assets falls while the index for housing is higher relative to the benchmark case. The worsening inequality in housing assets causes the overall net worth Gini coefficient to rise for all experiments except for the removal of MID. Quantitatively, considering either the Gini coefficient or the amount of wealth owned by the top 5% of the distribution, inequality increases significantly in the two cases where imputed rents are taxed and only the rich own homes. When faced with imputed rent taxation, significantly more individuals prefer to rent and put their savings into financial assets, thus the Gini coefficient for financial assets decreases as does the amount of financial wealth owned by the top 5% of the distribution, while it rises for housing.

Removing MID or PTD has a neutral effect for the most part on inequality. It slightly reduces net worth at the very top of the distribution while having no impact on that held by the bottom. The impacts on housing wealth of removing MID or PTD are slightly different, with MID removal slightly increasing housing wealth for the top 10% and PTD removal slightly decreasing it. In the two cases of taxing imputed rents, the distribution of net worth becomes more skewed with individuals at the top of the distribution gaining at the expense of those at the bottom. The majority of this redistribution comes from the changes in housing ownership, where individuals in the bottom 50 percentiles no longer have any housing wealth and those in the top percentiles thus own a significantly larger share. On the other hand, while individuals in the bottom 50% of the distribution reduce their housing wealth significantly, they increase their financial wealth so that we observe a redistribution of financial wealth from the top percentiles to the bottom 50 percentiles when imputed rents are taxed.

To determine how the welfare changes vary across different types of households, we look at the lifecycle changes in welfare for age cohorts differentiated by the productivity shock as shown in Table 13. Q1 through Q4 refers to income quartiles, where Q4 is the highest quartile (associated with the highest productivity shock). We find that welfare gains are spread across age groups and wealth quartiles for each of the policy experiments. As before, we find that removing MID results in a small positive improvement in welfare for all age groups and quantiles, except for the oldest group in the top quartile. Removing PTD similarly results in a small positive gain in welfare for most quartiles and age groups, however it is primarily concentrated among the youngest cohort in each quartile. During retirement, removing property tax deductibility is favored by the poorest households (Q1) while it has predominantly small but negative effects on welfare for the other retired households (Q2–Q4).

Taxing imputed rents, either on its own or combined with removing PTD, results in a large welfare improvement for the youngest cohorts in all quartiles. For the first two quartiles (the poor and lower middle class in our experiments), welfare gains are uniformly positive even into old age. This is due to the fact that very few of these households purchase homes

Table 12
Wealth Distribution-Variable interest rate.

	Benchmark	(1)	(2)	(3)	(4)
Total net worth by					
Top 5%	24.3	24.2	24.2	24.4	25.3
Top 10%	40.8	40.7	42.2	40.9	41.5
Top 20%	63.4	63.4	63.0	63.4	62.8
Bottom 50%	6.8	6.8	5.9	6.2	5.9
Percentile ratios					
p90/p25	50.6	50.6	49.5	50.4	49.6
p90/p50	5.9	5.9	7.1	6.3	7.1
p75/p25	26.3	26.7	24.0	26.7	24.0
Total financial net worth by					
Top 5%	25.9	25.9	24.2	26.0	23.7
Top 10%	41.8	41.7	37.2	42.4	38.7
Top 20%	64.5	64.3	56.4	64.6	59.2
Bottom 50%	5.9	5.9	7.8	5.9	7.6
Percentile ratios					
p90/p25	31.2	31.2	34.8	31.2	34.8
p90/p50	6.2	6.2	5.0	6.2	5.0
p75/p25	16.0	16.0	20.0	16.0	21.0
Total housing by					
Top 10%	29.2	30.4	39.7	28.2	45.5
Top 20%	55.0	55.0	88.3	54.8	91.5
Bottom 50%	6.7	6.6	0.0	6.3	0.0
Percentile ratios					
p90/p50	7.9	7.9	–	7.9	–
Gini net worth	0.632	0.632	0.644	0.633	0.643
Gini housing	0.624	0.625	0.797	0.628	0.816
Gini financial	0.661	0.660	0.625	0.660	0.623

Table 13
Disaggregated lifecycle changes in welfare (%).

