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Tax Treatment of Owner Occupied Housing and Wealth Inequality

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Abstract

In the U.S., mortgage interest deductibility provides a financial incentive for home ownership over renting as well as an incentive to "over-consume" housing since houses are not fungible. Home-ownership is also often promoted as a safe means of wealth creation. We construct and calibrate a quantitative general equilibrium lifecycle model with home-ownership and mortgage decisions to investigate the degree to which the wealth inequality in the United States is driven by the home mortgage interest deduction and the untaxed nature of imputed rents from owner-occupied housing. As the tax treatment of housing will disproportionately create tax savings for the top deciles of the income distribution, we quantify how the tax deductibility contributes to the heavily skewed distribution of wealth in the United States using data from the Survey of Consumer Finances. Although the tax treatment of owner occupied housing alone is unlikely to produce the extreme wealth concentration at the far right tail of the distribution, we argue that it is re-enforced by a bequest motive. We find that removing mortgage interest deductibility and taxing imputed rents reduces the Gini coefficient by 0.04 points, caused by a re-allocation of wealth from the top 10 percentiles to the bottom 50 percentiles of the wealth distribution.

JEL classification: E21
Keywords: Mortgage interest deductibility, housing, wealth, inequality

1 Introduction

For the majority of U.S. households, home-ownership is their surest means of wealth creation. In 2008, 67 percent of households owned their own home, and housing equity makes up almost 60 percent of the average household's financial portfolio. The 5 percent increase

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in home-ownership over the last 14 years represents the largest increase in ownership since the end of World War II. 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, Garriga, and Schlagenhauf 2007a).

Housing policy in the U.S. is predominantly directed toward increasing home-ownership through preferential tax treatment, government sponsored enterprizes (Fannie Mae and Freddie Mac) and downpayment assistance programs that provide low-income households with the possibility of purchasing a house. We consider whether the public policy goal of increasing home-ownership also contributes to wealth inequality. 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 would be welfare improving and what the distributional impacts of making such changes would be. We specifically focus on the home mortgage interest deduction and the untaxed nature of imputed rents from owner-occupied housing under different scenarios to maintain revenue neutrality: one in which the increase in housing taxation revenue is adjusted by a lower income tax rate, and another where the change in housing tax revenue is off-set by a direct rebate to renters only.

Our experiments show that the current level of wealth inequality in the United States can be partly accounted for by the mortgage interest deduction and the untaxed nature of the imputed rent from owner-occupied housing. Wealth inequality falls when mortgage interest is no longer tax deducted or when imputed rents from owner-occupied housing are fully taxed. The magnitude of this fall is greater when the additional tax revenue is lump-sum redistributed to the renters than when the income tax rate is lowered for all working households. Quantitatively, we find that under the lump-sum rental rebate scenario, the Gini coefficient falls by 0.03 points for the imputed rental tax on owner-occupied housing and by 0.02 points for the removal of mortgage interest deductibility, respectively. Removing mortgage interest deductibility and taxing imputed rents reduces the Gini coefficient by 0.04 points, which is mainly caused by a re-allocation of wealth from the top 10 percentiles to the bottom 50 percentiles of the wealth distribution.

2 Facts 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 in the U.S. specifically which we explore below. In this section, we set out some facts about the U.S. wealth distribution as well as discuss the previous literature on housing tenure choice and the tax treatment of housing.

The main source of microeconomic data on wealth for the U.S. 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.[1] Table 1 displays the wealth distribution given by 5 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, 2003). The most striking aspect of the table is how little wealth the first 5 deciles of the wealth distribution holds and, conversely, how much the top five percentiles hold. Households in the top five percentiles of the wealth distribution hold more than 50 percent of aggregate wealth, while households in the bottom 50 percentiles of the wealth distribution hold less than 5 percent of aggregate wealth. 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 1 signify increasing inequality.

Table 1: Percent of Wealth held by percentiles of the wealth distribution.

Percentile	**1989**	**1992**	**1995**	**1998**	**2001**
Top 1%	30.3	30.2	34.6	33.9	32.7
Top 5%	54.4	54.6	55.9	57.2	57.7
Top 10%	67.4	67.2	67.8	68.6	69.8
Top 50%	97.3	96.9	96.4	97.0	97.2
Bottom 50%	2.7	3.3	3.6	3.0	2.8
Gini	0.78	0.78	0.78	0.79	0.80

Note: Survey of Consumer Finances (SCF) data from reported years. Wealth refers to net worth calculated from data on assets and debt reported in the SCF. From Kennickell (2003), table 15 and Kennickell (2006), table 4.

[1] 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 upper portion of the U.S. wealth distribution.

In comparison to these wealth statistics, table 2 depicts the distribution of normal income for four waves of the SCF, 1989, 1992, 1995 and 1998.[2] It is readily observable that income, while fairly unequal, is distributed much more equally than wealth. Households in the top 5 percentiles of the income distribution earn approximately one third of aggregate income. The Gini coefficient for income, which averages 0.54, is also much lower than for the wealth distribution (which averaged 0.79). Although few countries exhibit the extreme concentration of wealth observed in the U.S., even moderately egalitarian countries such as Sweden have more concentrated distributions of wealth than income (De Nardi, 2004) and other countries such as the UK are catching up to the level of inequality in the U.S. (Banks, Blundell, and Smith, 2000). The data in these tables demonstrate wealth in the U.S. is much more concentrated than income and that this phenomenon has been persistent over at least the past decade. The fact that income is less concentrated than wealth implies income heterogeneity alone cannot explain the concentration of wealth.

Table 2: Percent of Income held by percentiles of the income distribution

Percentile	SCF 1989	SCF 1992	SCF 1995	SCF 1998
Top 1%	16.9	18.6	14.4	16.5
Top 5%	31.7	34.5	28.5	31.0
Top 10%	42.3	45.2	39.2	40.8
Top 20%	57.2	59.9	54.5	56.1
Gini	0.54	0.57	0.52	0.53

Note: The percent of income reported here is normal income reported in the Survey of Consumer Finances. Normal Income is the empirical equivalent of permanent income. Statistics from 1989 and 1992 SCF are from Quadrini (1999), statistics from the 1995 and 1998 SCF are the author's calculation using survey weights.

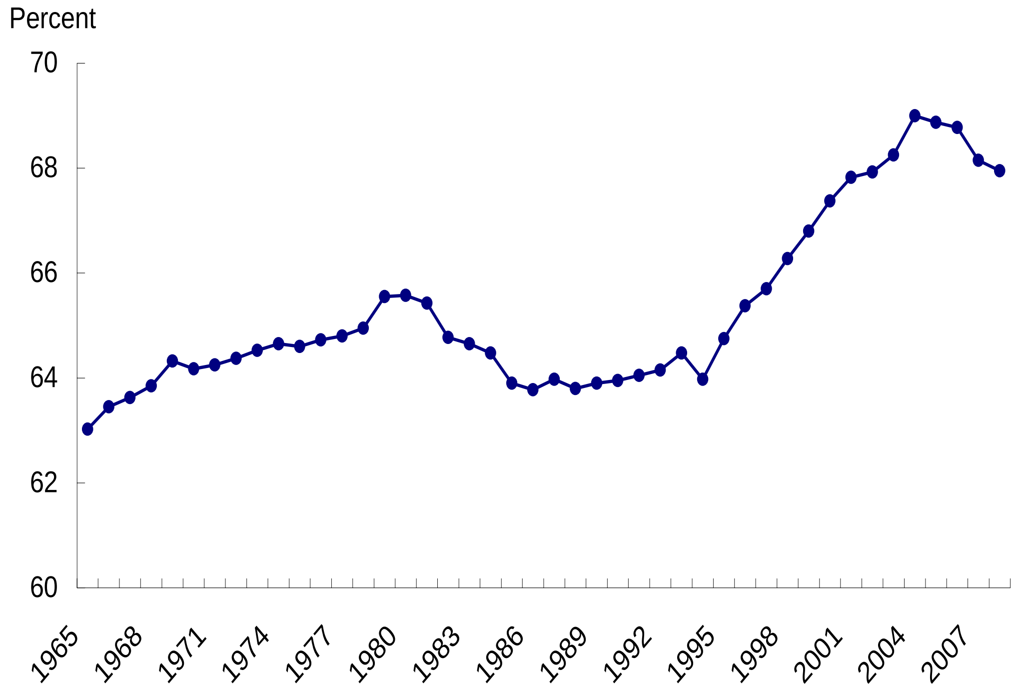
2.1 Home Ownership Facts and the Mortgage Interest Deduction

Currently 68 percent of households own their own home, up from 64 percent in the early 1990's, see Figure 1. Home-ownership displays a concave relationship with age, peaking between ages 70 and 74 and then declining slightly. Young households whose head is under 35 have the lowest rate of home-ownership (42 percent) although home-ownership among

[2] Normal income is an empirical measure that approximates permanent income. (Kennickell, 2003)

younger households has increased since the mid-1990s, see Figure 2.

