

On the Macroeconomic and Distributional Effects of Housing Taxation*

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Abstract

In most developed countries, housing receives preferential tax treatment relative to other assets. In particular (i) the housing services provided by owner-occupied housing (generally referred to as imputed rents) are untaxed and (ii) mortgage interest payments reduce taxable income. The potential economic distortions resulting from the unique treatment of housing may be substantial, especially in light of the fact that residential capital accounts for more than half of the assets in the U.S. In particular, this tax treatment distorts the households' portfolio composition, their saving rates and their tenure choice. In this paper we build a general equilibrium model populated by heterogeneous agents subject to idiosyncratic risk. We use this framework to quantitatively assess the macroeconomic and distributional distortions introduced by this preferential tax treatment. We also study the effects of alternative tax schemes which could correct the current system's bias.

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1 Introduction

In this paper we study the effect of taxes in shaping the household portfolio composition. We build a model economy with many things. We use our artificial economy to give a quantitative assessment of the aggregate and distributional effects of abolishing estate taxation.

Domeij and Heathcote (2002) assess quantitatively the consequences of changing the relative tax burden of labor income and capital income in a model in which agents are subject to uninsurable idiosyncratic risk. They construct their own earnings process.

2 The Model Economy

We consider a production economy populated by a continuum of households of measure one that live forever in a general equilibrium model with labor income uncertainty, durable goods and collateralized liquidity constraints. We focus our analysis on steady states. Sections 2.1, 2.2 and 2.3 describe the technology, preferences and the market arrangements. In section 2.7 we write down the household problem while section 2.8 presents a formal definition of steady state equilibrium.

2.1 Technology

Aggregate output, Y , is produced according to a neoclassical production function that takes the aggregate capital stock, K , and aggregate labor, L , as inputs: $Y = F(K, L)$. Given constant returns to scale, we can assume without loss of generality that there is a single representative firm.

The final good, can be either consumed, invested in capital or invested in residences on a one-to-one basis. Therefore, we can write the feasibility constraint as:

$$C + I_k + I_h + G = F(K, L), \tag{1}$$

where C is nondurable consumption, I_k is investment in capital and I_h is residential investment. We assume that houses and capital depreciate at the rates δ^h and δ^k respectively. G denotes public expenditures.

2.2 Preferences

Households derive utility from the consumption of a nondurable good, c , from the housing service flow, s . We write the per period utility as $u(c, s)$, and lifetime utility as $\sum_{t=0}^{\infty} \beta^t u(c_t, s_t)$, where β is the time discount factor.

Each period households receive a shock to their efficiency units of labor $e \in E = \{e_1, \dots, e_{n_e}\}$. This shock is Markov with transition matrix $\pi_{e,e'}$.

2.3 Market arrangements

We assume that there are no state contingent markets for the household specific shock.

Households hold residential assets $h \in [0, \infty)$, make a deposit, d , or contract a mortgage m with a financial institution. Deposits receive a return r^d , whereas mortgage's interest rate is denoted as r^m . Houses provide collateral for loans. In particular:

$$m \leq (1 - \theta)h. \tag{2}$$

This liquidity constraint implies that the maximum debt an individual can incur is a fraction $(1 - \theta)$ of his residential stock, which determines the upper bound for m , \bar{m} . The constraint summarizes several aspects of collateral lending that we see in reality. First, it means that when purchasing a house, a household can only finance a fraction $(1 - \theta)$ of it. In other words, it must satisfy a *down payment* requirement θ . The constraint also implies that when a household owns a house, it can obtain a loan for up to a fraction $(1 - \theta)$ of its value (*home equity loans*). In summary, at any point in time, an agent is only required to keep an accumulated home equity of θh . Note that the constraint also implies that the household cannot borrow if it does not own any residential stock. In practice, financial institutions require down payments for a number of reasons. They reduce the moral hazard problem in the care that owners take in maintaining the value of the durable and they also mitigate the effects of the adverse selection problem that results from asymmetric information in the credit market.

Owning a house of value h delivers housing services of value h . As an alternative to purchasing a house, households can rent housing services from a financial institution.

We also assume that selling a house is costly. A fraction of its value is lost when sold. This makes houses a less liquid asset than deposits. This cost comprises brokerage fees and can be thought of as an adjustment cost.