	(1)	(2)	(3)	(4)
Q1				
20–34	0.16	9.93	1.36	10.27
35–49	0.15	8.20	0.76	9.59
50–64	0.09	6.42	0.52	7.48
65–86	0.11	7.57	0.32	8.39
Q2				
20–34	0.16	9.90	2.08	9.75
35–49	0.17	6.01	0.91	4.52
50–64	0.13	3.74	0.78	4.46
65–86	0.12	1.57	−0.23	2.37
Q3				
20–34	0.17	7.98	0.87	6.62
35–49	0.10	5.31	0.52	5.80
50–64	0.05	2.74	0.09	2.88
65–86	0.07	−3.15	−0.78	−2.54
Q4				
20–34	0.08	6.67	0.87	6.89
35–49	0.36	4.13	0.14	4.41
50–64	0.07	−0.13	−0.15	0.16
65–86	0.00	−1.46	−0.26	−1.71

under these two experiments. In the third and fourth quartiles, the oldest cohorts experience a reduction in welfare. All of these policy changes create welfare gains for the young, regardless of income class, since they face lower income taxes and largely delay their housing purchases, freeing up income for more non-housing consumption. Taxing imputed rents places a somewhat significant burden on the elderly who retain their homes.

Our results are consistent with the results in Poterba et al. (2008), who find that the burden of changes in the marginal cost of housing due to removing either the MID or PTD varies across the wealth distribution. They find that the increase in the marginal cost of housing would be between 3% and 5% on average (depending on how the changes cause households to re-allocate their portfolios) but the cost increases would be largest at the upper end of the distribution and miniscule for the rest of the population.

The heterogeneity of effects from removing MID or the property tax deduction is due to the fact that the tax savings for the government are small and therefore the across the board reduction in the income tax rate (and reduction in the property tax rate) is very small and neither of these changes causes appreciable portfolio re-allocation so that the interest rate does not change. In general equilibrium, under removal of MID or PTD, the user cost of owner occupied housing rises, which should cause households to reduce the size of their home and to delay purchasing a home. But for households who can afford owner-occupied housing, they will eventually purchase a home, so aggregate debt is unchanged. Thus whether welfare is higher for particular wealth quartiles or age groups depends on whether individuals in those groups were purchasing houses to begin with, the age of their first purchase, as well as the size of their house since size determines the overall savings from the MID or PTD. Taxing imputed rents elicits much larger tax savings for the government resulting in a lower aggregate income tax rate as well as portfolio re-allocation toward holding more financial assets along with a reduction in the demand for mortgages, which causes a drop in the interest rate. Thus these changes have much more positive across the board effects for all but the wealthiest quartile. When we implement all policy changes simultaneously, maintaining MID, we find a welfare improvement for both of the lowest wealth quartiles for all age groups and for most of the upper and middle-class quartiles with the exception of retired individuals (between 65 and 86). Thus all households would gain from removing PTD and assessing a tax on imputed rents, except for the oldest wealthy households. The oldest wealthier households likely do not gain from these tax policy changes since for them, the cost of maintaining their house rises and there is not sufficient compensation from the lower income tax rate. Also, they likely have little debt but significant saving and the fall in the interest rate would have a negative impact on them.

Results of our experiments for the wealth distribution and the effect on welfare differ, to some extent, from those found by Gervais (2002). In Gervais (2002), either taxing imputed rents or removing MID lowers the tax rate on labor income, which contributes to higher after-tax income and thus a positive welfare gain for all quantiles. The welfare gains are also larger under taxing imputed rents than under the removal of MID, where imputed rents are taxed at the same rate as labor income. Our results, similarly, show that all experiments produce tax savings for the government and thus generate subsequent reductions in income tax. As for welfare gains, our results show positive welfare gains in the aggregate as well as over the lifecycle for average households. However, when we disaggregate households by age and by earnings, we see that elderly and rich households experience a welfare loss when we impose an imputed rental tax or remove property tax deductibility. The distributional impact in Gervais (2002) of removing MID is to lower the Gini coefficient (on wealth) by less than 1% while taxing imputed rent increases the Gini coefficient by 2.2%. For removing MID or taxing imputed rents, we find that the Gini for housing is higher but it is lower for financial wealth, with an ambiguous distributional effect on the net worth Gini. For MID removal, the Gini for net worth remains unchanged, whereas the Gini index under taxing imputed rents rises by 1.9%.