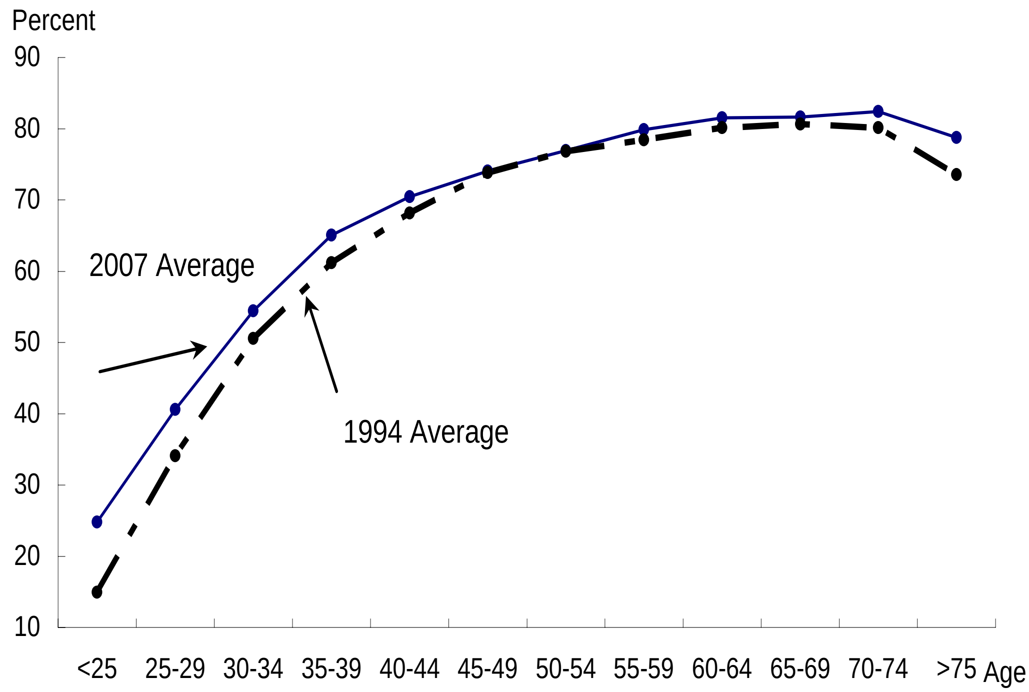
Figure 1: Homeownership Rate, Average in US



Housing has a tax advantage over other assets in three ways: the service income provided by owner-occupied housing is not taxed, mortgage interest payments are also deductible from taxable income and capital gains on housing are not fully taxable. Note that this tax advantage is not significantly reduced by the fact that home owners pay property taxes. Fullerton (1987) estimates that the effective tax rate on owner occupied housing is 19 percent while it is 36 percent on non-housing assets. Property taxes may also be considered 'fees for services' such as garbage collection, road clearing, etc.

The preferential tax treatment of housing provides an incentive for individuals to own rather than rent and also to purchase larger houses than they otherwise would. The fact that imputed rents are not taxed drives a wedge between the after-tax return on housing assets and non-housing assets, thus distorting the household's financial portfolio. The deductibility of mortgage interest payments contributes to the wedge but it is not sufficient or necessary for the difference between the two rates of return.

Figure 2: Homeownership by Age, Average in US



The effects of the preferential tax treatment of housing, in terms of the over-consumption of housing and the wedge between rates of return on housing versus non-housing assets, has been known since at least the early work of Laidler (1969) and Poterba (1990, 1992) but Gervais (2002) was the first to model an explicit tenure decision in a dynamic general equilibrium framework. Gervais (2002) develops a model of housing tenure decisions and finds 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 choices in an environment where there is a down-payment requirement, creates significant distortions in individuals' lifetime savings and consumption profiles. He shows that removing mortgage interest deductibility reduces these distortions and at least in some contexts, households would rather live in a world where mortgage interest payments are not deductible. When imputed rents are taxed, he finds that one quarter of homeowners change their tenure choice.

Alternatively, if mortgage interest deductibility is removed, it has no impact on the level of total housing capital but only delays individuals' decision to purchase a home. However, Gervais (2002) does not carefully model both sides of the government budget but focuses only on taxation.

Chambers, Garriga, and Schlagenhauf (2007b) consider the impact of housing taxation on tenure choice and the supply of rental services. They argue that studies that use an aggregate rental firm with a perfectly elastic supply miss the fact that changing tax policy has implications for the supply of rental property and the overall housing stock. They also find that the progressiveness of income taxation has important implications both for the tenure decision and the size of housing units purchased in the context where houses are purchased for consumption and investment purposes.

2.2 The Mortgage Interest Deduction

The home mortgage interest deduction putatively creates an incentive to purchase larger houses and to become a homeowner. Home-ownership is encouraged as a public good due to the potential social externalities created from owner-occupied residences (Glaeser and Shapiro, 2002). However, Gervais (2002) and Campbell and Cocco (2003) find that the mortgage interest deduction does little, if anything, to encourage home-ownership. It serves mainly to raise the price of housing and land and encourage people who do buy homes to borrow more and to buy larger homes than they otherwise would. Moreover, households with low to moderate incomes typically do not itemize their income tax deductions (Glaeser and Shapiro, 2002) and thus are not able to take advantage of the mortgage interest deduction even if they were to buy a home.

Periodically the U.S. Congress re-visits the mortgage interest deduction and considers whether the cost in lost revenue is worth the perceived benefits. Most recently, the President's Advisory Panel on Federal Tax Reform (2005) considered the tax treatment of housing. The main reason frequently cited for removing mortgage interest deductibility is the cost to the government. This cost is estimated by the Office of Management and Budget to be over $68 billion for 2004. Gervais and Pandey (2005) find, however, that eliminating the deductibility of mortgage interest would not necessarily have as large a fiscal impact as anticipated. Most previous studies looked at the cost of mortgage interest deductibility to the government in a static framework where individuals did not re-optimize their portfolios in response to a removal of the mortgage interest deduction. However, it is likely that if the mortgage interest deduction were removed, individuals with other financial assets will use those assets to reduce their mortgage debt. Since the government taxes interest earnings on financial assets, this re-allocation would reduce the savings to the government. Gervais and Pandey (2005) find that when taking into consideration this potential re-allocation, that the savings to the government in terms of additional tax revenue would be less than 60 percent of the conventional figure.

In this paper, we argue that removing the mortgage interest deduction or taxing imputed rents would reduce wealth inequality and that this is another reason to re-consider the tax treatment of housing.

3 Benchmark Model

We consider a general equilibrium overlapping generations model populated by *ex ante* heterogenous 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. Houses also have a minimum size. Our benchmark model considers the current tax treatment of housing, where imputed rents are not taxed and mortgage interest payments are tax deductible.

3.1 Demographics

Each model period is calibrated to correspond to five years. Agents or households actively enter into working life at 20 (denoted as $j = 1$ in the model)[3] and live until 80 (denoted as $J = 13$), when he/she dies for certain. All agents enter their working life as renters with zero financial and housing assets. They work and receive earnings until the age of mandatory retirement denoted as j^*. Following each period after retirement, agents face a

[3]Age is indexed with subscript j and time is indexed with subscript t.

positive probability of dying. This is denoted by s_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 $\prod_{t=1}^{j} s_t$. Since death is certain after age J, $s_J = 0$. Upon death, household's net worth is wholly taxed by the government. 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 lifecycle is constant and replaces the number of agents dying each period. In addition, the model abstracts from fertility choice and changes in the 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 aggregate capital stock K and aggregate labor input L:

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

The production function is a standard Cobb-Douglas form. The production function is increasing in both arguments, strictly concave, homogeneous of degree one, and satisfies the Inada conditions. The 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, the business capital and the housing capital depreciate at a rate 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 housing stock, h, as well as from bequests, q, left upon death. Assuming agents derive utility from leaving a bequest (or '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 is proportional to the housing stock. Following the set up by Plantania and Schlagenhauf (2002) and Ortalo-Magné and Rady (1998), we assume that the utility derived from housing is higher for a homeowner than for a renter[4]. That is, renters will only derive a fraction $\lambda < 1$ of utility compared to a homeowner who has the same housing stock. The instantaneous utility function for a household aged j is of CRRA type as follows:

$$U(c_j, h_j) = \frac{\left[c_j^{1-\omega} f(h_j)^{\omega}\right]^{1-\gamma}}{1-\gamma} \tag{3}$$

where

$$f(h_j) = I_j h_j + (1 - I_j)\lambda h_j$$

$$I_j = \begin{cases} 1 & \text{if homeowner} \\ 0 & \text{otherwise} \end{cases}$$