2.4 The financial institutions

We assume that financial institutions receive deposits from households. Then they give loans to purchase houses, rent capital to the representative firm and have a stock of houses that rent to households.

2.5 The government sector

The government imposes taxes on income, τ_y . We also assume that interest payments on mortgages are deductible from the tax base. The tax revenues finance the production of a public good.

2.6 The financial institution's problem

The problem they solve is

$$\begin{aligned}
& \max_{D_{t+1}, M_{t+1}, K_{t+1}, S_t^f, H_{t+1}^f} \sum_{t=0}^{\infty} p_t \left\{ D_{t+1} - (1+r^d) D_t - M_{t+1} + (1+r^m - \xi) M_t \right. \\
& \qquad \qquad \qquad \left. - K_{t+1} + (1+r) K_t + r^h S_t - H_{t+1}^f + (1-\delta^h) H_t^f \right\} \\
& \text{s. t.} \qquad \qquad \qquad S_t^f \leq H_t^f, \\
& \qquad \qquad \qquad K_{t+1} + M_{t+1} + H_{t+1}^f \leq D_{t+1}.
\end{aligned} \tag{3}$$

We assume that there are some cost associated to giving credit. The idea is that for the amount r^m paid by the household, the amount ξ is lost. Thus, we allow for a spread in interest rates.

2.7 The household's problem

The household's state variables are its labor endowment shock, its deposits d , its level of debt m and the houses it owns, h , $\{e, d, m, h\}$. We are going to assume that home owners consume the services of the houses they own and we do not allow them to rent housing services from the financial intermediaries. We denote as s^f housing services purchased in the market and $s(h)$ denotes the services obtained from the houses owned.

The problem that a household solves is:

$$\begin{aligned}
v(e, d, m, h) &= \max_{c, s, d', m', h', x} \{u(c, s) + \beta \pi_{e', e} v(e', d', m', h')\} \\
\text{s. t.} \qquad & c + r^h s^f + d' - m' + h' + \rho(h', h) \leq \\
& we + (1+r^d) d - (1+r^m) m + (1-\delta^h) h - \tau_{y_\tau}(y_\tau), \\
& 0 \leq m' \leq (1-\theta) h', \\
& c \geq 0, d' \geq 0, m' \geq 0, h' \geq 0, \\
& s = z \phi s^f + (1-z) s(h) \geq 0, z \in \{0, 1\}, \\
& y_\tau = we + r^d d - \tau_m r^m m
\end{aligned} \tag{4}$$

Note the timing of the model: consumption of the nondurable good takes place after depreciation of the stocks, whereas services of owned houses are obtained before the stock depreciates. We have denoted taxable income as y_τ and the income tax function $\tau_{y_\tau}(\cdot)$ can vary with the level of income. Notice that mortgage interest payments are deductible from the tax base at the rate $\tau_m \in [0, 1]$. The amount of housing services consumed satisfies $s = z \phi s^f + (1-x) s(h)$, where $z \in \{0, 1\}$, where ϕ is different from one. This means that rental housing services and services of owner occupied housing are not perfect substitutes. The function $\rho(h', h)$ the adjustment cost paid when the household sell its stock of houses.

We may use the compact notation $x = \{e, d, m, h\}$ and $X = \{E \times [0, \bar{d}] \times [0, \bar{m}] \times [0, \bar{h}]\}$. With respect to deposits, the required condition is that we have a low enough rate of return, $\beta < \frac{1}{1+r}$. See Aiyagari (1994), Huggett (1993), or Quadrini and Ríos-Rull (1997) for details.

It is possible to construct a Markov process for the individual state variables, from the Markov process on the shocks and from the decision rules of the agents (see Huggett (1993) or Hopenhayn and Prescott (1992) for details). Let \mathcal{B} be the σ -algebra generated in X by, say, the open intervals. A probability measure μ over \mathcal{B} exhaustively describes the economy by stating how many households are of each type.