7. Conclusion

In answer to the question, does the tax treatment of housing make us more unequal in terms of wealth, our results do not provide a strongly affirmative answer. However, the current tax treatment may act as a wedge in favor of housing as an investment as well as a consumption good. Thus, favorable tax treatment of owner-occupied housing causes agents to over-invest and over-consume housing. Removing this wedge, as evidenced from our policy experiments, results in portfolio re-allocation towards financial assets as well as consumption re-allocation towards non-housing consumption. The latter provides grounds for positive welfare gains in the aggregate. The welfare implications are mixed across different demographic groups as the wealthiest retired households experience welfare losses. However, it appears that current tax policy, particularly the fact that imputed rents are not taxed (while mortgage interest is deductible) causes agents to save more overall, particularly when young.

The relationship between home-ownership and housing tax policy is complex particularly in a general equilibrium context where individuals have choices over various asset classes and differing marginal tax rates and where state and federal tax policies interact. When taxpayers itemize their tax returns, the MID and the PTD encourage home-ownership through reducing the cost of owning compared to renting. The deductibility of mortgage interest (and PTD) reduces the user cost of housing for those individuals who itemize their tax returns and the benefit of the deduction is increasing in the marginal tax rate (Poterba, 1992). Both of these tax expenditures however, are likely capitalized, to some extent, in housing prices, particularly for those residences that are purchased by higher income individuals (who are likely to itemize and receive a substantial benefit for both expenditures).

Like Gervais (2002) and Campbell and Cocco (2003), we find that the mortgage interest deduction does little, if anything, to encourage home-ownership. It serves mainly to raise the price of housing and encourage people who do buy homes to borrow more and to buy larger homes than they otherwise would, while removing the MID makes little change to the home-ownership ratio. Our results also corroborate the recent findings by Chambers et al. (2009b) that the elimination of the mortgage interest deduction has a small effect on homeownership. Periodically the US Congress re-visits the mortgage interest deduction and considers whether the cost in lost revenue is worth the perceived benefits. As noted above, the cost of MID was projected to be roughly $80 billion in 2009, which while not huge compared to the entire budget, is almost 9% of non-defense discretionary spending for 2009 (Kleinbard, 2008). Gervais and Pandey (2008) find, however, that eliminating the deductibility of mortgage interest would not necessarily have as large a fiscal impact as anticipated. More recently, Poterba et al. (2008) estimate that repealing mortgage interest deductibility would result in an increase in tax revenues of approximately $62 billion or roughly 85% of the traditional figure, assuming no change in house prices. This estimate is larger than that found in Gervais and Pandey (2008) due to the assumption that households would liquidate low-yielding assets first and assuming high-marginal tax rate households would have more available equity to reduce their housing debt. We find evidence for the same result: when the tax advantages of housing assets are removed, individuals re-allocate assets and pay down their mortgages faster, reducing the amount of extra revenue for the government.

It is important to note that our model abstracts from several important issues. In terms of modeling the housing market, we ignore housing price fluctuations, which impact the size of debt leverage as well as the distribution of wealth. Over the past decade, in particular, house price appreciation has outpaced inflation and resulted in large wealth gains for some fortunate home-owners. More recently, with the extended fall in national house prices many of these gains have been reversed. The model, however, does not consider specialized tax rules that affect housing capital gains related to price appreciation. We also assume a uniform income tax rate, rather than consider how these tax benefits vary with tax incidence. Notably, a recent study by Chambers et al. (2009b) showed that a reduction in the degree of progressivity in the income tax code causes the interest rate to fall and average income to rise, thereby inducing higher household savings and an increase homeownership. We leave these important issues for future extensions.