The parameter ω measures the relative importance of housing service expenditures in relation to non-housing goods consumption, h_j is the consumption received from housing or housing services and γ is the relative risk aversion parameter. I_j is an indicator function denoting whether the household of age j is a homeowner or a renter in the given period. As for the utility derived from leaving bequests, q, we follow the specification made by De Nardi (2004) denoted as:

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

[4]Glaeser and Shapiro (2002) explain the externalities of homeownership over renting in detail. Poterba (1992) details various tax benefits such as home mortgage interest deductions and tax deductions on the capital gains from selling the house. In addition, higher utility gains for homeowners than renters incorporate the fact that housing can be used as an investment asset with possible capital gains, which is an aspect of housing the model abstracts from. A partial equilibrium model incorporating aggregate housing return risks in Korea is found in Cho (2007)

The term φ_1 reflects the parent's concern about leaving bequests to children, while φ_2 measures the extent to which bequest is a luxury good. The remaining bequests are fully taxed by the government. Finally, the lifetime utility function can then be written as[5]:

$$E\left\{\sum_{j=1}^{J}\beta^{j-1}(\prod_{t=1}^{j}s_{t-1})[U(c_j,h_j)+(1-s_j)\varphi(q_j)]\right\}$$

3.4 Labor Income Dynamics

Agents enter into the life-cycle either as a renter or a homeowner. Renters have zero financial or housing assets, whereas homeowners have zero financial assets but positive housing assets. During each period prior to the mandatory retirement age denoted as j^*, agents are endowed with one unit of time which they supply inelastically. Agents also face the same 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. These shocks are represented by a finite-state Markov process defined on $(Y, \mathcal{B}(Y))$ and characterized by a transition function Q_y, where $Y \subset R_{++}$ and $\mathcal{B}(Y)$ Borel algebra on Y. This Markov process is the same for all households. The total productivity of a worker of age j at period t is given by the product of the workers' stochastic productivity in that period and the workers' deterministic efficiency index at the same age: $y_t\epsilon_j$. Working agents also pay social security payroll taxes on their labor income. Under an unfunded pay-as-you-go (PAYG) social security system, the government distributes the tax revenue across the retired agents. For simplicity, the level of social security benefits (b) is fixed at a constant amount regardless of the contribution made during the working stage.

3.5 Housing and Tenure Choice

This subsection describes the housing and the tenure choice decisions made by households. Each period, households decide whether to become a renter or a homeowner.[6] A renter has

[5]Here, $s_0 = 1$

[6]For simplicity, we abstract from various taxes related to housing.

the option to continue renting or to buy a house and become a homeowner. If the renter of age j at period t decides to rent in the next period, a rental payment of $p_t f(h_{j+1})$ and a deposit of ιh_{j+1} is paid to the rental agency. In the beginning of the next period, the renter receives the rental deposit net of any interests and taxes. The renter may also decide to stay at the same rental property and renew the existing contract or decide to move into a rental house of different size. On the other hand, if the renter wants to become a homeowner, the renter can purchase a house with size h_{j+1}. By purchasing owner-occupied housing, the household pays a transaction cost proportional to the new housing property, $\phi^b h_{j+1}$. We assume that h_j is a measure of the size of the house which is proportional to its value (larger houses are more valuable).

We assume that the housing capital is not perfectly divisible, as we introduce a minimum size, $\underline{H}$, for owner-occupied housing as was introduced in Gervais (2002) and Cocco (2005), among others. The constraint on minimum housing size is as follows:

$$h_j \geq \underline{H} \quad \forall j.$$

For renters, there is no such lower bound on the size of the rental property. A homeowner, on the other hand, can decide whether to keep the house or to sell and move. Homeowners also pay a maintenance cost equal to the level of depreciation (δ^h) in the period during which the house was owner-occupied. If the household sells the house, he can decide to buy a different-sized house or become a renter. Selling the house incurs a transaction cost equivalent to $\phi^s h_j$ and buying a new house incurs a transaction cost amounting to $\phi^b h_{j+1}$. In addition, the house can be used as collateral for homeowners 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 household of age j is as follows:

$$a_{j+1} \geq -\kappa h_{j+1} \quad \forall j \tag{4}$$

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 in the first period takes deposits from the homeowners, D_t,[7] and buys rental properties denoted as S_t. Renting out the rental properties, the agency receives rental payments, $p_t S_t$. In the next period, a cohort of new institutions enter the market, while the existing institution earns interest on the rental deposit and returns the principal to the renters. Using the proceeds, the institution pays interest on the deposit as well as bears the maintenance costs of the rental properties. At the end of the second period, the existing institution sells the un-depreciated part of the residential stock to a new institution. The problem of this rental agency is formulated as follows:

$$\max_{S_{t+1}, D_{t+1}} \quad p_{t+1} S_{t+1} - \delta^h S_{t+1} - r_{t+1} D_{t+1} \tag{5}$$

subject to

$$S_{t+1} \leq D_{t+1} \tag{6}$$

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

$$p - \delta^h = r \qquad \text{or} \qquad p = \delta^h + r \tag{7}$$

Here, p denotes the price paid per unit of rental service flow. Equation (7) states that renting residential capital, earning revenue equal to p net of maintenance costs δ^h provides the same yield as earning riskfree interest from interest bearing assets (e.g., bank deposits). This condition implies that the rental agency will also satisfy zero-profit conditions in equilibrium. In addition, given the interest rate and the depreciation rate, the rental price of a rental unit is uniquely determined.

[7]Note that the homeowners are indifferent between holding interest bearing assets and purchasing business capital as the rate of return on both assets is equalized at r.

3.6 Government & Taxation

Here the government collects income tax from the households at a rate τ proportional to their labor earnings and the interest income from financial net worth. Negative financial net worth implies the household is making mortgage payments, and under the US tax code, we allow the mortgage interest payment to be tax deductible. We use $\tau_m = 1$ to denote full mortgage deductibility in the equation below which shows financial net worth with risk-free returns:

$$I^a(1 + r(1 - \tau))a + (1 - I^a)(1 + r(1 - \tau\tau_m))a$$

where $I^a = 1$ if the financial net worth is positive and 0 otherwise. Housing assets generate income in the form of imputed rents. We allow for the fact that the imputed rents can also be subject to taxation at τ_r. Thus, homeowners pay tax τ_r on the housing service purchased, $pf(h)$. As the US tax system does not tax imputed rents, $\tau_r = 0$ in the benchmark. Later in the policy experiment, we change the values of τ_m and τ_r.

The tax revenues are used to provide a constant level of social security benefits, b, for the retired households as well as some fixed level of government expenditures denoted as G. The government maintains a balanced budget every period. For simplicity, the bequest collected by the government does not enter into the government expenditure.

3.7 The Household's Recursive Problem

This subsection describes the recursive problem faced by the households in different states. The state space is a set $x = \{j, h, a, I, y\}$, where j is the age of the household, h is the stock of housing, a is the financial net worth carried from the previous period, I is the tenure status of the household in the current period, and y is the exogenous productivity process.

At the beginning of period t, working households receive labor earnings net of social security payroll taxes, $(1 - \tau)w\epsilon y$. If the households are retired ($j^* < j \leq J$), on the other hand, they receive pension benefits b, which are a constant fraction χ of the average household earnings. We use the indicator I^w to distinguish working ($I^w = 1$) versus retired ($I^w = 0$)

Table 3: Value Functions

Current Tenure Status	V^i	Decision for the Next Period
Homeowner	V^c	Sell and buy a new house
	V^k	Maintain existing house
	V^r	Sell existing house and rent
Renter	V^c	Buy a new house
	V^r	Stay as renter

households.

Given the housing tenure status, households decide whether to maintain their current status or not. Homeowners decide whether to stay in the current property, move to a different sized property, or become renters. The sale and purchase of owner-occupied housing incurs transaction costs, ϕ^s, ϕ^b respectively. Renters decide to stay as renters or become homeowners. Incorporating the tenure decision, the value function for a household depends on the tenure choice decision made in the next period:

$$V(x) = \max \left\{ V^c(x), V^k(x), V^r(x) \right\} \tag{8}$$

The V^c, V^k, V^r are, respectively, the value functions of changing the house or becoming a homeowner, keeping the house, and renting next period as summarized in Table 1.

