DISCUSSION PAPER SERIES

DP13067

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MACROECONOMICS AND GROWTH and PUBLIC ECONOMICS

ISSN 0265-8003

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Discussion Paper DP13067
Published 23 July 2018
Submitted 23 July 2018

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Abstract

We analyze the optimal combination of wealth and labor tax rates in a model where wealth-to-income ratios and wealth inequality are rising endogenously due to unbalanced technological improvement in a two-sector economy. We consider rich and poor households, financial and housing wealth, and find that a ”realistic” optimal steady state tax structure includes some taxation of labor, zero taxation of financial wealth, a housing wealth tax on rich households and a housing wealth subsidy on poor households. These findings are robust with respect to variations in the housing demand elasticity.

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Keywords: Wealth, inequality, Wealth Taxes, Housing

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Wealth Taxes and Inequality *

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This version: July 20, 2018

Abstract

We analyze the optimal combination of wealth and labor tax rates in a model where wealth-to-income ratios and wealth inequality are rising endogenously due to unbalanced technological improvement in a two-sector economy. We consider rich and poor households, financial and housing wealth, and find that a "realistic" optimal steady state tax structure includes some taxation of labor, zero taxation of financial wealth, a housing wealth tax on rich households and a housing wealth subsidy on poor households. These findings are robust with respect to variations in the housing demand elasticity.

KEYWORDS: housing wealth, wealth inequality, optimal taxation.

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1 Introduction

As a response to the long-run upward trend in wealth inequality that has been documented for many advanced economies, some observers have proposed shifting taxation from labor to wealth (for example, Piketty (2014), Piketty et al. (2013) and Altman (2012)). In this paper we investigate the long run social welfare impact of such tax reform by considering a simple model with heterogeneous households and financial and real assets (housing), where the wealth to income ratio and wealth inequality are endogenous (*i.e.*, they depend on unbalanced productivity growth and land scarcity). We find that the optimal steady state tax structure includes some taxation of labor, zero taxation of financial wealth and a positive tax (subsidy) on the housing wealth of individuals with positive (zero) net wealth. When wealth inequality increases because of unbalanced productivity growth and the share of rich households is small enough, housing tax rates on rich households are high and increase with inequality.

Our modelling approach is motivated by some key observations and stylized facts. First, wealth appears to be strongly and increasingly polarized. In particular, Piketty and Zucman (2014) have documented an increasing trend in wealth–to–income ratios and wealth inequality starting from around 1970, which is, in turn, responsible for rising inequality across households. Second, a large fraction of the rising wealth–to–income ratios is due to capital gains on a variety of assets or durable goods, such as housing and land[1]. In particular, Piketty and Zucman (2014) find that capital gains account for about 30% of the average yearly growth rate of national wealth, and Rognlie (2014), using the same data, finds that housing accounts for nearly all of the long-term increase. Third, wealth inequality across households appears to be largely independent from earnings inequality. For instance, using standard infinite horizon or life cycle economies with financial frictions, Castaneda et al. (2003), Kindermann and Krueger (2014),

[1]According to OECD statistics, dwellings are a large fraction of households' wealth, between 30 and 50% in most advanced economies (Ynesta, 2008).

and Benhabib et al. (2017) show that the degree of earning inequality necessary to replicate the observed wealth inequality is unrealistically large. In addition, Benhabib et al. (2017) document a negative correlation between earning and wealth inequality in many countries. These findings suggest that higher tax rates on high earnings may not translate into a lower wealth dispersion, so that a shift of taxation from labor to wealth may be more effective to cope with rising wealth inequality.

Following these observations, we consider a very simple model with three main assumptions. First, households accumulate housing and financial wealth in the presence of borrowing constraints. Second, households have different time discount factors and supply labor inelastically. Specifically, we assume two types of households: patient and impatient households. In this set up, the steady state distribution of wealth is perfectly polarized between a set of wealthy lenders (i.e., the patient households) and a set of poor borrowers (i.e., the impatient households). All households own some housing wealth, but in different quantities. Third, we assume that the economy produces two goods, a perishable consumption good (also called manufacturing good) and housing, and that the housing stock evolves due to physical depreciation and new constructions. For simplicity, we consider technologies that employ labor but no capital, although the housing sector also needs some flow of new land available for construction every period. In the model, total wealth is defined as the sum of financial and housing wealth. The wealth–to–income ratio, our measure of wealth inequality, is increasing in the relative productivity of manufacturing and scarcity of new land, and decreasing in the growth rate of productivity[2].

We analyze the impact of different, distortionary, linear tax rates on labor income, financial and housing wealth, and relate the optimal tax structure with the dynamics of wealth inequality. For reasons of realism, we assume that labor tax rates cannot

[2] Borri and Reichlin (2018) consider an overlapping generations model with similar characteristics and show that the relative productivity in the manufacturing sector may be responsible for rising wealth inequality because of a cost disease type of problem (Baumol, 1967).

be individual specific (and conditional on wealth holdings). First, we find that the optimal steady state tax structure is characterized by a linear tax (subsidy) on housing wealth for the lenders (borrowers), some taxation of labor and zero taxation of financial wealth. Second, we simulate the model to understand how optimal tax rates change when inequality increases. We follow our previous work, and consider an exogenous increase in the relative productivity in manufacturing with respect to construction, which generates an increase in housing prices, wealth–to–income ratios, and wealth inequality (Borri and Reichlin, 2018). We show that when relative productivity in manufacturing increases by 75%, as we observed since 1970 in a sample of developed countries, the housing tax rate on rich households also increases by the same proportion when the share of rich households is small enough. On the contrary, if the share of rich households is large, it is optimal to keep the positive housing tax rate on rich household constant, while poor households receive a housing subsidy.

Our results depend on some strong assumptions. First, an inelastic labor supply makes the model biased towards the idea that wealth should not be taxed, so that a positive taxation on housing should be fairly robust[3]. Second, by ignoring capital as input in the production functions implies that we are effectively underestimating the distortionary effect of taxing financial wealth (which is anyway strongly inefficient at steady states). Third, deriving the wealth distribution from different subjective discount factors and debt limits has clear limitations, although it is a very standard practice in neoclassical growth and, in some way, necessary to produce much stronger polarization in wealth than in income (which is observed in the data and not easily reproducible in models with homogeneous preferences). Fourth, concentrating the analysis on steady states is motivated by the need to focus on long-run phenomena.

The literature on wealth taxation is large and controversial. If we abstract from

[3]On the empirical support of this assumption we refer to the review by Saez et al. (2009), where it is claimed that the estimated compensated elasticity of labor is small (close to zero for prime-age males).

life-cycle considerations, precautionary savings and imperfect information, the optimal tax on capital income is zero even when the economy is populated by households with no wealth or inheritances (Chamley, 1986; Judd, 1985). The reason is that capital taxation implies exponentially growing distortions of investment over time, so that there are large benefits from shifting the tax burden from capital to labor. Note, however, that housing, which constitutes a large fraction of total households wealth, is at the same time a store of value and a source of housing services that provide utility benefits[4]. For this reason, a wealth tax may not be as inefficient as predicted in models where wealth is only held for intertemporal consumption allocation, such as the models with infinitely lived individuals and no frictions in asset markets. Regarding the specific role of housing property in the design of an optimal tax system, the Mirrlees' Review (Mirrlees et al. (2011)) claims that housing should be thought of as a large consumer durable and, as such, it is appropriate to tax housing services. Consistently with this argument, Correia et al. (2017) consider optimal housing and land taxation and argue that, if consumption is taxed, then housing services should also be taxed. In practice, taxation of owner occupied housing services is difficult to implement (and very often non implemented). The Mirrlees' Review suggests that a tax related to the consumption value of a property bears some resemblance with the British *council tax*, which is essentially a locally collected property tax based on a limited set of brackets (*bands*) for the property values. Similar tax systems for housing wealth are applied in almost all advanced economies. The Mirrlees' Review also claims that the council tax is generally regressive relative to its base and should be replaced by a *housing service tax*, *i.e.*, a flat percentage of the rental value of property, whether it is rented or owner-occupied. In our model the steady state value of the imputed rent on owner occupied housing is proportional to the *user cost of housing*, which represents the price of housing services, and a tax on housing wealth can perfectly replicate a tax on

[4]More generally, Saez and Stantcheva (2017) assume that wealth enters the households utility function directly for various reasons, among which are "social status", "power", "philanthropy", etc.