Let $Q(x, B)$ denote the probability that a type $\{x\}$ has of becoming of a type in $B \subset \mathcal{B}$. The function Q naturally describes how the economy moves over time by generating a probability measure for tomorrow μ' given a probability measure, μ , today. The exact way in which this occurs is

$$\mu'(B) = \int_X Q(x, B) d\mu. \quad (5)$$

If the process for the earnings shock is normal in the sense that it has a unique stationary distribution, then the economy will also have a unique stationary distribution.¹ Furthermore, this unique stationary distribution is the limit to which the economy converges under any initial distribution.²

2.8 Equilibrium

We have almost all the ingredients to define a steady state equilibrium. We only need to add the condition that marginal productivities yield factor prices as functions of μ . Note that to obtain a steady state, we look for a measure of households μ such that given the prices implied by that measure, households actions reproduce the same measure μ in the following period. Formally, a steady state equilibrium for this economy is a set of functions for the household problem $\{v, g^d, g^m, g^h, g^c, g^s\}$, and a measure of households, μ , such that:

1. Interest rate on deposits equals the capital rental price, $r^d = r$.
2. Interest on mortgages and that of deposits satisfy $r^m = r + \xi$.
3. The rental price of housing services satisfies $r^h = r + \delta^h$.
4. The total housing services for not owned houses equals the total houses owned by the financial institution, $S^f = H^f$.
5. The total amount of capital satisfies $K = D - M - H^f$.
6. Factor rental prices are factor marginal productivities, $r = F_1(K, L) - \delta^k$, and $w = F_2(K, L)$.
7. Given μ , K , and L the functions $\{v, g^d, g^m, g^h, g^s, g^c\}$ solve the households' decision problem described in subsection 2.7.
8. The government expenditures equal the total tax revenue, $G = \int_X [\tau_y(y)] d\mu$.

¹For example if it satisfies the "American-dream American-nightmare" condition stated in Ríos-Rull (1995), then there is a unique stationary distribution of households over earning shocks, assets holdings and stock of habits.

²This does not mean that this will happen in equilibrium outside the steady state since the transition Q has been constructed under the assumption that the households think that prices are constant.

9. The total volume of deposits and mortgages satisfy $D = \int_X g^d(x) d\mu$ and $M = \int_X g^m(x) d\mu$.
10. The rental market of housing services clears, $S^f = \int_X g^s(x) d\mu$.
11. The market for the final good clears: $I_h = \delta^h H^f + \int_X [g^h(x) - (1 - \delta^h) h + \rho (g^h(x), h)] d\mu$,
 $C = \int_X g^c(x) d\mu$, $C + \delta^k K + I_h + G = F(K, L)$.
12. The measure of households is stationary: $x(B) = \int_X Q(x, B) d\mu$, for all $B \subset \mathcal{B}$.

3 The household's portfolio composition

Proposition 1. *Let us assume that there is no spread between the return on deposits and the mortgage's interest rate, $r^d = r^m$, and that mortgage interest payments are fully deductible, $\tau_m = 1$. Then, there are two types of households. Those who are liquidity constrained hold only debt. Those who are not may hold both deposits and debt as they are only concerned with their net position $d_t - m_t$.*

Proof: See Appendix.

This proposition says that households are indifferent between equity and debt. As a matter of fact, they will always refinance their mortgage.

Proposition 2. *If there is spread between the return on deposits and the mortgage interest rate, $r_t^m > r_t^d$, or mortgage interest payments are not fully deductible, $\tau_m < 1$, then households with non-negative level of deposits hold zero debt. Likewise, those households with positive debt have zero deposits. In other words, there is a complete segmentation of households: those who hold debt do not hold deposits and vice versa.*

Proof: See Appendix.

This proposition says that households always prefer equity to debt and the only reason to hold the latter is to buy residential stock.

4 Calibration

4.1 The earnings process

With respect to the process for earnings, Aiyagari (1994) sets an AR(1) in the logarithm of labor income. The process is fully described by two parameters: its persistence and its volatility. He chooses both values following estimates of Kydland (1984) that used PSID data and of Abowd and Card (1987) and Abowd and Card (1989) that used both PSID and NLS data. Then, he approximates the process by using a seven-state Markov chain following the procedures described in Tauchen (1986). Importantly, Aiyagari (1994) does not succeed in accounting for the degree of wealth inequality in the U.S. The main reason for this failure is that the earnings process that he uses is much more egalitarian than what we see in the data. In his benchmark calibration, the Gini index for earnings is 0.10, while it is around 0.60 for the U.S. economy. Table 1 shows the earnings process we use. This process is very similar to the one used by Díaz, Pijoan-Mas, and Ríos-Rull