3.7.1 Homeowner changing the house or renter buying a house: V^c, $I' = 1$

At the beginning of period t, homeowners have a position on the housing capital net of maintenance costs and transaction costs for selling. On net, the homeowner receives $(1 - \delta^h - \phi^s)h$. In addition, the homeowner is subject to tax on the imputed rent. Renters receive the security deposit paid in the last period with an interest payment. On net, the renting household receives $(1 + r)\iota h$. Households also receive realized riskfree returns net of taxes on their financial assets. For homeowners with outstanding mortgage payments, mortgage interest is tax deductible. Given the available resources, the household then chooses consumption of non-housing goods, c, next period financial net worth, a', and buys a new house with transaction costs, $(1 + \phi^b)h'$. In the case that the retired households do not survive until the next period, all their assets (housing and financial) are left as a bequest, which is taken away by the government. If the household chooses to stay as a homeowner, the minimum housing size constraint holds, and the household can borrow up to a certain fraction of the value of the house, with the house as collateral. The problem for homeowners changing their housing size or renters buying a house can be formed recursively as follows:

$$V^c(j,h,a,I,y) \quad = \quad \max_{c,h',a'} \; [U(c,f(h)) + s\beta E(V(j+1,h',a',I'=1,y')) + (1-s)\varphi(q)]$$

subject to

$$\begin{aligned}
c + a' + (1+\phi^b)h' &\leq I^w(1-\tau)\omega\epsilon y + (1-I^w)b + \\
&\quad I\left\{(1-\delta^h-\phi^s)h - \tau_r p f(h) + I^a(1+r(1-\tau))a + (1-I^a)(1+r(1-\tau\tau_m))a\right\} + \\
&\quad (1-I)\left\{(1+r(1-\tau))(\iota h + a)\right\} \\
c &\geq 0 \qquad (9) \\
a' &\geq -\kappa h' \qquad (10) \\
q &= a' + h' \qquad (11) \\
h' &\geq \underline{H} \qquad (12)
\end{aligned}$$

3.7.2 Homeowner maintaining existing house: V^k, $(I, I') = (1, 1)$

In the beginning of period t, homeowners have a position on the housing capital net of maintenance costs. In net, the household receives $(1-\delta^h)h$. In addition, the homeowner is subject to tax on the imputed rent. Households also receive financial net worth with realized riskfree returns, $(1+r)a$. Given the available resources, the household then chooses consumption of non-housing goods, c, next period financial net worth, a', and maintains the same housing size $(h' = h)$.

$$V^k(j,h,a,I=1,y) \quad = \quad \max_{c,h',a'} \; [U(c,f(h)) + s\beta E(V(j+1,h'=h,a',I'=1,y')) + (1-s)\varphi(q)]$$

subject to

$$\begin{aligned}
c + a' + h' &\leq I^w(1-\tau)\omega\epsilon y + (1-I^w)b + \\
&\quad (1-\delta^h)h - \tau_r p f(h) + I^a(1+r(1-\tau))a + (1-I^a)(1+r(1-\tau\tau_m))a
\end{aligned}$$

and $(9), (10), (11), (12)$

3.7.3 Becoming a renter: V^c, $I' = 0$

In the beginning of period t, homeowners have a position on the housing capital net of maintenance costs and transaction costs for selling, while renters receive the security deposit paid in the last period with interest payment. Given the available resources, the household then chooses consumption of non-housing goods, c, next period financial net worth, a', pays rent, which is priced at $\tilde{p}$ per unit of rental service flow $f(h')$, and pays security deposit which is ι fraction of the rental stock. This is denoted as $\iota h'$. The security deposit will be returned next period with interest.[8] As the household becomes a renter, the household does not have any collateral to borrow. The problem for renting next period can be formed recursively as follows:

$$V^c(j,h,a,I,y) = \max_{c,h',a'} [U(c,f(h)) + s\beta E(V(j+1,h',a',I'=0,y')) + (1-s)\varphi(q)]$$

subject to

$$\begin{aligned} c + a' + \tilde{p}f(h') + \iota h' &\leq I^w(1-\tau)\omega\epsilon y + (1-I^w)b + \\ &\quad I\left\{(1-\delta^h-\phi^s)h - \tau_r p f(h) + I^a(1+r(1-\tau))a + (1-I^a)(1+r(1-\tau\tau_m))a\right\} + \\ &\quad (1-I)\left\{(1+r(1-\tau))(\iota h + a)\right\} \\ c, a' &\geq 0 \quad (13) \\ q &= a' + \iota h' \quad (14) \end{aligned}$$

3.8 Definition of a stationary equilibrium

A stationary equilibrium is given by a set of government policy arrangements $\{\tau, \tau_m, \tau_r, b, T, G\}$; a set of prices $\{p, r, w\}$; value functions $V(x)$; and allocations $c(x), a'(x), h'(x)$; a time-invariant distribution of agents over the state variables $x = \{j, h, a, I, y\}$, $m^*(x)$; and aggregate quantities $\{Y, C, H, K, L, S, D\}$ 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).

[8]The notion of a security deposit is used to keep track of the housing stock which will be a state variable.

(ii) factor prices are equal to their marginal products:

$$r = F_K(K,L) - \delta^k \quad (15)$$

$$w = F_L(K,L) \quad (16)$$

(iii) $\{S, D\}$ solves the rental agency's problem given in (5) and (6).

(iv) the government policies satisfy:

$$\tau w L + \int I^a \tau r K + (1 - I^a)\tau\tau_m r K \;\; m^*(dx) + \int Ipf(h) \;\; m^*(dx) = b\int_{j=j^*,\ldots,J} m^*(dx) + G \quad (17)$$

$$b = \frac{\chi w L}{\int_{j=1,\ldots,j^*-1} m^*(dx)} \quad (18)$$

$$(19)$$

(v) m^* is the invariant distribution of households over the state variables for this economy.

(vi) all markets clear.

$$K = \int a \;\; m^*(dx) - D \quad (20)$$

$$H = \int h \;\; m^*(dx) - S \quad (21)$$

$$L = \int \epsilon y \;\; m^*(dx) \quad (22)$$

$$C = \int c \;\; m^*(dx) \quad (23)$$

$$S = \int_{I=0} h \;\; m^*(dx) \quad (24)$$

$$S = D \quad (25)$$

$$Y = C + \delta^k K + \delta^h H + \delta^h S + \Pi + G \quad (26)$$

$$where \quad \Pi = (\phi^s + \phi^b)H$$

As for the government policies, the condition (17) states that the sum of the income tax and housing tax revenues is equal to the pension benefit paid to the retired households and the fixed government expenditure. The equation (18) states that the pension benefit for a retiree in a given period is a fraction χ of the average earnings of the working households. The first market clearing condition (20) states that the total aggregate of the financial net worth held by the household which is not deposited into the rental agency must be equal to the aggregate stock of business capital in the economy. The second condition (21) states that the aggregate stock of housing is the sum of stocks of owner-occupied and rental housing, where the latter is equivalent to the sum of deposits accepted by the rental agency, as shown in (3.5.1).

4 Calibration

The set of parameters will be 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 five year 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, the relative risk aversion coefficient, γ, is taken from Attanasio, Banks, Meghir, and Weber (1999), which falls in the range commonly used in the macroeconomics literature. For the bequest parameter, ϕ_1 governs the degree in which parents care about leaving bequest, while ϕ_2 measures the degree in which bequest is considered as a luxury good. The bequest parameters are taken from Yang (2005), which tries to match the wealth distribution in the United States. The other two preference parameters are: λ, which measures the degree of households' preference for homeownership to renting, and ω, which governs the share of housing vs. non-housing consumption in the household expenditure. The two parameters will be chosen specific to each country to match the aggregate ratios, as will be shown later. In the aggregate production function, α, the share of income attributed to physical capital, is calibrated at 23.7% in both countries. The annual depreciation rate of the capital stock and the housing stock are 7.6% and 4.2%, respectively. For the transaction cost parameters, ϕ^s and ϕ^b, Gruber and Martin (2003) estimate the relocation cost of tax and agency cost from the US Consumer Expenditure Survey (CEX), and find that the median

Table 4: Parameter Definition and Values

Parameters	Definition	Values
γ	Risk-aversion coefficient	1.5
ϕ_1	Bequest parameter	-17
α	Capital income share	0.237
δ^h	Housing depreciation rate	0.042
δ^k	Business capital depreciation rate	0.076
ϕ^s	Selling transaction cost	0.06
ϕ^b	Buying transaction cost	0.02
χ	Replacement ratio	40%
ρ	Persistence of income process	0.85
ϵ_j	Age-efficiency profile	Hansen (1993)
κ	Loan-to-value ratio	0.75
σ_y^2	Innovation of income process	0.30
τ	Income tax rate	29.1%
τ_m	Mortgage interest deductibility	1
τ_r	Tax on imputed rent	0
j^*	Retirement age	65
s_j	Survival probability	Bell, Wade, and Goss (1992)
ϕ_2	Bequest parameter	8
G	Fixed government expenditure	18% of GDP

household pays costs on the order of 7%. I assume the selling and buying transaction costs to be 6% and 2% of the property value, respectively. The deterministic age-efficiency profile ϵ_j, is calculated from the estimate of the mean age-income profile from Hansen (1993) for US. The corresponding age-efficiency profile in Korea is adjusted accordingly taking into account the difference in the retirement age. For tax rates, as the benchmark case simulates the current tax system in the United States, mortgage interest is fully deductible ($\tau_m = 1$) and imputed rent on owner-occupied housing is untaxed ($\tau_r = 0$). Hence, the tax rate on labor and asset income, τ, is chosen to balance government budget, which is used to finance social security payments and some government expenditure, G, which is fixed at 18% of GDP.