housing services. However, our findings prove that, with an inequality averse planner, this tax should not be flat, but contingent on the size of individuals' net wealth. From the empirical perspective, there is a large literature estimating the elasticity of taxable income with respect to marginal tax rates (see Saez et al. (2009)), but little evidence regarding the wealth elasticity with respect to wealth taxes. Having a reliable estimate is important, because, if the elasticity of wealth to the tax rate is small, shifting taxation from income to wealth appears to be intuitively reasonable in light of the alleged increasing trend in wealth to income ratios. Looking at Danish data, Jacobsen et al. (2017) find some evidence that wealth is relatively inelastic with respect to tax rates, suggesting that, leaving aside efficiency considerations, taxing wealth may be an effective tool for reducing wealth inequality. A relatively low elasticity, in the range of 0.1 and 0.3 is also found by Seim (2017) for the Swedish economy. On the other hand, using variations across Swiss cantons, Brülhart et al. (2016) provides a much larger estimate (about 1.2). We provide a rough estimate of the elasticity of aggregate net wealth with respect to a wealth tax for our model under a plausible parameter configuration, when the wealth tax rate is close to the value reported by Seim (2017) for the Swedish economy. Our theoretical estimate is larger (around 0.5) in the case of a uniform tax on wealth (for the rich individuals only) and smaller in the case of a tax on housing wealth only (about 0.002). In both cases, rising the wealth tax increases lifetime welfare inequality (across rich and poor), but by a substantial amount in the first case and by a negligible amount in the second.

The remainder of this paper is organized as follows. Section 2 presents the model; section 3 considers the optimal taxation problem; section 4 presents the results of our quantitative analysis; section 5 presents our conclusions.

2 The Model

In this section we present a model with two sectors, manufacturing and housing, and different types of households with preferences over consumption of the two goods.

Time is discrete, taking values $t = 0, 1, ..,$ and production takes place in two sectors, manufacturing (m) and housing (h). While the manufacturing good is produced using labor only, housing requires labor and land. Technology in the two sectors is defined by

$$Y_t^m = z_t^m L_t^m, \qquad Y_t^h = F(z_t^h L_t^h, \Lambda_t),$$

where, for $j = m, h$, and all $t \geq 0$, z_t^j is the exogenous sector-specific labor augmenting technical progress, L^j the number of workers employed in sector j, Λ_t is the flow of new land available for housing construction, and $F(.)$ is an increasing, concave and constant returns to scale production function[5]. The housing stock (H_t) evolves according to

$$H_t = (1 - \delta)H_{t-1} + f(x_t)\Lambda_t, \tag{1}$$

where $\delta \in (0, 1]$ the depreciation rate and

$$x_t = z_t^h L_t^h / \Lambda_t, \qquad F(x_t, 1) = f(x_t).$$

To simplify the exposition we assume that the labor supply is constant and normalized to one, and that labor productivity (ρ) grows at the same constant rate across the two sectors

$$1 + \rho = z_t^j / z_{t-1}^j.$$

Furthermore, we impose that the government sets a constant level of public spending (g) and new land (ξ) in units of labor efficiency in manufacturing Namely, letting G_t

[5]We think of the flow of new available land as "land permits". In line with existing literature on housing, we assume that land permits are regulated by the government. For example, Favilukis et al. (2015) and Borri and Reichlin (2018)

be public spending, for all $t \geq 0$ we have the following policies

$$g = G_t / z_t^m, \qquad \xi = \Lambda_t / z_t^m.$$

In what follows, we denote with $\zeta = z^m / z^h$ *relative labor productivity in manufacturing*, and with lower case letters variables in per capita terms and per unit of labor efficiency in the manufacturing sector. Specifically, we denote with $c^i = C^i / z^m$, $h^i = H^i / z^m$ the consumption of manufacturing and housing, in units of labor efficiency in manufacturing, of household i. Then, given a policy (ξ, g), and some given initial allocation of the housing stock, h_{-1}, a *feasible allocation* of individuals' consumption and sector specific employment is a sequence $\{c_t^i, h_t^i, l_t^m, l_t^h;\ i \in \mathcal{I}\}_{t=0}^{\infty}$, satisfying

$$\sum_i m_i c_t^i = c_t, \qquad \sum_i m_i h_t^i = h_t,$$

and

$$\begin{aligned}
c_t + g &= l_t^m, && (2)\\
h_t &= f(x_t)\xi_t + \left(\frac{1-\delta}{1+\rho}\right) h_{t-1}, && (3)\\
x_t &= \frac{l_t^h}{\zeta_t}\xi_t, && (4)\\
l_t^m + l_t^h &= 1, && (5)
\end{aligned}$$

for all $t \geq 0$ and where $\mathcal{I}$ is a finite set. In particular, we assume that there are different households types, indexed by i, each type having a mass $m_i \in (0,1)$ (per total population) with $\sum_i m_i = 1$. Households are all working and they belong to infinitely lived dynasties. They have identical time-invariant preferences for manufacturing consumption and housing services, measured by the housing stock. Utility over these two goods at all periods is discounted at heterogeneous rates

$$\mathcal{U}^i = \sum_{t=0}^{\infty} \beta_i^t U(C_t^i, H_t^i),$$

where $\beta_i \in (0,1)$ and $U(.)$ is strictly increasing and strictly concave. To simplify the exposition, it is convenient to assume that

$$U(C,H) = \log u(C,H),$$

where $u(C,H)$ is homogeneous of degree one. As a result, lifetime utility can be written as

$$\mathcal{U}^i = \sum_{t=0}^{\infty} \beta_i^t \log u(c_t^i, h_t^i) + \Gamma^i, \tag{6}$$

where

$$\Gamma^i = \frac{\log z_0^m}{1-\beta_i} + \sum_{t=0}^{\infty} \beta_i^t \log(1+\rho)^t.$$

Therefore, we can represent the lifetime utility of any dynasty as the sum of two components: the first component, which we denote as

$$\Omega^i \equiv \sum_{t=0}^{\infty} \beta_i^t \log u(c_t^i, h_t^i) \tag{7}$$

is a linearly homogeneous function of household specific consumption per labor efficiency; the second component is a common factor (up to the time preference parameter β_i) containing technological parameters only.

We let manufacturing be the *numeraire* good, q_t the unit price of housing and W_t the real wage rate. Assuming perfect competition in both sectors, from profit maximization and perfect labor mobility we get

$$W_t = z_t^m = q_t z_t^h f'(x_t). \tag{8}$$

Combining (8) with the definition of relative labor productivity in manufacturing (ζ), we obtain that the unit price of housing is

$$q_t = \frac{\zeta_t}{f'(l_t^h/\zeta_t \xi_t)}. \tag{9}$$

Note that the housing price is increasing in the share of labor in construction per unit of new land. On the other hand, the relative productivity in manufacturing has ambiguous effects on q. In particular, a higher ζ generates a higher unit price of housing if and only if the elasticity of the marginal product of labor in construction is less than one

$$-xf''(x)/x \leq 1.$$

In this case we say that there is *cost disease problem*, because the unbalanced sectoral productivity growth produces an increase in the price of the good in the sector characterized by relatively stagnant productivity growth (Baumol, 1967)[6].

We assume that firms in the construction sector rebate any remaining profit to the government as a compensation for the use of land permits. This implies that the government revenue from land permits is

$$T_t^l = q_t(f(x_t) - x_t f'(x_t))\Lambda_t. \tag{10}$$

In addition, we assume that the government use these resources to finance wasteful public spending g.

Any household i, at all time $t \geq 0$, buys some units of a 1-period bond with gross pre-tax interest rate, R_{t+1}, and acquires some residential property with unit price q_t, enjoys the housing services generated by it, and then resells the property the next

[6] In principle, the model can generate two polar situations. First, a totally exogenous housing price together with a flexible supply of housing when $f(x)$ is a linear function. In this case, q is simply proportional to ζ. Second, an approximately fixed exogenous supply of new housing (almost equal to Λ) selling at a price totally unrelated to the productivity parameters for $f'(x)$ converging to zero.

period and pays taxes on realized wealth. We assume that the government imposes linear tax rates on labor and wealth. For realism and convenience, labor taxes are assumed to be equal across individuals, whereas wealth taxes may be differentiated across types of wealth (i.e., financial or housing). In particular, as it is common in most tax codes, we impose that taxes on financial wealth may differ from zero if and only if the latter is positive. Denoting with b_{t+1} the units of the 1-period bond (per unit of z^m_{t+1}), and defining with τ^w, $\tau^{k,i}$ and $\tau^{h,i}$ the tax rates, respectively, on labor income, financial and housing wealth, all smaller than one, then the per period budget constraint is

$$\left(\frac{1+\rho}{R_{t+1}}\right) b^i_{t+1} + c^i_t + q_t h^i_t = \hat{w}_t + b^i_t(1-\tau^{k,i}_t) + \left(\frac{1-\delta}{1+\rho}\right) \hat{q}^i_t h^i_{t-1}, \tag{11}$$

where $\hat{w}_t = (1-\tau^w_t)$ is the after tax wage rate per unit of efficiency[7], $\hat{q}^i_t = q_t(1-\tau^{h,i}_t)$ is the housing price net of the housing wealth tax. As we have already anticipated, debt is untaxed, *i.e.*, $\tau^{k,i}_t = 0$ if $b^i_t \leq 0$.