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Appendix A. Discussion of the assumptions

This section discusses our choice of utility function. The first rationale for the utility function is that it is consistent with our choice of utility premium parameter λ and its role in the marginal rate of substitution (MRS) between housing and non-housing consumption for renters. To illustrate this, consider the standard CRRA utility function $\frac{[c^{\omega}f(h)^{1-\omega}]^{1-\sigma}}{1-\sigma}$ with the implied marginal rate of substitution shown as follows:

$$\frac{U_{f(h)}(c, f(h))}{U_c(c, f(h))} = \frac{1-\omega}{\omega}\frac{c}{h}$$

For our utility function (assuming for now $\sigma_1 = \sigma_2 = \sigma$),

$$\frac{U_{f(h)}(c, f(h))}{U_c(c, f(h))} = \frac{1-\omega}{\omega}\lambda^{1-\sigma}\left(\frac{c}{h}\right)^{\sigma}$$

Note that the marginal rate of substitution between housing and non-housing consumption is decreasing in λ for $\sigma > 1$, which is intuitive as a lower λ value implies renters obtain less utility from housing (than owners) and thus, are more willing to give up housing consumption in exchange for an additional unit of non-housing consumption (higher MRS).

The second rationale for our choice of utility function is that the standard CRRA utility function implies that the ratio of housing to non-housing consumption will stay constant over the life cycle, whereas evidence shows that as income grows, households will likely spend more on housing than non-housing consumption, Jeske (2005). Empirical evidence shows that the average ratio for individuals who are 45 years old is twice what it is for those aged 30, and the gap quadruples as individuals reach 80. Although a mixture of borrowing constraints and housing transaction costs can tackle this issue, our choice of utility function and the curvature parameter values σ_1 and σ_2 can effectively match the ratio as well.

Appendix B. Computation of the model

Since there is no closed form solution to the model, the stationary equilibrium of the model is solved numerically to determine the optimal decision rules as a function of the state variables. The optimal decision rules were found by backward induction, starting at the terminal period J and working all the way recursively to the initial period. In period J, the value functions coincide with the sum of the period utility function and the bequest function, and, given the realization of the state variables, the consumption and bequest choices are trivial. Based on the period J policy functions, in every period prior to J, the values associated with the different choices of housing in the next period were calculated, and consumption and asset portfolio choices conditional on different housing choices were obtained subsequently. For choices of control variables that violate various constraints, a large negative utility is given so that an optimizing household would never opt for these choices. The realizations of the earnings process were discretized into a four-point grid space. The state space for owner-occupied housing and financial assets were discretized into a finite number of grid points.

$$a \in \{a_{min}, \ldots, 0, \ldots, a_{max}\}$$
$$h \in \{\underline{H}, \ldots, h_{max}\}$$

On the other hand, households that rent may choose a continuous quantity of rental housing, s. Whenever the upper limit for the grids turned out to be binding in the solution to the problem, the upper and lower bounds were increased and the problem was solved again. In the end, the boundaries for the grids became sufficiently large and no longer imposed any constraint on the optimization process.

In order to solve for the stationary equilibrium, we take the following steps:

1. Guess the initial values of the interest rate r and solve for the rental price p using the no-arbitrage condition and the wage rate w using the equilibrium conditions in the factor market.
2. Guess the initial level of income tax on working households.
3. Solve for the individual household's recursive problem from the terminal period J.
4. Given the policy function in period J, iterate backwards until the first period in life. This yields the policy functions and the value functions for all periods.
5. Using forward induction of the policy function, compute the stationary distribution of households m^*.
6. Given the stationary distribution and policy functions, compute the level of income tax. If the taxes converge, then go to the next step. If not, update the tax rate and go back to step 2.
7. Given the stationary distribution and prices, compute aggregate capital and compute the interest rate r. Iterate until the interest rate r converges.

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