(2000), which is constructed to match the Lorenz curves of the U.S distributions for earnings and total wealth.³

4.2 Preferences, and technology

For preferences over consumption of the nondurable good and services from the durable good we choose $u(c, s) = \left(\frac{c^{1-\sigma}}{1-\sigma} + \gamma \frac{s^{1-\sigma}}{1-\sigma} \right)$ as in Farr and Luengo-Prado (2001). The amount of housing services consumed satisfies $s = z \phi s^f + (1-x)h$, where $z \in \{0, 1\}$. This specification means that services from owner occupied housing are proportional to the durable stock on a one-to-one basis. Households derive higher services from own houses than from rented houses. We set $\phi = 0.9$, so that the ownership rate in our model matches that of the U.S. economy, 70 percent.

We calibrate γ to match the ratio of nondurable goods to investment in durable goods, $C/I_H = 12.33$, that we see in the data. We set the discount factor β so that net interest rate in the steady is 4.63 percent. We choose $\sigma = 3$.⁴

Feasibility in our model is given by expression (1). Thus, in this model aggregate output corresponds to measured GDP minus housing services. The share of capital is 0.18639. We set depreciation rates so that $\delta^k = \frac{I^k/Y}{K/Y} = \frac{0.1189}{1.4673} = 0.081$ and $\delta^h = \frac{I^h/Y}{H/Y} = \frac{0.0500}{1.1779} = 0.0426$.

4.3 Market arrangements

We assume that there is no spread between borrowing and lending rates. Therefore, $r^d = r^m$.

The parameter θ of the borrowing constraint is set equal to 0.3 to roughly match the average down payment for cars and houses during the period that we consider, 1954-1999. Thus, individuals can borrow up to 70 percent of the value of their holdings of durable good.

We consider non convex costs of adjustment as proposed by Grossman and Laroque (1990). The specification is:

$$\rho(h', h) = I\varepsilon(1 - \delta^h) h, \tag{6}$$

where:

$$I = \begin{cases} 0 & \text{if } h' - h = 0, \\ 1 & \text{otherwise.} \end{cases}$$

This specification implies that households engage in maintenance of their stock and do not let it to depreciate. Whenever there is a change in the stock a sale takes place and the household pays the adjustment cost $\varepsilon(1 - \delta^h) h$. We assume that the adjustment cost ε is 6 percent of the depreciated value of the stock, as the standard brokerage fee in the U.S.

4.4 Fiscal policy

We are going to start assuming that there is a proportional income tax. That is, there is no redistribution associated to this tax system. First of all we need to define taxable income. In

³See Castañeda, Díaz-Giménez, and Ríos-Rull (2000), and Díaz, Pijoan-Mas, and Ríos-Rull (2000) for a discussion on this calibration choice.

⁴Results did not change qualitatively for $\sigma = 1$ and $\sigma = 2$ and nonseparable utility functions.

our model, taxable income is labor income plus the interest from deposits minus the deduction on mortgages payments,

$$y_\tau = w e + r^d d - \tau_m r^m m.$$

We set the deduction of interest payments equal to 100 percent, $\tau_m = 1$. We set the income tax so that total tax revenues as a fraction of aggregate output are equal to the observed ratio of government expenditures to output. Given our definition of aggregate output this ratio is $G/Y = 0.229137492$. Notice that aggregate taxable income is not the same as aggregate output. Using market clearing conditions it is easy to check that taxable aggregate income is

$$Y_\tau = Y \left(1 + r \frac{H^f}{H} \frac{H}{Y} \right). \quad (7)$$

We set the income tax equal to 0.23.