It is convenient to introduce the definition of household net wealth

$$a^i_t = b^i_t(1-\tau^{k,i}_t) + ((1-\delta)/(1+\rho))q_t h^i_{t-1}(1-\tau^{h,i}_t), \tag{12}$$

where $\hat{R}^i = R(1-\tau^{k,i})$ is the after tax interest rate, and

$$\hat{\pi}^i_t = q_t - (1-\delta)\hat{q}^i_{t+1}/\hat{R}^i_{t+1} \tag{13}$$

is the after tax *user cost of housing*. The latter is a measure of the net of tax market price of housing services and it is equivalent to the present value of next period *imputed*

[7]Note that, from the first order condition (8) the before tax wage rate per unit of efficiency is $w = W/z^m = 1$.

rent from owner occupied housing[8]. Then, the t-period budget constraint becomes

$$\left(\frac{1+\rho}{\hat{R}^i_{t+1}}\right) a^i_{t+1} + c^i_t + \hat{\pi}^i_t h^i_t = \hat{w}_t + a^i_t, \tag{14}$$

We assume that total net wealth must be non-negative at all periods,

$$a^i_{t+1} \geq 0, \tag{15}$$

i.e., households debt must be fully collateralized by the housing wealth. The household i's optimal choice is then a sequence $\{c^i_t, h^i_t, a^i_{t+1}\}_{t=0}^{\infty}$ that maximizes lifetime utility subject to the sequence of budget constraints (14) and non-negative bequests (15). The first order conditions of this problem are

$$U_1(c^i_t, h^i_t) \geq \beta_i(\hat{R}^i_{t+1}/(1+\rho))U_1(c^i_{t+1}, h^i_{t+i}), \tag{16}$$

$$U_1(c^i_t, h^i_t)\hat{\pi}^i_t = U_2(c^i_t, h^i_t), \tag{17}$$

and the complementary slackness condition implies

$$\left(U_1(c^i_t, h^i_t) - \beta_i \left(\frac{\hat{R}^i_{t+1}}{1+\rho}\right) U_1(c^i_{t+1}, h^i_{t+1})\right) a^i_{t+1} = 0. \tag{18}$$

We assume that the government cannot issue any public debt. Then, combining the expression defining the total government revenues from the land permits (10) and

[8] This can be seen as follows. Let re_t be the net imputed rent, to be defined implicitly from the (net of taxes and depreciation costs) market fundamental:

$$q_t = \sum_{k=1}^{\infty} \frac{re_{t+k} - q_{t+k}(\delta + (1-\delta)\tau^h_{t+k})}{\Pi^k_{j=1}\hat{R}_{t+j}}.$$

By some elementary manipulations of the above expression, we derive

$$re_{t+1}/\hat{R}_{t+1} = q_t - (q_{t+1}/\hat{R}_{t+1})(1-\delta)(1-\tau^h_{t+1}) \equiv \hat{\pi}_t.$$

the expression for the housing price (9), we obtain the government budget constraint

$$g_t = \tau_t^w + \sum_i m_i \left(\tau_t^{k,i} b_t^i + q_t \left(\frac{1-\delta}{1+\rho} \right) \tau_t^{h,i} h_{t-1}^i \right) + \left(\frac{f(x_t)}{x_t f'(x_t)} - 1 \right) l_t^h. \tag{19}$$

A *competitive equilibrium* is a sequence of quantities and prices,

$$\{c_t^i, h_t^i, l_t^h, q_t, b_{t+1}^i, R_{t+1}, i \in \mathcal{I}\}_{t=0}^{\infty},$$

and a policy $\mathcal{P} = \{\xi_t, \tau_t^{j,i}; j = s, w, k, h, i \in \mathcal{I}\}_{t=0}^{\infty}$, satisfying utility maximization (equations (14)–(18)), the profit maximization condition $w_t = 1$, the resource feasibility constraints (equations (2)–(5)), the housing supply schedule (equation (9)), the government budget constraint (equation (19)) and the financial market equilibrium

$$\sum_i m_i b_t^i = 0 \tag{20}$$

for all $t \geq 0$ and some given initial stocks of housing and public debt (h_{-1}, b_0).

In the reminder of the paper, we impose that households belong to only two types, *i.e.*, $i \in \mathcal{I} = \{1, 2\}$, with $\beta_1 > \beta_2$. This assumption implies that, at a steady state equilibrium, the first type of household (i.e., the patient household) lends to the second (i.e., the impatient household), and, then, the impatient household has zero net total wealth ($a^2 = 0$) and $\tau^{k,2} = 0$. By allowing $\tau^{h,1} \neq \tau^{h,2}$, we consider the possibility of a subsidy on the housing wealth that is backed by mortgages. Given this equilibrium structure, it is natural to refer to the first type of household as *lenders*, or "rich" households, and to the second as *borrowers*, or "poor" households. Observe that, at a steady state equilibrium where borrowers face a binding debt limit, the lenders satisfy the Euler equation (34) with equality. Furthermore, since the borrowers' financial wealth is negative, our assumptions about the tax code imply $\hat{R}^2 = R = \hat{R}^1/(1-\tau^k)$, where $\tau^{k,1} = \tau^k$ is the tax rate on financial wealth paid by the lenders only. These features deliver

$$\hat{R}^1 = (1+\rho)/\beta_1 < \frac{(1+\rho)/\beta_1}{(1-\tau^k)} = R = \hat{R}^2 \leq (1+\rho)/\beta_2,$$

which is satisfied for

$$\beta_2 \leq \beta_1(1-\tau^k). \tag{21}$$

The above shows that, for given tax rates on housing wealth, a positive financial tax on type 1 households raises the user cost of housing for type 2 households. In particular, we have

$$\hat{\pi}^1 = q\left(1 - \left(\frac{1-\delta}{1+\rho}\right)\beta_1(1-\tau^{h,1})\right), \quad \hat{\pi}^2 = q\left(1 - \left(\frac{1-\delta}{1+\rho}\right)\beta_1(1-\tau^{h,2})(1-\tau^k)\right),$$

so that

$$\hat{\pi}^2 \geq \hat{\pi}^1 \quad \Leftrightarrow \quad \tau^k \geq \frac{\tau^{h,1}-\tau^{h,2}}{1-\tau^{h,2}}.$$

The above shows that, with a positive financial tax rate, borrowers may end up paying a higher user cost of housing than the lenders unless the latter are charged a large enough housing wealth tax compared to the borrowers. This simple arithmetics provides some intuition as to why financial tax rates are not only inefficient but also harmful from the point of view of the distribution of welfare across households.

3 Optimal Taxation

In this section, we consider the optimal taxation problem that derives from the maximization of the average per period utilities (with equal weights) across the two types of households assuming that these per period utilities are discounted at the same rate β_1, i.e., the discount rate of patient households. We adopt this specification in order to obtain the steady state allocation as a possible solution to the optimal policy. Note that this type of social welfare function implies that the impatient households will be saving more than they would if the planner was discounting utilities at the (heterogeneous) subjective discount rates. However, if the equilibrium generated by the Planner's policies implies binding debt limits for the impatient households at all $t \geq 0$, replacing their subjective discount rate (β_2) with the higher value β_1 has no consequences on these households' net wealth, which is going to be zero in both cases. Social welfare functions with welfare weights reflecting the planner's (or society's) preferences have been widely used in the literature. For instance, Saez and Stantcheva (2016) propose to evaluate tax reforms using "generalized social marginal welfare weights" to capture society's concerns for fairness without being necessarily tied to individual utilities.