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

$$\ln y_t = \rho \ln y_{t-1} + \mu_t \tag{27}$$

The disturbance term μ_t is normally distributed with mean zero and variance σ_y^2. The

Table 5: Parameters to Match Aggregate Target Ratios

Parameters	Definition	Value
β	Discount factor	0.952
$\underline{H}$	Minimum housing size	1.375
λ	Dispremium of renting vs. homeownership	0.25
ω	Share of housing consumption	0.12

variance σ_y^2 as well as the persistence parameter ρ for the United States are taken from estimates by De Nardi (2004). The productivity shocks are discretized into a four-state Markov chain according to Tauchen and Hussey (1991). The resulting values for the productivity process are $\{0.2594, 0.6513, 1.5355, 3.8547\}$ for the United States. The transition matrix Q_y is given by:

$$\left\{\begin{array}{cccc} 0.7132 & 0.2764 & 0.0104 & 0.0000 \\ 0.1467 & 0.6268 & 0.2210 & 0.0055 \\ 0.0055 & 0.2210 & 0.6268 & 0.1467 \\ 0.0000 & 0.0104 & 0.2764 & 0.7132 \end{array}\right\}$$

We take the average loan-to-value ratio,κ, to be 75%. The implied average down-payment requirement is 25 percent. The average loan-to-value ratios are lower than those reported in Jappelli and Pagano (1994), which reports the maximum loan-to-value ratios of 89% for the United States. Income tax rates were endogenously determined from the model to fund social security benefit with a replacement ratio of 40% ($\chi = 0.4$) and government expenditure (G) fixed at 18% of GDP. For lifetime uncertainty, the conditional survival probabilities for the retired households are taken from Bell, Wade, and Goss (1992).

The next four remaining parameters are chosen such that the predictions generated by the model can match a given set of aggregate ratios from the National Income and Product Account tables, as shown in Table 5.

The first target ratio is the capital-output ratio, which was 3.173 averaged over the period 1959-2004. Here, capital is defined as the sum of physical and housing capital. The physical capital stock is the sum of private and government non-residential fixed assets and inventories, while the housing capital stock comprises residential fixed assets. Output is defined as the gross domestic product minus the expenditure on housing services. The second target ratio is the share of housing capital in the total capital stock from the National Accounts table, which is 0.385. This value is also similar to the aggregated ratio calculated using the Survey of Consumer Finances. While previous literature (Chambers, Garriga, and Schlagenhauf, 2007a; Yang, 2005) uses the share of housing to non-housing consumption expenditure, ω, to match the share of housing capital stock, this paper takes a direct approach, by using the minimum housing size parameter, $\underline{H}$, to match the ratio of housing capital to the total capital stock.[9] The implied value for the minimum housing size was 1.375 times the average annual income. The third target ratio is the aggregate homeownership ratio, which for the United States, the average homeownership ratio from 1965 to 1995 was around 64%. Previous literature uses the minimum housing parameter to match the aggregate homeownership ratio. However, since there is no direct linkage between homeownership and the minimum housing size, we use the preference parameter, λ, which is an effective gauge of the preference of homeownership over renting, to match the aggregate homeownership ratio.[10] The calibrated value of the preference parameter was 0.25, which encompasses various benefit of homeownership over renting such as the prospect of housing price appreciation and other institutional benefits abstracted in the model. Finally, the last target ratio is the ratio of housing stock to non-housing consumption expenditure in the National Accounts data. Non-housing consumption expenditure is defined as the sum of personal consumption expenditure, excluding the expenditure on housing services, and government expenditure. In the model, the ratio corresponds to $\frac{H}{C}$, which is 1.512. We use the preference parameter ω, which is the weight of housing to non-housing consumption in the utility function, to directly match this target ratio.

[9]Here, the unit of normalization is the average labor income.

[10]We are not aware of the literature that effectively calibrates the preference parameter, λ. While similar set-up is introduced in Plantania and Schlagenhauf (2002)and Ortalo-Magné and Rady (1998), the former cites a value of 0.7 without an empirical reference, while the latter is purely theoretical.

5 Results

5.1 Benchmark

Our benchmark simulation, which is calibrated to match 4 parameters of aggregate US data, is presented in Table 6. Table 6 also reports empirical aggregate statistics for the US. We also report the average homeownership ratio for 4 different age-cohorts and compare it against the US data, taken from the 2001 SCF data.

Table 6: Aggregate Statistics for Benchmark Simulation

	Benchmark Simulation	US data
Capital Output Ratio ($\frac{H+K}{Y}$)	3.176	3.173
Aggregate Homeownership Ratio	0.633	0.640
Homeownership Ratio (20-35 yo)	0.426	0.403
Homeownership Ratio (35-50 yo)	0.645	0.677
Homeownership Ratio (50-65 yo)	0.709	0.800
Homeownership Ratio (65 yo & above)	0.742	0.793
Housing Capital Ratio ($\frac{H}{H+K}$)	0.381	0.385
Housing to Non-housing Consumption ($\frac{H}{C}$)	1.514	1.512

The benchmark simulation, which includes mortgage interest deductibility and no taxation on imputed rents, matches the aggregate homeownership ratio, housing capital ratio and ratio of housing to non-housing consumption well. When broken down by age group, it does not match the homeownership ratio as well, under-predicting homeownership between age 35 and 50 by approximately 3 percent and between ages 50 and 65 by almost 10 percent, while after age 65 it under-predicts by less than 5 percent.

Table 7: Percent of Wealth held by percentiles of the wealth distribution.

Percentile	Benchmark Simulation	**SCF 2001**
Top 1%	7.0	32.7
Top 5%	28.3	57.7
Top 10%	45.7	69.8
Top 50%	87.5	97.2
Bottom 50%	12.5	2.8
Gini	0.62	0.80

The benchmark model, however, is not able to replicate the distribution of wealth displayed in Table 7 very well. It does not capture the concentration of wealth in the top 5 percentiles of the wealth distribution and generates too much wealth for the lower 50 percentiles. But we are interested in whether removing the MID or taxing imputed rents (or both) decreases wealth inequality compared to the benchmark case. We explore these experiments in the section below.

5.2 Policy Experiments

5.2.1 With Revenue Neutrality

In this section we consider the effect on the aggregate economy of changing the tax treatment of housing as well as the distributional impact of such a change. Table 8 reports the aggregate statistics for different policy changes in housing taxation under the assumption of revenue neutrality. We analyze the case of taxing imputed rent at 5% (denoted as (1)), the case of eliminating mortgage interest deductibility (denoted as (2)), and the combination of the two (denoted as (1) + (2)).

Table 8: Aggregate Statistics for Changing Housing Taxation - Revenue Neutrality

	Benchmark	(1)	(2)	(1)+(2)
Capital Output Ratio ($\frac{H+K}{Y}$)	3.176	3.159	3.1829	3.166
Homeownership Ratio	0.633	0.601	0.580	0.574
Homeownership Ratio (20-35 yo)	0.426	0.370	0.315	0.362
Homeownership Ratio (35-50 yo)	0.645	0.617	0.587	0.578
Homeownership Ratio (50-65 yo)	0.709	0.694	0.695	0.686
Homeownership Ratio (65 yo & above)	0.742	0.710	0.710	0.655
Housing Capital Ratio ($\frac{H}{H+K}$)	0.381	0.377	0.385	0.377
Housing to Non-housing Consumption ($\frac{H}{C}$)	1.514	1.436	1.454	1.395
Income tax rate	29.14%	28.69%	29.05%	28.68%

When imputed rents are taxed, it makes sense for the expenses used to create that income to be deductible (Gervais (2002)). This is the first experiment reported in (1) of Table 8. We find that taxing imputed rent results in a reduction of the capital output ratio by decreasing the amount of housing stock and not creating a sufficient rise in non-housing capital to cover the reduction in housing. Taxing imputed rents also reduces the home-ownership ratio by 3 percent and lowers the ratio of housing to non-housing consumption because individuals switch to renting which is available at a lower minimum size. Households whose savings are sufficient to meet the downpayment requirement and who meets the networth constraint, with assets larger than housing costs (including tax), will continue to be home-owners. Taxing imputed rents at a lower rate than investment income does not cause households to re-allocate their portfolios toward financial assets, but it pushes households to purchase smaller houses particularly in the presence of a lower income tax rate. This result is similar to the findings of Chambers, Garriga, and Schlagenhauf (2007b). In order to keep the government size at 18 percent of GDP, when we introduce a tax on imputed rents the income tax rate falls to 28.7 percent from 29 percent in the baseline case. We tax assets at the same rate as income so there should be no portfolio shuffling due to introducing a tax on imputed rents.