Appendices

A The household's portfolio

If we solve the household's problem shown in expression (4) we obtain the following first order conditions,

$$c_t : \beta^t u'(c_t) - \lambda_t = 0, \text{ for all } t, \quad (8)$$

$$s_t : \phi \gamma \beta^t u'(\phi s_t + h_t) - \lambda_t r_t^h + \varphi_t^s = 0, \quad (9)$$

$$d_{t+1} : -\lambda_t + E_t \lambda_{t+1} \left\{ (1 + r^d) - \tau'_{y^r}(y^r) r^d \right\} + \varphi_t^d = 0, \text{ for all } t, \quad (10)$$

$$m_{t+1} : \lambda_t - E_t \lambda_{t+1} \left\{ (1 + r^m) - \tau'_{y^r}(y^r) \tau_m r^m \right\} + \varphi_t^m - \mu_t = 0, \text{ for all } t, \quad (11)$$

$$h_{t+1} : E_t \gamma \beta^{t+1} u'(\phi s_{t+1} + h_{t+1}) - \lambda_t + E_t \lambda_{t+1} [1 - \delta^h - \tau_h - \varrho(1 - \delta^h) L_{t+1}] + (1 - \theta) \mu_t + \varphi_t^h = 0, \text{ for all } t. \quad (12)$$

where λ_t is the multiplier of the budget constraint, φ_t^d and φ_t^m are the multipliers of the non-negativity constraints for deposits and mortgages, respectively, and μ_t is the multiplier associated to the liquidity constraint shown in (2).

Lemma App. 1. *The liquidity constraint and the non negativity constraint on mortgages cannot bind simultaneously.*

Proof. Straightforward. □

Lemma App. 2. *The non negativity constraint on deposits and mortgages cannot bind simultaneously.*

Proof. We prove it by contradiction. Let us assume that $\varphi_t^d > 0$ and $\varphi_t^m > 0$. If $\varphi_t^d > 0$, then by (10) we have that $-\lambda_t + E_t \lambda_{t+1} \left\{ (1 + r_{t+1}^d) - \tau'_{y^r}(y^r) r_{t+1}^d \right\} < 0$. In (11) it implies that $\mu_t > 0$, violating Lemma 1. Therefore, both non negativity constraints cannot bind at the same time. □

Lemma App. 3. *The non negativity constraint on mortgages is never binding, $\varphi_t^m = 0$.*

Proof. If $\varphi_t^d > 0$ then Lemma 2 ensures that $\varphi_t^m = 0$. If $\varphi_t^d = 0$, then we have that $\varphi_t^m = \mu_t$. If $\varphi_t^m > 0$ this implies that $\mu_t > 0$, which contradicts Lemma 1. □

Proof of Proposition 1.

Proof. Adding expressions (10) and (12) we obtain $\varphi_t^d + \varphi_t^m - \mu_t = 0$. By Lemma 3 this expression becomes $\varphi_t^d = \mu_t$. Thus, if the liquidity constraint is binding the household holds no deposits and $m_{t+1} = (1 - \theta) q_t h_{t+1}$. If the liquidity constraint is not binding only the difference $d_t - m_t$ matters. Hence we can set $m_{t+1} = 0$ and the result follows. \square

Proof of Proposition 2.

Proof. Adding expressions (10) and (12) we obtain

$$E_t \lambda_{t+1} \left[(1 - \tau'_{y^r}(y_t^r)) r_t^d - (1 - \tau'_{y^r}(y_t^r) \tau_m) r_t^m \right] + \varphi_t^d + \varphi_t^m - \mu_t = 0.$$

Notice that since we assume that $r_t^d \leq r_t^m$, $\tau'_{y^r}(y_t^r) < 1$, and $\tau_m \leq 1$, the expression inside the brackets is negative. Then it must be that $\varphi_t^d + \varphi_t^m - \mu_t > 0$, which implies that $\varphi_t^d + \varphi_t^m > 0$. Thus, if the household holds deposits, $\varphi_t^d = 0$, it holds no debt, $\varphi_t^m > 0$. If the household holds debt, the opposite occurs. \square

Table 1: THE EARNINGS PROCESS

$e \in \{e_1, e_2, e_3\} =$	$\{1.00, 5.29, 46.55\}$		
$\pi_{e,e'} =$	$\begin{bmatrix} 0.96500 & 0.00347 & 0.000333 \\ 0.03937 & 0.95000 & 0.010625 \\ 0.00000 & 0.08300 & 0.917000 \end{bmatrix}$		
Stationary distribution			
$\pi^* =$	0.4983	0.4429	0.05870

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