The menu of tax rates on housing and financial wealth is unrestricted, but we maintain the assumption that labor taxes cannot be individual specific. Then, using (16) in (14) together with the complementary slackness condition (18), and by forward iteration of the period-by-period budget constraints, we obtain a present value representation of the lifetime budget constraint in terms of subjective prices

$$\sum_{t=0}^{\infty} \beta_i^t H(c_t^i, h_t^i, \hat{w}_t) = U_1(c_0^i, h_0^i) a_0^i, \tag{22}$$

where

$$H(c^i, h^i, \hat{w}) \equiv U_1(c^i, h^i) \left(c^i + \hat{\pi}^i h^i - \hat{w}^i \right) = U_1(c^i, h^i)(c^i - \hat{w}) + U_2(c^i, h^i) h^i.$$

We restrict attention to equilibria such that the impatient households have a binding debt limit at all $t \geq 0$. Then, $a_t^2 = 0$ for all $t \geq 0$ and, using again the first order condition (17)

$$H(c_t^2, h_t^2, \hat{w}_t) = 0 \tag{23}$$

for all $t \geq 0$. Conditions (22) and (23) are the standard *implementability constraints*, and any sequence $\{c_t^i, h_t^i; i = 1, 2\}_{t=0}^{\infty}$ satisfying these conditions together with the resource feasibility constraints, (equations (2), (3), and (5)), the asset market clearing equation (20), for all $t \geq 0$, and for some initial aggregate wealth,

$$k_0 = \left(\sum_i m_i(1 - \tau_0^{k,i}) b_0^i + q_0(1 - \delta) \sum_i m_i(1 - \tau_0^{h,i}) h_{-1}^i / (1 + \rho) \right)$$

is a competitive equilibrium implemented by some set of implicit individual specific tax rates (Chari and Kehoe, 1999). The left hand side of equation (22) may be interpreted as the present value of the net government revenue. Observe that, by the linear homogeneity of the function $u(c, h)$, we have

$$H(c, h, \hat{w}) = 1 - \hat{w} U_1(c, h),$$

so that the net government revenue is decreasing in the net wage rate and in the net present value price of consumption.

Before deriving the Planner's problem, we follow two further steps. First, using the feasibility constraint (2)–(5), we obtain a reduced form resource feasibility constraint, or *transformation function*

$$h_t = \left(\frac{1 - \delta}{1 + \rho} \right) h_{t-1} + \xi_t f \left(\frac{1 - c_t - g_t}{\zeta_t \xi_t} \right). \tag{24}$$

Furthermore, using equation (23), we derive type 2 households' consumption as a function of housing demand and the net wage

$$c^2 = \psi(h_t^2, \hat{w}_t).$$

Under the maintained assumptions, the above is a continuously differentiable function such that

$$\psi_1(h,\hat{w}) = -\frac{U_{12}}{U_{11}} \geq 0 \quad \Leftrightarrow \quad U_{12} \geq 0, \qquad \psi_2(h,\hat{w}) = -\frac{U_1}{\hat{w}U_{11}} > 0.$$

Then, type two households' consumption is increasing in the net wage rate and it is increasing in their housing demand only if the elasticity of substitution between consumption and housing is greater than one.

We define the *pseudo welfare function*[9]

$$\mathcal{U}_t = m_1 U(c_t^1, h_t^1) + m_2 U(\psi(h_t^2,\ w_t), h_t^2) + \mu m_1 H(c_t^1, h_t^1, \hat{w}_t)$$

where the multiplier μ is positive if the planner needs to use distortionary taxation. This multiplier represents a "bonus to date-t allocations that bring in extra government revenues, thereby relieving other periods from distortionary taxation, and the same term imposes a penalty in the opposite situation" (Erosa and Gervais, 2001).

Then, we define the optimal taxation problem as follows

$$\max_{\{c_t^1, h_t^i, \hat{w}_t; i=1,2\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta_1^t \mathcal{U}_t - \mu U_1(c_0^1, h_0^1) k_0 \qquad \text{s.t.:}$$

$$\begin{aligned} \sum_i m_i h_t^i &\leq \xi_t f(x_t) + \left(\frac{1-\delta}{1+\rho}\right) \sum_i m_i h_{t-1}^i & (25) \\ \zeta_t \xi_t x_t &\leq 1 - m_1 c_t^1 - m_2 \psi(h_t^2, \hat{w}_t) - g_t. & (26) \end{aligned}$$

Before we derive the solution to the above planning problem, it may be useful to briefly comment on the optimal tax design in the benchmark case characterized by no financial market distortions, *i.e.*, no debt limits. The main observation to be made in this case, is that, because we are assuming that labor supply is inelastic, there are

[9]This approach, commonly called the primal approach, is developed in Lucas Jr and Stokey (1983) and, for example discussed in Ljungqvist and Sargent (2012) and Jones et al. (1997).

always welfare gains from shifting the tax burden from wealth (housing and financial) to labor income. Then, one trivial solution to the optimal taxation problem without debt limits is such that all public spending is financed with labor taxes and housing goes untaxed. When this possibility is ruled out because of some exogenous upper bound on the labor tax rate, an optimal steady state allocation is characterized by zero tax on financial wealth and some tax on housing wealth. The reason for this result will be apparent from the following discussion and, in particular, it follows from the characteristics of the utility function.

Let $\{\eta_t\}_{t=0}^{\infty}$ be the non-negative discounted Lagrange multipliers associated to the feasibility constraints (25), $U^i_{j,t}$ and $U^i_{jk,t}$ the first and second partial derivatives of the i-th type household's utility with respect to the j-th and k-th arguments, and $\chi_t = (m_1 U^1_{1,t})/(m_2 U^2_{1,t})$. Then, we have the following first order characterization of the optimal taxation problem

$$U^1_{1,t}\left(1 - \mu\hat{w}_t U^1_{11,t}/U^1_{1,t}\right) = U^2_{1,t}\left(1 + \mu\chi_t\hat{w}_t U^2_{11,t}/U^2_{1,t}\right) = \eta_t/q_t, \tag{27}$$

$$U^1_{2,t}\left(1 - \mu\hat{w}_t U^1_{12,t}/U^1_{2,t}\right) = U^2_{2,t}\left(1 + \mu\chi_t\hat{w}_t U^2_{12,t}/U^1_{2,t}\right) = \eta_t - \eta_{t+1}\beta\left(\frac{1-\delta}{1+\rho}\right) \tag{28}$$

The right-hand sides of the above equations represent the shadow prices of consumption and housing. The left-hand sides the net individuals' benefits of increasing consumption and housing, *i.e.*, the sum of the direct utility benefit on utility (i.e., U^i_j) and the indirect benefits due to the reduced distortions brought about by the government extra-revenue (i.e., $-\mu\hat{w}U^i_{1j}$). The standard result of zero tax rate on financial wealth for economies with infinitely lived individuals holds also in this model. Specifically, at steady state, $\eta_{t+1}/\eta_t = \beta_1$, and then, by equations (27) and (28), the household specific marginal rates of substitution between consumption and housing services at the planning optimum are

$$\frac{U_2^1}{U_1^1} = \pi^* \left(1 + \tau^{o,1}\right), \qquad \frac{U_2^2}{U_1^2} = \pi^* \left(1 - \tau^{o,2}\right), \tag{29}$$

where $\pi^* = 1 - \beta_1(1-\delta)/(1+\rho)$ is the steady state user cost of housing and

$$\begin{aligned} \tau^{o,1} &= \frac{\mu}{1 - \mu\hat{w}U_{12}^1/U_2^1}\left(\frac{U_{12}^1}{U_2^1} - \frac{U_{11}^1}{U_1^1}\right) \\ \tau^{o,2} &= \frac{\mu\chi}{1 + \mu\chi\hat{w}U_{12}^2/U_2^2}\left(\frac{U_{12}^2}{U_2^2} - \frac{U_{11}^2}{U_1^2}\right) \end{aligned}$$

Then, the optimal linear tax structure at steady state can be implemented through the menu of taxes considered in section 2, *i.e.*, a menu of wealth and labor taxes, by setting $\tau^{k,1} = \tau^{k,2} \equiv \tau^k = 0$ and

$$\tau^{h,i} = \tau^{o,i}\left(\frac{1+\rho}{(1-\delta)\beta_1} - 1\right).$$

Notice that, since $\eta > 0$,

$$1 - \mu\hat{w}U_{12}^1/U_2^1 > 0, \qquad 1 + \mu\chi\hat{w}U_{12}^2/U_2^2 > 0,$$

and, then, the sign of $\tau^{o,i}$ is positive if and only if

$$U_{12}^i/U_2^i - U_{11}^i/U_1^i > 0. \tag{30}$$

It turns out that the inequality of equation (30) is always verified under our specification of preferences, regardless of the elasticity of substitution between consumption and housing services. This follows, in particular, from the linear homogeneity of the utility function $u(c, h)$. In fact, from $cU_1 + hU_2 = 1$ we obtain

$$U_1 + cU_{11} + hU_{12} = 0,$$

so that

$$\frac{U_{12}}{U_2} - \frac{U_{11}}{U_1} = -\frac{U_1}{hU_2}\left(1 + \frac{cU_{11}}{U_1}\right) - \frac{U_{11}}{U_1} = -\frac{1}{hU_2}\left(U_1 + \frac{U_{11}}{U_1}\right),$$

and, since $U_{11}/U_1 = u_{11}/u_1 - U_1$, we derive

$$\frac{U_{12}}{U_2} - \frac{U_{11}}{U_1} = -\frac{u_{11}/u_1}{hU_2} = \frac{\zeta_1 - \zeta_2}{\hat{w}} > 0.$$

Then, we can state the following proposition.