For the second experiment, (see (2) in Table 8) we remove mortgage deductibility, but do not tax imputed rents. In this case, housing assets no longer have a tax advantage over financial assets and households prefer to re-allocate financial assets toward paying down their mortgage more quickly. We find that the capital output ratio rises (where capital includes housing and non-housing capital) while the home-ownership ratio falls to 58 percent from 63 percent in the benchmark case (the homeownership ratio in US data over the last 10 years is 64 percent). We also find that the ratio of housing to all capital rises a small amount (0.4 percent). In the case where we remove mortgage interest deductibility but do not tax imputed rents, since households will re-allocate their financial portfolio, the government will not realize as much tax saving on removing the mortgage interest deduction than a static analysis would predict. As a result, the decrease in the income tax rate is very small, less than .1 percent. Even though fewer households become homeowners, the ratio of housing to non-housing consumption rises because housing is now more expensive for homeowners or takes up a larger fraction of their total consumption expenditures because they do not receive a tax break on their housing interest payments.

In the final experiment, reported in (3) in Table 10, we remove mortgage interest deductibility and tax imputed rents. Although under the current U.S. tax system, the combination of these two policies is unlikely, several governments in Europe did tax imputed rents even without mortgage interest deductibility. In this case we find that the overall capital output ratio falls compared to the benchmark case. The ratio of housing capital to total capital also falls by the same amount as in the case with taxation on imputed rents only. This is to be expected, since only the taxation of imputed rents effects the tenure decision whereas removal of mortgage interest deductibility only affects the timing of home-ownership and financing, that is, whether households use their own assets to pay for their house or incur additional debt. The homeownership ratio in this case also falls relative to the benchmark case and is the lowest of the three experiments. The income tax rate is also the lowest of the three cases at 28.7 percent.

In Figure 3, we compare home-ownership rates, for different ages, under each of our 3 experiments and the benchmark with data from the Federal Housing Authority for 1994 for the case where we reduce income taxes to maintain revenue neutrality. As mentioned above, our benchmark model does not fully match the data for home-ownership between the ages of 35 and 70, where our benchmark is flatter rather than steeply increasing as in the 1994 data. Removing the mortgage interest deduction decreases home-ownership during early adulthood, but by age 50, home-ownership is roughly the same without mortgage interest deductibility as it is in the benchmark model. When we tax imputed rents (but leave the mortgage interest deduction in place), we find that home-ownership is slightly lower during the ages 25 to 40 and then increases by age 50 to the level exhibited by the benchmark model. Removing mortgage interest deductibility and taxing imputed rents simultaneously, results in a generally lower level of home-ownership for all ages than in the benchmark model. Although by age 50 it is close to the benchmark level again.

Turning to the distributional aspect of each of the three experiments, we find that introducing a tax on imputed rents lowers the Gini coefficient by .02 relative to the benchmark case and reduces the wealth holdings of the top percentiles of the wealth distribution while increasing the wealth holdings in the middle of the distribution.

5.2.2 With Rebate to Renters

Next we turn to a different policy to retain revenue neutrality: we rebate the excess tax revenue equally to all renters. Table 10 reports the aggregate statistics for the three experiments

Figure 3: Comparison of Home-ownership By Age, Lower Income Tax

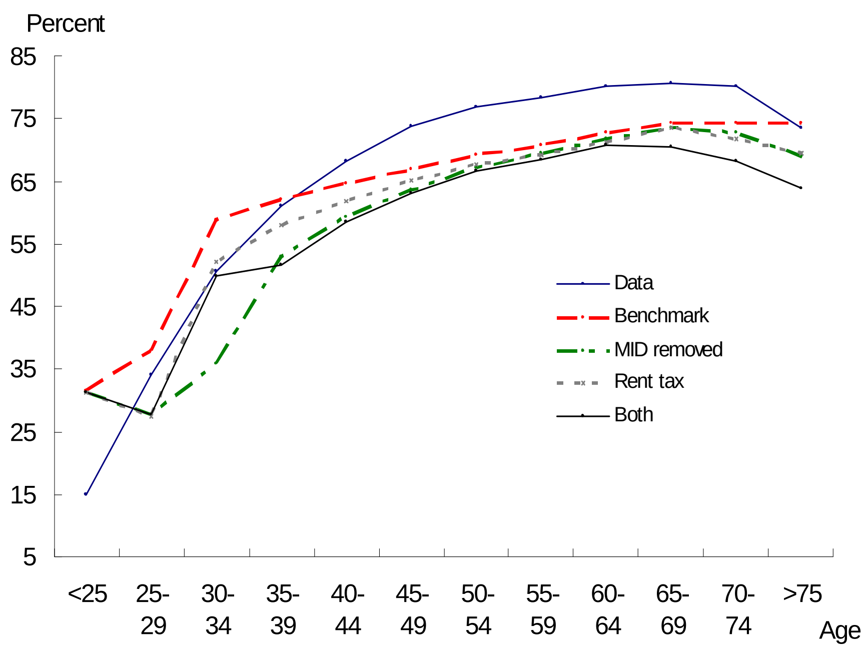


Table 9: Percent of Wealth held by percentiles of the wealth distribution.

Percentile	Benchmark	(1)	(2)	(1) + (2)
Top 1%	7.0	7.0	6.8	6.9
Top 5%	28.3	27.5	27.5	27.0
Top 10%	45.7	44.8	44.6	45.0
Top 50%	87.5	88.3	88.0	87.0
Bottom 50%	12.5	11.7	12.0	13.0
Gini	0.620	0.609	0.600	0.597

under this scenario, as well as the amount of rental rebate expressed as a fraction of average income.

Table 10: Aggregate Statistics for Changing Housing Taxation - Rental Rebate

	Benchmark	(1)	(2)	(1)+(2)
Capital Output Ratio ($\frac{H+K}{Y}$)	3.176	3.133	3.175	3.134
Homeownership Ratio	0.633	0.515	0.576	0.502
Homeownership Ratio (20-35 yo)	0.426	0.296	0.314	0.291
Homeownership Ratio (35-50 yo)	0.645	0.528	0.587	0.505
Homeownership Ratio (50-65 yo)	0.709	0.628	0.692	0.623
Homeownership Ratio (65 yo & above)	0.742	0.600	0.698	0.576
Housing Capital Ratio ($\frac{H}{H+K}$)	0.381	0.392	0.387	0.397
Housing to Non-housing Consumption ($\frac{H}{C}$)	1.514	1.319	1.449	1.307
Rental rebate	-	0.0161	0.0029	0.0164

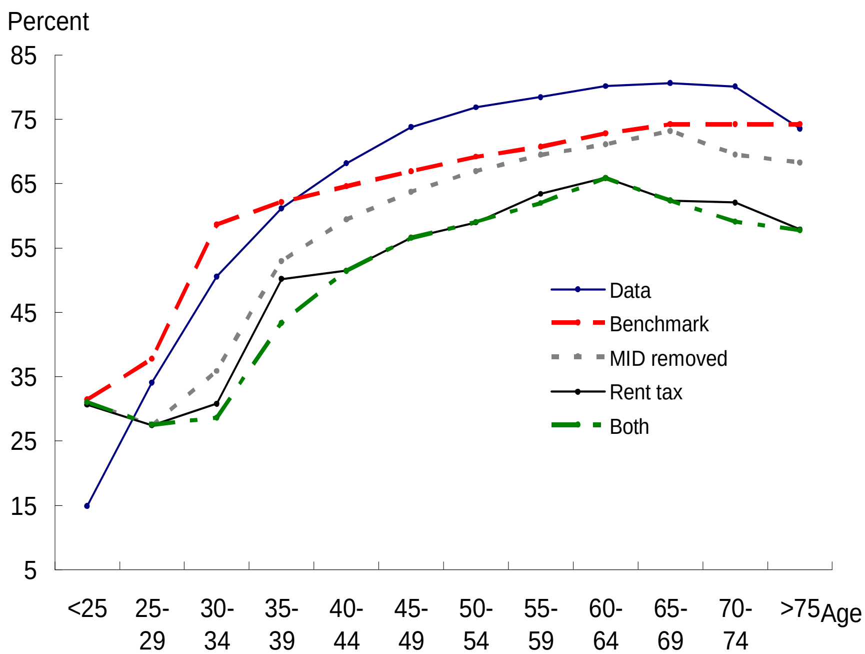
When we provide a rebate to renters as a way of dispersing the excess tax revenues, we find that for the first case, where imputed rents are taxed, the capital output ratio declines and the homeownership ratio drops significantly (by over ten percent) reported in Table 10. This is because renting earns approximately a 1 percent return and now housing services are taxed which lowers the net benefit of home-ownership, even for households who meet the net worth and down-payment requirements. We also find that housing to non-housing consumption falls, which is due to the fact that fewer people own homes and since renting is a cheaper option, the fraction of consumption accounted for by housing falls.