Proposition 1. *The optimal tax rates at a steady state equilibrium are characterized by a zero tax rate on financial wealth, a positive tax rate on the housing wealth of the lenders, and a negative tax rate on the housing wealth of the borrowers.*

To understand the proposition, it is useful to follow Chari and Kehoe (1999) and define

$$\epsilon_j^i \equiv 1 + H_j^i/U_j^i,$$

for $j = 1, 2, 3$, as the *general equilibrium elasticities* related to the tax rates on capital, housing and labor income, respectively. These capture the extent to which a fall in the corresponding tax rates is reducing distortions. Observe that,

$$\epsilon_1^i = 1 - \hat{w}U_{11}^i/U_1^i, \qquad \epsilon_2^i = 1 - \hat{w}U_{12}^i/U_2^i, \qquad \epsilon_3^i = 0. \tag{31}$$

Therefore, a change in the tax rate on labor has no effects on distortions. On the contrary, $\epsilon_1 > 0$ because of the strict concavity of the utility function implies (i.e., $U_{11}^i < 0$). Then, a fall in the tax rate on financial wealth reduces distortions. Since the sign and magnitude of the ratio U_{12}^i/U_2^i depends on the elasticity of substitution between housing services and consumption, then the effect on distortions of a changing tax rate on housing wealth (*i.e.*, the sign of ϵ_2) is ambiguous. If, for instance, there is a high elasticity of substitution between the two goods (i.e., $U_{12}^i < 0$), then $\epsilon_2^i > 0$. In our model, because of the specification of preferences, we have that $\epsilon_2 < \epsilon_1$, so that financial wealth taxes are more distortionary than housing wealth taxes (see condition (30)). These conditions unconver a conflict of interests between lenders and borrowers. In particular, a rise the tax rate on labor income benefits lenders because it reduces distortions, but it harms borrowers because it reduces their consumption. Hence, a wealth tax on housing on the lenders coupled with a subsidy on housing for the borrower, along with some wage tax, is the solution to the optimal tax problem.

Assuming the CES utility function

$$u(c,h) = \begin{cases} \left[(\theta)^{\frac{1}{\gamma}} c^{\frac{\gamma-1}{\gamma}} + (1-\theta)^{\frac{1}{\gamma}} h^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} & \text{if } \gamma \neq 1, \\ c^{\theta} h^{1-\theta} & \text{otherwise}, \end{cases} \tag{32}$$

we derive

$$\tau^{o,1} = \frac{\mu\hat{w}/c^1}{\gamma + (\gamma-1)\frac{\mu}{1+(1-\beta_1)a^1/\hat{w}}}, \qquad \tau^{o,2} = -\frac{m_1}{m_2}\left(\frac{\mu\hat{w}/c^2}{\gamma(1+(1-\beta_1)a^1/\hat{w}) - (\gamma-1)\mu\frac{m_1}{m_2}}\right).$$

The equations above suggest that a higher wealth–to–wage ratio (*i.e.*, a higher degree of wealth inequality) is associated to a smaller subsidy to the borrowers for all γ. On the other hand, a higher wealth–to–wage ratio is associated to a smaller (higher) $\tau^{o,1}$ if $\gamma < 1$ ($\gamma > 1$).

4 Quantitative Analysis

In this section, we provide a quantitative analysis of the set of steady state equilibria assuming an exogenous tax structure that retains, in a very stylized way, the main features of tax codes we typically observe in most countries. We numerically solve for the steady state of the model laid out in section 3 for an exogenous tax structure and investigate the optimal combination of taxes to maximize welfare. We assume that the financial wealth tax is set to zero ($\tau^k = 0$) for both type of households; that the labor income tax cannot be household specific; and that, on the contrary, the housing tax can be different for the two types of households.

4.1 Model Specification

We impose two key assumptions on technology and preferences with the aim of providing a simpler and parametric representation of some key properties of this model. First, the construction sector technology is defined by a Cobb-Douglas production function

$$f(x) = x^{\alpha}. \tag{33}$$

Second, $u(c, h)$ is represented by a CES utility function defined in (32).

Under these restrictions, the first order conditions (16)–(17), at steady state, deliver

$$\hat{R}^i \leq (1+\rho)/\beta_i, \tag{34}$$

$$\hat{\pi}^i h^i = \left(\frac{1-\phi(\hat{\pi}^i)}{\phi(\hat{\pi}^i)}\right) c^i \tag{35}$$

where $\phi(.) = c^i U_1^i(c^i, h^i)$, with the terms ϕ and $1-\phi(.)$ representing the expenditure shares in manufacturing (housing) consumption in a static model with some given income, I^i, and budget constraint $c^i + \hat{\pi}^i h^i = I^i$. By the intertemporal consolidation of the budget constraints (14) and the transversality condition, the housing demand of the lenders and the borrowers are

$$\hat{\pi}^1 h^1 = (1-\phi(\hat{\pi}^1))\left(\hat{w} + (1-\beta_1)a^1\right), \tag{36}$$

$$\hat{\pi}^2 h^2 = (1-\phi(\hat{\pi}^2))\hat{w}. \tag{37}$$

The above characterization is the only possible outcome of an equilibrium configuration at steady states under condition (21). Notice that, by the definition of private net wealth in (12) and the asset market clearing condition (20), the aggregate net private wealth is

$$\bar{a} \equiv m_1 a^1 = \left(\frac{1-\delta}{1+\rho}\right) q \left(\sum_i m_i h^i (1-\tau^{h,i}) - \tau^k m_2 h^2 (1-\tau^{h,2})\right). \tag{38}$$

Finally, using the Cobb-Douglas representation, (33), in the market clearing condition in the housing market and in the housing price function, (9), we derive the following steady state conditions

$$l^h = \zeta \xi^{\frac{\alpha-1}{\alpha}} \left(\left(\frac{\delta+\rho}{1+\rho}\right) h\right)^{\frac{1}{\alpha}}, \qquad q = \frac{\zeta \xi^{\frac{\alpha-1}{\alpha}}}{\alpha} \left(\left(\frac{\delta+\rho}{1+\rho}\right) h\right)^{\frac{1-\alpha}{\alpha}}. \tag{39}$$

Then, the government budget constraint at steady state boils down to

$$g = \tau^w + \left(\frac{1-\delta}{1+\rho}\right) \left(\sum_i m_i \tau^{h,i} q h^i + \tau^k m_2 q h^2 (1-\tau^{h,2})\right) + (1-\alpha) \left(\frac{\rho+\delta}{1+\rho}\right) qh. \tag{40}$$

Then, a *steady state equilibrium* is an array $\{h^i, \hat{w}, q, \bar{a}; i = 1, 2\}$ satisfying equations (36), (37), (38), (39) and (40), for a given policy $(g, \tau^w, \tau^k, \tau^{h,i}; i = 1, 2)$.

4.2 Simulations Results

We report all the parameters used in the quantitative analysis in Table 1. We set the consumption preference parameter $\theta = 0.8$, in order to match the U.S. households expenditure on housing services (approximately 15% of 2015 GDP according to the BEA NIPA Table 2.3.5). Following Ogaki and Reinhart (1998), we set the elasticity of inter-temporal substitution for the households' preferences, γ, to a number smaller than 1 and, specifically, to 0.5 and in section 4.3 we discuss the robustness of the results with respect to values larger than unity[10]. The time discount parameter of rich

[10]Note that if $\gamma = 0.5$, the inter-temporal elasticity of substitution is smaller than 1. In order to match asset prices data Bansal et al. (2008) use a relatively high value of 1.5. Previous literature had estimated a much lower value, closer to zero, through direct estimates of the first order conditions of the solution of the optimal intertemporal consumer problem (cf. (Hall, 1988)). Standard RBC literature has been used a value of 0.66, estimated by Kydland and Prescott (1982).

households is set to $\beta_1 = 0.95$, implying a steady state before tax real interest rate of 5%. Impatient households have a lower value for the time discount parameter, which we set to $\beta_2 = 0.80$. The annual depreciation of the housing stock is set equal to $\delta = 2\%$ as in Iacoviello and Neri (2010) and the growth rate in productivity to $\rho = 3\%$ to match the U.S. long-run GDP growth. Finally, we set the government expenditure g to 0.40, in line with the U.S. Federal expenditure to GDP, and the share of rich (i.e., patient) households to 5% and then provide robustness results for a higher value equal to 10%. For simplicity, we set government debt to zero (i.e., $b = 0$). In section 5 of the appendix we discuss, for robustness, results in the case of a higher share of the patient households, and for a version of the model with homogenous housing tax rates for the two types of households. These results are summarized, and compared to our baseline results, also in table 3.

Table 1: Parameters

Preferences		
Weight consumption:	θ	0.80
EIS:	γ	0.50
discount rate patient household:	β_1	0.95
discount rate impatient household:	β_2	0.80
Technology		
Housing depreciation:	δ	0.02
Growth rate productivity:	ρ	0.03
Cobb-Douglas:	α	0.67
Economy structure		
Government expenditure:	g	0.40
Government debt:	b	0.00
Share patient households:	m_1	0.05
Share impatient households:	m_2	0.95
Flow new land:	Λ	0.25

Notes: This table reports the parameters used to simulate the model. The model is simulated for different values of the relative productivity in manufacturing ($\zeta = 1, \ldots, 1.75$). The utility function u is CES and described in equation (32).

Before presenting the quantitative results of the optimal taxation problem, it is instructive to solve the model for an exogenous tax structure and analyze the impact of different taxes on the key variables of the model. Specifically, we fix the relative productivity parameter to $\zeta = 1.75$, and simulate the model under two scenarios. In both, the tax rates on housing and financial wealth for poor households is set to 0%. On the contrary, in the first scenario rich households face non negative identical tax rates on housing and financial wealth ($\tau^k = \tau^{h,1} \geq 0$); in the second, rich households face, instead, a non negative tax rate on housing wealth only, while financial wealth is not taxed ($\tau^k = 0, \tau^{h,1} \geq 0$). The tax rate on labor income ($\tau^w = 40\%$) is computed as solution to the steady state conditions. Table 2 presents the results of the simulations, for tax rates that increase from 0% to 1.5%. We choose this specific range to qualitatively replicate the wealth tax design in Sweden as described by Seim (2017). Panel A corresponds to the first scenario. When the tax rate on wealth increases, mean wealth ($\bar{a}$) decreases. Specifically, for a 1% increase in the tax rates on both financial and housing wealth, from 0.5% to 1%, mean wealth decreases by approximately 5.29%. Housing prices (q), the tax rate on labor income, and aggregate welfare (Ω) all decrease along the increase in the tax rates. Interestingly, welfare inequality *increases* by approximately 20%, despite the increase in the tax rates faced by rich households. This last result depends on the fact that when rich households' wealth decreases, consumption of poor households, who are net borrowers, decreases as well. Panel B corresponds to the second scenario. The tax rate on financial wealth is set to zero for both types of households, and we consider different values for the housing tax rates for the rich households. In this case, the drop in mean wealth is much smaller than under the first scenario. In fact, for a 1% increase in $\tau^{h,1}$, mean wealth drops by approximately 0.23%. Housing prices, the tax rate on labor income, and welfare are flat, while welfare inequality increases by a very small amount.

We now consider the quantitative results of the optimal taxation problem and simulate the model for different values of the relative productivity in manufacturing (i.e.,

Table 2: Wealth Elasticity

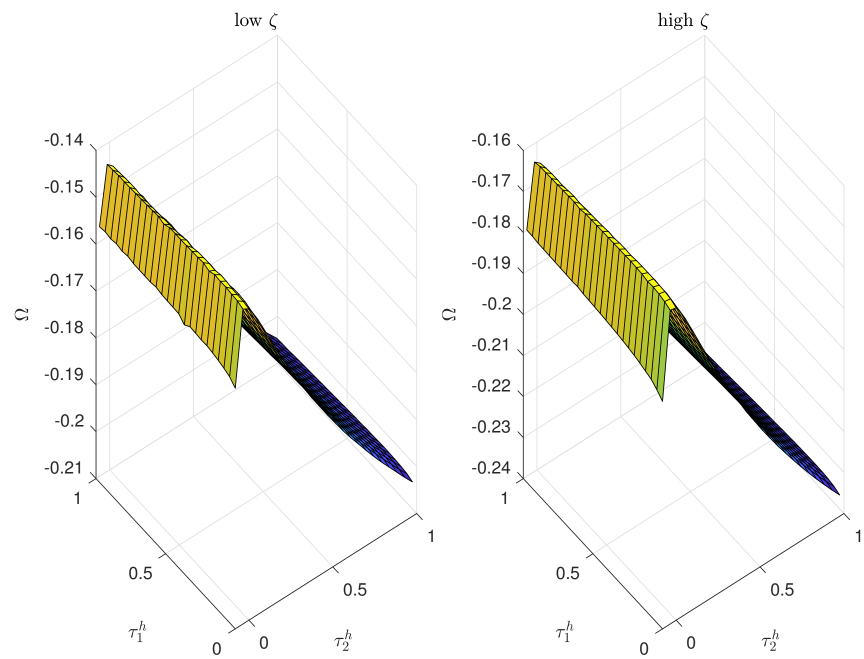
tax rate (τ,%)	0.00	0.50	1.00	1.50
	Panel A: $\tau^k = \tau^{h,1} \geq 0$			
$\bar{a}$	7.80	7.37	6.98	6.62
q	0.83	0.82	0.81	0.79
τ^w (%)	39.30	39.14	39.00	38.87
Ω	-0.16	-0.18	-0.20	-0.22
$(\Omega_1 - \Omega_2)/\lvert\Omega_1\rvert$	157.96	169.20	181.31	194.92
	Panel B: $\tau^k = 0, \tau^{h,1} \geq 0$			
$\bar{a}$	7.80	7.78	7.76	7.74
q	0.83	0.83	0.83	0.83
τ^w (%)	39.30	39.29	39.27	39.26
Ω	-0.16	-0.16	-0.16	-0.16
$(\Omega_1 - \Omega_2)/\lvert\Omega_1\rvert$	157.96	158.65	159.24	159.84

Notes: Model simulated for exogenous tax structure using the parameters described in table 1 We set $\zeta = 1.75$ and the housing tax rate on the poor households to $\tau^{h,2} = 0$. The tax rate on labor (τ^w) income is computed as solution to the steady state conditions. Panel A considers the case of identical and non negative tax rate on housing and financial wealth for rich households. Panel B considers the case of non negative housing tax rate on the rich households, and zero tax on financial wealth. Ω^1 and Ω^2 are the type-specific welfare measures.

$\zeta = 1, \ldots, 1.75$) to match the average increase in relative productivity in manufacturing, relative to the housing sector, observed in developed countries since 1970 (Borri and Reichlin, 2018). Figure 1 plots the steady state values of welfare for different housing tax rates for the patient ($\tau^{h,1}$) and impatient ($\tau^{h,2}$) households and for low and high relative productivity in manufacturing (ζ). Note that in what follows we focus only on the household specific component of the lifetime utility function described in equation (6), and not on the common component which is increasing in ζ. Results can be summarized as follows. For a given housing tax rate on the rich, welfare is higher for values of the housing tax rate slightly below zero for the poor, and then declines steeply both for the case of low and high ζ. On the contrary, for a given housing tax rate on the poor, welfare is not much affected by the housing tax rate on rich households.