Moving to the next experiment, we remove mortgage interest deductibility but do not tax of imputed rents, and provide a rental rebate for the excess tax revenues. In this case, the excess tax revenues are not as large, since households re-allocate their portfolio so that they hold a larger equity position in their house and a lower percentage of their portfolio in financial assets. This results in a higher capital output ratio than the case where imputed rents are taxed and the capital output ratio is similar to the benchmark case. The homeownership ratio falls by about 5 percent from the benchmark case and the ratio of housing to total capital rises compared to the benchmark case though is not as high as in the case where imputed rents are taxed. The ratio of housing to non-housing consumption rises compared to the case where imputed rents are taxed but is not as high as the benchmark case.

In the case where we tax imputed rents and remove mortgage interest deductibility, we find in Table 10 that the capital output ratio is about the same as it is in the case with taxation of imputed rents, but is lower than the benchmark case. The home-ownership ratio is the lowest of the three cases and is approximately 13 percent lower than in the benchmark case. The ratio of housing to total capital rises compared to the benchmark case while the ratio of housing to non-housing consumption is the lowest of all three cases and much lower than in the benchmark case. This is due to the fact that there is a positive and a negative incentive to not purchasing a home, in that imputed rents are taxed and rental rebates are given to renters, although the rental rebates will depend on the number of households who remain home-owners. The lack of the mortgage interest deduction also results in households putting off the purchase of a house until later in their lifetimes.

In Figure 4, we compare home-ownership rates, for different ages, under each of our experiments plus the benchmark with data from the Federal Housing Authority for 1994 for the case where rental rebates are used to maintain revenue neutrality. As discussed above for Figure 3, our benchmark model does not quite match the data for home-ownership between the ages of 35 and 70, where our benchmark is flatter rather than steeply increasing as the 1994 data. Removing the mortgage interest deduction has a similar effect under a regime of rental rebates. It decreases home-ownership during early adulthood, but by age 50, home-ownership is roughly the same without mortgage interest deductibility as it is in the benchmark model. When we tax imputed rents (but leave the mortgage interest deduction in place), this time we find that home-ownership is significantly lower throughout the life-cycle. Removing mortgage interest deductibility and taxing imputed rents, also results in a

Figure 4: Comparison of Home-ownership By Age, Rental Rebates



generally lower level of home-ownership for all ages than in the benchmark model. Previously, we found that changing the tax treatment of housing did not significantly alter the overall home-ownership ratio, this was because reducing income taxes made all households better off, in general, and more able to meet downpayment requirements. In the case where we provide a rental rebate to renters, the rebate creates an incentive to remain a renter and to switch to rental housing later in life, thereby reducing the rate of homeownership at all ages.

Comparing the distributional aspects of these policies in Table 11, we find that the Gini coefficients are lower under any of the three experiments than in the benchmark case, and that the Gini coefficient is a full .04 lower in the case with both taxation of imputed rents and no mortgage interest deductibility and a rental rebate. We also find that there is less wealth inequality when excess government revenue is rebated to renters under each of the changes in housing tax policy than the case where excess revenues are used to lower the overall income tax rate.

Table 11: Percent of Wealth held by percentiles of the wealth distribution.

Percentile	Benchmark	(1)	(2)	(1) + (2)
Top 1%	7.0	7.1	7.2	6.7
Top 5%	28.3	27.5	27.4	26.9
Top 10%	45.7	43.9	44.5	43.9
Top 50%	87.5	87.3	87.9	86.6
Bottom 50%	12.5	12.7	12.1	13.4
Gini	0.620	0.589	0.598	0.582

6 Conclusion

In this paper we examined the impact of the tax treatment of housing on wealth inequality. We find that removing the mortgage interest deduction or taxing imputed rents reduces wealth inequality measured by a reduction in the Gini coefficient and by comparing the wealth holdings of various percentiles of the wealth distribution. We also determine that removing the mortgage interest deduction or taxing imputed rents, in a revenue neutral context, results in a decline of the average personal income tax rate of approximately 2 percent. However, it also causes a decline in home-ownership by 3 and 5 percent respectively, when we either tax imputed rents or remove mortgage interest deductibility. In the case where rental rebates are provided to renters as a means of re-distributing the additional tax revenue from eliminating mortgage interest deductibility or taxing imputed rents, home-ownership falls between 10 and 13 percent overall but the Gini coefficient measure of wealth inequality falls by 0.04 and the wealth distribution becomes more equal as more wealth is held by the bottom 50 percentiles and less by the top 10 percent. This work is a first step in determining the relationship among taxes, home-ownership and wealth inequality.

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7 Appendix

7.1 Optimality Conditions

7.1.1 For changing housing arrangements next period

Consider the case of changing housing arrangements next period $(t+1)$ (corresponding to the value function V^c). This involves current period homeowners moving to a different-sized house or renters deciding to buy a house and become homeowner next period. We look at the case of retired households with no income uncertainty (they receive no income shocks) in period t. Using the functional form for the instantaneous utility function and the 'warm-glow' bequest function, the household problem can be written as follows:

$$\max_{c_t, h_{t+1}, a_{t+1}} \quad E\left\{ \sum_{t=1}^{T} \beta^{t-1} (\prod_{j=1}^{t} s_{j-1}) [U(c_t, f(h_t)) + (1-s_j)\varphi(q_{t+1})] \right\}$$

subject to

$$\begin{aligned} c_t + a_{t+1} + (1+\phi^b)h_{t+1} \quad &\leq \quad b_t + \\ &\quad I_t \left\{ (1-\delta^h - \phi^s)h_t + I^a(1+r_t(1-\tau))a_t + (1-I^a)(1+r_t(1-\tau\tau_m))a_t - \tau_r p_t f(h_t) \right\} \\ &\quad (1-I_t)\left\{ (1+r_t(1-\tau))(a_t + \iota h_t) \right\} \qquad (28) \\ c_{t+1} + a_{t+2} + (1+\phi^b)h_{t+2} \quad &\leq \quad b_{t+1} + (1-\delta^h - \phi^s)h_{t+1} + \\ &\quad I^a(1+r_{t+1}(1-\tau))a_{t+1} + (1-I^a)(1+r_{t+1}(1-\tau\tau_m))a_{t+1} - \tau_r p_{t+1} f(h_{t+1}) \qquad (29) \\ c_{t+1} + a_{t+2} + h_{t+2} \quad &\leq \quad b_{t+1} + (1-\delta^h)h_{t+1} + \\ &\quad I^a(1+r_{t+1}(1-\tau))a_{t+1} + (1-I^a)(1+r_{t+1}(1-\tau\tau_m))a_{t+1} - \tau_r p_{t+1} f(h_{t+1}) \qquad (30) \\ c_{t+1} + a_{t+2} + p_{t+1}f(h_{t+2}) + \iota h_{t+2} \quad &\leq \quad b_{t+1} + (1-\delta^h - \phi^s)h_{t+1} + \\ &\quad I^a(1+r_{t+1}(1-\tau))a_{t+1} + (1-I^a)(1+r_{t+1}(1-\tau\tau_m))a_{t+1} - \tau_r p_{t+1} f(h_{t+1}) \qquad (31) \\ \text{and} \quad (9), (10), (11), (12) \end{aligned}$$

Here, the equations (29),(30), and (31) refers to the possible budget constraint faced by the homeowner in period $t+1$, depending on the housing choices made for period $t+2$. Taking first order conditions with respect to c_t for homeowners $(i = O)$ and renters $(i = R)$ in period

t, c_{t+1} for homeowners in period $t+1$, a_{t+1}, and h_{t+1}, give the following equations:

$$\beta^t U_c^i(c_t, f(h_t)) = \mu_t^i \quad (32)$$

$$s_t \beta^{t+1} U_c^O(c_{t+1}, f(h_{t+1})) = \mu_{t+1}^O \quad (33)$$

$$(1-s_t)\varphi'(a_{t+1}+h_{t+1}) - \mu_t^i + \{I^a(1+r_{t+1}(1-\tau)) + (1-I^a)(1+r_{t+1}(1-\tau\tau_m))\}\,\mu_{t+1}^O = 0 \quad (34)$$

if agent $i \in O, R$ chooses to change house or rent in period $t+1$

$$s_t \beta^{t+1} U_h^O(c_{t+1}, f(h_{t+1})) + (1-s_t)\varphi'(q_{t+1}) - (1+\phi^b)\mu_t^i + (1-\delta^h-\phi^s-\tau_r p_{t+1})\mu_{t+1}^O = 0 \quad (35)$$

if agent $i \in O, R$ chooses to keep in period $t+1$

$$s_t \beta^{t+1} U_h^O(c_{t+1}, f(h_{t+1})) + (1-s_t)\varphi'(q_{t+1}) - (1+\phi^b)\mu_t^i + (1-\delta^h-\tau_r p_{t+1})\mu_{t+1}^O = 0 \quad (36)$$

where the marginal utilities have the following functional form:

$$U_c^O(c_t, f(h_t)) = (c_t^{1-\omega} h_t^{\omega})^{-\gamma} h_t^{\omega}(1-\omega)c_t^{-\omega}$$
$$U_c^R(c_t, f(h_t)) = (c_t^{1-\omega} (\lambda h_t)^{\omega})^{-\gamma} (\lambda h_t)^{\omega}(1-\omega)c_t^{-\omega}$$
$$U_h^O(c_{t+1}, f(h_{t+1})) = (c_{t+1}^{1-\omega} h_{t+1}^{\omega})^{-\gamma} h_{t+1}^{\omega-1}\omega c_{t+1}^{1-\omega}$$