Figure 2 provides a snapshot on the results for the optimal taxation, i.e., the steady state values obtained for the welfare maximizing combination of tax rates. First, we find that poor households receive a subsidy (i.e., $\tau^{h,2} < 0$) that does not change with

Figure 1: Welfare and Housing Taxes



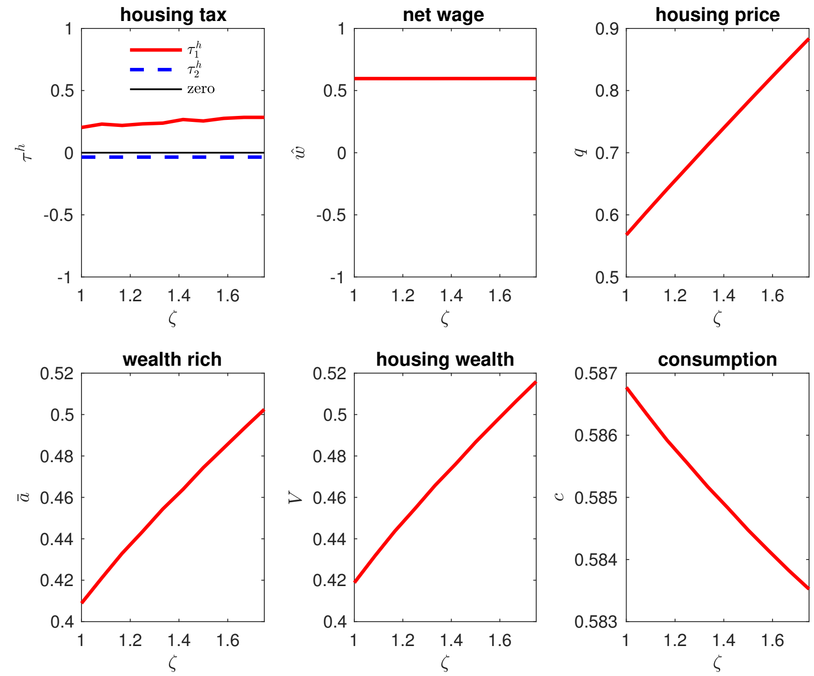
Notes: This figure plots the values of the welfare function Ω for different values of the housing tax rates of the patient ($\tau^{h,1}$) and impatient ($\tau^{h,2}$) households. The left (right) panel corresponds to the case of low (high) relative productivity in manufacturing (i.e., ζ equal to 1 and 1.75 respectively). The model is simulated using the parameter values from Table 1.

relative productivity in manufacturing, while rich households pay a positive housing tax rates that increases when relative productivity in manufacturing increases. Second, the tax rate on wages, common for both types of households, is constant and large. This result depends on our assumption of perfectly inelastic labor supply. Housing prices increases, because of the unbalanced increase in sectoral productivity, and rich households wealth, and total housing wealth increase, while consumption decreases. These results depend on the assumption of low elasticity of substitution. Panel A of table 3 reports the quantitative results both for the baseline case of a fraction of rich households equal to 5%, and for a higher value of 10%. Poor households receive a housing subsidy of approximately 3.5% regardless of the relative productivity in manufacturing and the share of rich households. On the contrary, we find that when the share of rich households is small, they pay a positive housing tax rate which increases from approximately 20% to 28% with the increase in relative manufacturing productivity. When the fraction of rich household is, instead, larger and equal to 10%, rich household pay a positive, but lower, housing tax rate of approximately 4% that does not change with the increase in relative productivity. Note how, while both the housing price and average wealth increase with relative productivity, the welfare measure Ω decreases. This depends on the fact that we focus only on the component of welfare that is household-specific and not on the component that depends on the increase in productivity. Finally, we report a measure of change in household welfare inequality. Specifically, we compute the difference in welfare for rich and poor households as a fraction of the absolute value of the rich households welfare. Therefore, an increase (decrease) in the measure describes an increase (decrease) in inequality. We find that, after an increase in relative productivity, welfare inequality increases when the share of rich households is small ($\Delta = 2.38\%$), while it decreases when the share of rich household is larger ($\Delta = -7.22\%$).

4.3 Alternative parameters

In this section we consider the robustness of our results to higher values of the elasticity of substitution. Specifically, we simulate the model using the same parameters presented in table 1 with the exception of γ, which we set to a value greater than 1 ($\gamma = 1.5$). We report results in table 4. When housing tax rates can be different for rich and poor households, we find that rich households pay a positive tax, that is lower than for the baseline case of low γ, while poor households face a 0% housing tax rates for low and high values of ζ and m_1. Note how, because of the higher elasticity of substitution, housing prices are higher and total and housing wealth decline with the increase in relative productivity. In section 5 of the appendix we report additional details on the case of high elasticity of substitution, along with additional robustness results.

Figure 2: Welfare, Inequality, and Taxes



Notes: This figure plots the welfare optimizing values of the housing tax (τ^h), the net wage ($\hat{w}$), the housing price (q), the average wealth of rich households ($\bar{a}$), the housing wealth (v), and total consumption (c) for different values of the relative productivity in manufacturing $\zeta = 1, \ldots, 1.75$. For the housing tax, we report the welfare optimizing tax rates for patient households (red solid line) and impatient households (dashed blue line). The model is simulated using the parameter values from Table 1.

5 Conclusions

Based on the observation that the wealth to income ratio and wealth inequality have been generally increasing in advanced economies since 1970, it has been suggested that the tax structure should be rebalanced from labor income to wealth. In this paper we have considered a simple model with rich and poor households, financial and housing wealth, and find that the optimal steady state tax structure includes some taxation of labor, zero taxation of financial wealth, and a housing tax on rich households and a housing subsidy on poor households. When wealth inequality increases by about 25%, because of unbalanced productivity growth, and the share of rich household is small enough, it is optimal to increase housing tax rates on rich households by 40%. Wage taxes and housing wealth subsidies appear to be quite insensitive to the dynamics of

Table 3: Simulation

	$m_1 = 5\%$		$m_1 = 10\%$	
	$\zeta = 1.00$	$\zeta = 1.75$	$\zeta = 1.00$	$\zeta = 1.75$
	Panel A: different $\tau^{h,i}$			
$\tau^{h,1}$ (%)	20.312	28.438	4.062	4.062
$\tau^{h,2}$ (%)	-3.541	-3.541	-3.541	-3.541
τ^{w} (%)	40.364	40.323	40.454	40.545
q	0.568	0.884	0.568	0.886
$\bar{a}$	0.409	0.502	0.411	0.509
Ω	-0.142	-0.162	-0.139	-0.158
$(\Omega_1 - \Omega_2)/\vert\Omega_1\vert$	1.624	1.663	2.808	2.605
Δ	–	2.38 %	–	-7.22 %
	Panel B: same $\tau^{h,i}$			
$\tau^{h,1}$ (%)	-0.446	-0.446	-3.540	-3.540
$\tau^{h,2}$ (%)	-0.446	-0.446	-3.540	-3.540
τ^{w} (%)	39.575	39.472	40.769	40.955
q	0.538	0.839	0.577	0.900
$\bar{a}$	0.340	0.423	0.433	0.537
Ω	-0.143	-0.163	-0.140	-0.160
$(\Omega_1 - \Omega_2)/\vert\Omega_1\vert$	1.589	1.560	2.224	2.109
Δ	–	-1.86 %	–	-5.18 %

Notes: This table reports the welfare optimizing values of the housing tax (τ^h), the net wage ($\hat{w}$), the housing price (q), the average wealth of rich households ($\bar{a}$), and welfare Ω for low and high values of the productivity in manufacturing (ζ) and low and high share of rich households (m_1). Ω is the household specific component of the lifetime utility function described in equation (6). $(\Omega_1 - \Omega_2)/|\Omega_1|$ measures welfare inequality. Δ measures the change in welfare inequality when ζ increases to 1.75. Panel A corresponds to the case in which housing tax rates can be household specific. Panel B corresponds to the case in which housing tax rates must be the same for rich and poor households. The model is simulated using the parameter values from Table 1.

wealth and housing prices in our simulation.

Table 4: Simulation (high EIS)

	$m_1 = 5\%$		$m_1 = 10\%$	
	$\zeta = 1.00$	$\zeta = 1.75$	$\zeta = 1.00$	$\zeta = 1.75$
	Panel A: different $\tau^{h,i}$			
$\tau^{h,1}$ (%)	16.250	16.250	8.125	8.125
$\tau^{h,2}$ (%)	0.000	0.000	0.000	0.000
τ^{w} (%)	31.019	32.372	31.022	32.329
q	1.118	1.557	1.126	1.567
$\bar{a}$	3.003	2.654	3.071	2.704
Ω	0.382	0.223	0.407	0.247
$(\Omega_1 - \Omega_2)/\lvert\Omega_1\rvert$	0.808	0.889	0.751	0.850
Δ	–	10.08 %	–	13.13 %
	Panel B: same $\tau^{h,i}$			
$\tau^{h,1}$ (%)	2.648	2.648	2.648	2.648
$\tau^{h,2}$ (%)	2.648	2.648	2.648	2.648
τ^{w} (%)	27.926	29.496	27.926	29.496
q	1.084	1.503	1.084	1.503
$\bar{a}$	2.703	2.351	2.703	2.351
Ω	0.357	0.203	0.385	0.228
$(\Omega_1 - \Omega_2)/\lvert\Omega_1\rvert$	0.848	0.919	0.791	0.883
Δ	–	8.33 %	–	11.66 %

Notes: This table reports the welfare optimizing values of the housing tax (τ^h), the net wage ($\hat{w}$), the housing price (q), the average wealth of rich households ($\bar{a}$), and welfare Ω for low and high values of the productivity in manufacturing (ζ) and low and high share of rich households (m_1). Ω is the household specific component of the lifetime utility function described in equation (6). $(\Omega_1 - \Omega_2)/|\Omega_1|$ measures welfare inequality. Δ measures the change in welfare inequality when ζ increases to 1.75. Panel A corresponds to the case in which housing tax rates can be household specific. Panel B corresponds to the case in which housing tax rates must be the same for rich and poor households. The model is simulated using the parameter values from Table 1, with the exception of $\gamma = 1.5$.

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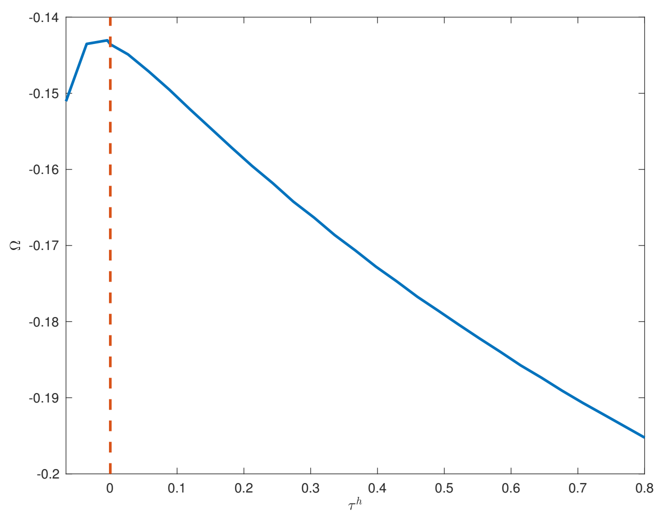
Appendix: Additional Robustness Results

In this section, we present robustness results for our quantitative analysis presented in section 4. Specifically, section 5 the case of uniform housing tax rates across the two types of households; and section 5 the case of higher elasticity of substitution.

Model with Same Housing Tax

In this section we present results for a version of the model in which we assume that the housing tax τ^h is the same for the two types of households. The results are also summarized in panel B of table 3. In this case, we find that it is optimal to set a small and negative housing tax rates for both rich and poor households. Figure A1 shows how welfare is maximized for a small but negative value of τ^h. Figure A2 shows that the housingand wage tax rates do not change with the increase in relative productivity, while housing prices and housing wealth increase with ζ.

Figure A1: Welfare and Housing Taxes (same τ^h)

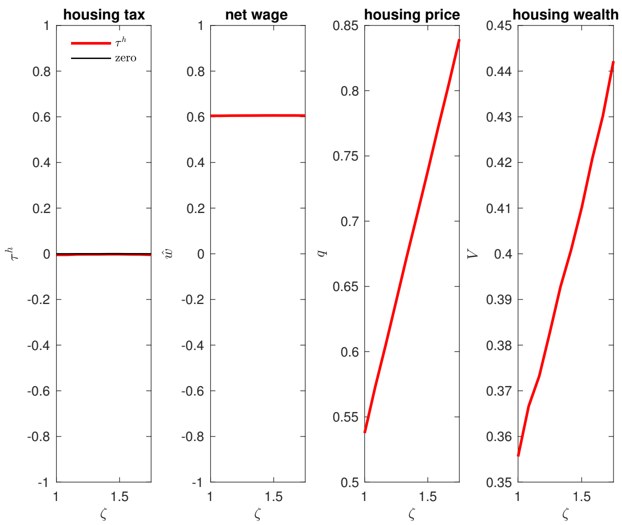


Notes: This figure plots the values of the social welfare function Ω for different values of the housing tax rate τ^h common across the two types of households. The model is simulated using the parameter values from Table 1, setting $\tau^k = 0$, and for a value of $\zeta = 1$. The vertical red dashed-line correspond to a zero housing tax rate.

Model with High EIS

In this section we present quantitative results obtained by simulating the model using the parameter values from Table 1 with the exception of $\gamma = 1.5$. This is the case of high elasticity of substitution. Table 4 in the paper anticipates the results of this section. Figure A3 provide additional graphical results on the behavior of the steady state values of the main variables at the welfare maximizing combination of tax rates. Note how housing tax rates do not change with relative productivity, but rich and

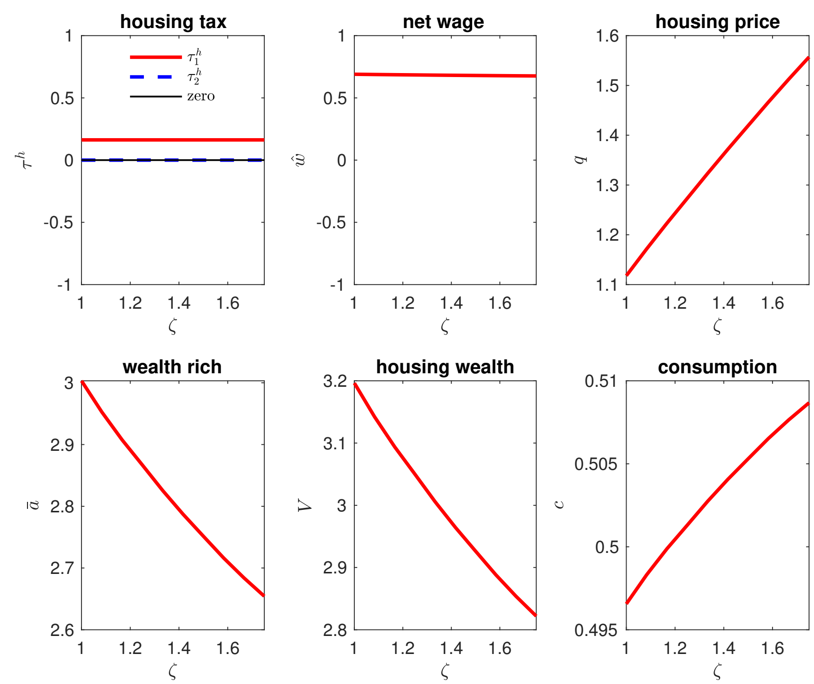
Figure A2: Welfare, Inequality, and Taxes (same τ^h)



Notes: This figure plots the welfare optimizing values of the housing tax (τ^h), the net wage ($\hat{w}$), the housing price (q), the average wealth of rich households ($\bar{a}$), the housing wealth (v), and total consumption (c) for different values of the relative productivity in manufacturing $\zeta = 1, \ldots, 1.75$. The model is simulated using the parameter values from Table 1 and setting $\tau^k = 0$. The model is simulated adding the constraint $\tau^{h,1} = \tau^{h,2}$.

poor households have different housing tax rates. Specifically, rich households pay a positive housing tax, while poor households face a zero rate. In addition. Since $\gamma > 1$, despite the fact that housing prices increase with relative productivity, total wealth and housing wealth decline, while consumption increases.

Figure A3: Welfare, Inequality, and Taxes (high EIS)



Notes: This figure plots the welfare optimizing values of the housing tax (τ^h), the net wage ($\hat{w}$), the housing price (q), the average wealth of rich households ($\bar{a}$), the housing wealth (v), and total consumption (c) for different values of the relative productivity in manufacturing $\zeta = 1, \ldots, 1.75$. For the housing tax, we report the welfare optimizing tax rates for patient households (red solid line) and impatient households (dashed blue line). The model is simulated using the parameter values from Table 1 with the exception of $\gamma = 1.5$.