Proposition 1. *Keeping the housing stock constant, $c_t^R < c_t^H$, where c_t^R, c_t^H denote the non-housing consumption of renter and homeowners in period t, respectively.*

Proof. The marginal utility of consumption for renters in period t can be arranged as:

$$\begin{aligned} U_c^R(c_t, f(h_t)) &= (c_t^{1-\omega}(\lambda h_t)^{\omega})^{-\gamma}(\lambda h_t)^{\omega}(1-\omega)c_t^{-\omega} \\ &= \lambda^{\omega(1-\gamma)}(c_t^{1-\omega}h_t^{\omega})^{-\gamma}(h_t)^{\omega}(1-\omega)c_t^{-\omega} \\ &= \lambda^{\omega(1-\gamma)}U_c^O(c_t, f(h_t)) \end{aligned}$$

where $U_c^O(c_t, f(h_t))$ is the marginal utility of consumption for homeowners in period t. Since $\lambda^{\omega(1-\gamma)} > 1$ for $\gamma > 1$, $0 < \lambda < 1$, and $0 < \omega < 1$, $U_c^R(c_t, f(h_t)) > U_c^O(c_t, f(h_t))$. Hence, $c_t^R < c_t^O$. □

The Euler equation derived from the first order conditions will depend on whether the agent is homeowner or renter ($i \in O, R$) this period as well as what the homeowner will do next period.

- If household $i \in O, R$, in period t decides to change the housing size or rent in period

$t+1$,

$$s_t\beta U_h^O(t+1) - \phi^b U_c^i(t) - (I^a r_{t+1}(1-\tau) + (1-I^a)r_{t+1}(1-\tau\tau_m) + \delta^h + \phi^s + \tau_r p_{t+1}) s_t \beta U_c^O(t+1) \quad = \quad 0$$

- If household $i \in O, R$, in period t decides to keep the housing in period $t+1$,

$$s_t\beta U_h^O(t+1) - \phi^b U_c^i(t) - (I^a r_{t+1}(1-\tau) + (1-I^a)r_{t+1}(1-\tau\tau_m) + \delta^h + \tau_r p_{t+1}) s_t \beta U_c^O(t+1) \quad = \quad 0$$

7.1.2 For keeping the house next period

For the case of keeping the house next period, since $h_{t+1} = h_t$, the maximization reduces to finding the optimal c_t and a_{t+1}.

7.1.3 For renting next period

For the case of renting next period $(t+1)$ (corresponding to the value function V^r), the corresponding maximization problem is as follows.

$$\max_{c_t, h_{t+1}, a_{t+1}} \quad E\left\{\sum_{t=1}^{T} \beta^{t-1} (\prod_{j=1}^{t} s_{j-1})[U(c_t, f(h_t)) + (1-s_j)\varphi(q_{t+1})]\right\}$$

subject to

$$\begin{aligned}
c_t + a_{t+1} + p_t f(h_{t+1}) + \iota h_{t+1} \quad &\leq \quad b_t + I_t\left\{(1-\delta^h-\phi^s)h_t + I^a(1+r_t(1-\tau))a_t + (1-I^a)(1+r_t(1-\tau\tau_m))a_t - \tau_r p_t f(h_t)\right\} \\
&\quad + (1-I_t)\left\{(1+r_t(1-\tau))(a_t + \iota h_t)\right\} \qquad (37) \\
c_{t+1} + a_{t+2} + (1+\phi^b)h_{t+2} \quad &\leq \quad b_{t+1} + (1+r_{t+1}(1-\tau))(a_{t+1} + \iota h_{t+1}) \qquad (38) \\
c_{t+1} + a_{t+2} + p_{t+1} f(h_{t+2}) + \iota h_{t+2} \quad &\leq \quad b_{t+1} + (1+r_{t+1}(1-\tau))(a_{t+1} + \iota h_{t+1}) \qquad (39) \\
\text{and} \quad (13), (14)
\end{aligned}$$

Here, the equations (38) and (39) refer to the possible budget constraint faced by the renter in period $t+1$, depending on the housing choices made for period $t+2$. Taking first order conditions with respect to c_t for homeowners (with superscript O) and renters (with superscript R) in period t, c_{t+1} for homeowners in period $t+1$, a_{t+1}, and h_{t+1}, give the following equations:

$$\beta^t U_c^i(c_t, f(h_t)) = \mu_t^i \quad (40)$$

$$s_t \beta^{t+1} U_c^R(c_{t+1}, f(h_{t+1})) = \mu_{t+1}^R \quad (41)$$

$$(1 - s_t)\varphi'(q_{t+1}) - \mu_t^i + (1 + r_{t+1}(1 - \tau))\mu_{t+1}^R = 0 \quad (42)$$

$$s_t \beta^{t+1} U_h^R(c_{t+1}, f(h_{t+1})) + (1 - s_t)\varphi'(q_{t+1})\iota - (p_t\lambda + \iota)\mu_t^i + \iota(1 + r_{t+1}(1 - \tau))\mu_{t+1}^R = 0 \quad (43)$$

Corollary 1. *Keeping the consumption of non-housing goods constant,* $h_{t+1}^R < h_{t+1}^O$*, where* h_{t+1}^R*,* h_{t+1}^O *denote the housing stock of renter and homeowners in period* $t + 1$*, respectively.*

Proof. The marginal utility of housing consumption for renters in period $t+1$, $U_h^R(c_{t+1}, f(h_{t+1}))$ is shown as:

$$\begin{aligned} U_h^R(c_{t+1}, f(h_{t+1})) &= (c_{t+1}^{1-\omega}(\lambda h_{t+1})^{\omega})^{-\gamma}\lambda^{\omega} h_{t+1}^{\omega-1}\omega c_{t+1}^{1-\omega} \\ &= \lambda^{\omega(1-\gamma)}(c_{t+1}^{1-\omega} h_{t+1}^{\omega})^{-\gamma} h_{t+1}^{\omega-1}\omega c_{t+1}^{1-\omega} \\ &= \lambda^{\omega(1-\gamma)} U_h^O(c_{t+1}, f(h_{t+1})) \end{aligned}$$

where $U_h^O(c_{t+1}, f(h_{t+1}))$ is the marginal utility of housing service consumption for homeowners in period $t + 1$. Since $\lambda^{\omega(1-\gamma)} > 1$, $U_h^R(c_{t+1}, f(h_{t+1})) > U_h^O(c_{t+1}, f(h_{t+1}))$, and thus, $h_{t+1}^R < h_{t+1}^O$. □

The Euler equation derived from the first order conditions will depend on whether the agent is homeowner or renter $i \in O, R$ this period.

$$s_t \beta U_h^R(t + 1) - \tilde{p}_t \lambda U_c^i(t) = 0$$

7.2 Computation of the Model

Since there is no closed form solution to the model, the stationary equilibrium of the model is solved numerically to work out 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 realization of the earnings process are approximated using a Markov process following Tauchen and Hussey (1991). The state space for housing and financial assets were discretized into a finite number of grid points.

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

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.

Solving for the stationary equilibrium, I take the following steps:

1. Guess the initial values of the interest rate r and solve for the rental deposit price p using the equilibrium conditions (7) and for the wage rate w using the equilibrium conditions in the factor market in (16).

2. Guess the initial level of income tax rate.

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. For each period prior to period J, start with an initial guess for the choice of housing assets and solve for the individual household's recursive problem to find the policy function for consumption and financial assets. Find the policy function for housing

asset next period that satisfies the Euler equation and update the guess on the choice of the housing assets and re-solve the household's recursive problem. 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 rate. If the tax rates converge, then go to the next step. If not, update the tax rate and go back to step 3.

7. Given the stationary distribution and prices, compute aggregate capital and compute interest rate r using equation (15). Iterate until the interest rate r converges.