# Consumption taxation and redistribution: the role of housing wealth*
# (Preliminary and incomplete)

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**Abstract**

An increase in consumption taxes reduces the purchasing power of existing wealth. Hence, it effectively acts as a capital levy. However, this capital levy does not apply to housing wealth in the same manner as it applies to financial wealth. Moreover, tax reforms inducing changes in the after-tax interest rate will affect households differently depending on whether most of their overall wealth is in the form of housing or financial wealth. We use a dynastic model of household savings and labour supply to study the distributional implications of tax reforms that consist of eliminating capital income taxation and increasing consumption taxes In contrast to previous literature, we distinguish between financial wealth and housing wealth. Our results suggest that the special role of housing wealth makes such tax reforms much more progressive than what one would expect based on a model with a financial asset only.

*Keywords:* Taxation, distributional effects, dynamics, housing

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# 1 Introduction

An increase in consumption taxation decreases the amount of goods and services one dollar can buy. It can therefore be characterized as a capital levy. As stressed by Correia (2010), this mechanism is important for both efficiency and equity. The lump-sum nature of the capital levy obviously provides efficiency gains. Correia argues that a reform consisting of increasing consumption taxes and lowering income taxes is also likely to benefit mostly the welfare poor households. Essentially, this is because they have little wealth also relative to their labor income. Hence, while they benefit from lower income taxes after the reform, they are not much affected by the capital levy. Taking these mechanisms into account, Correia finds that replacing the current US tax system with a flat rate consumption tax is likely to reduce welfare inequalities while increasing aggregate efficiency.

In this paper, we take a closer look at the distributional effects of such tax reforms. Specifically, we consider tax reforms that consist of eliminating or lowering capital and labor income taxation while increasing the consumption taxation. In principle, the consumption tax can equally well take the form of a value-added tax (VAT) or a retail sales tax, although VAT is often argued to be more efficient in practice.[1]

In contrast to Correia (2010) and other related studies[2], we distinguish between financial wealth and housing wealth. This is important for several reasons. First of all, it is not clear that the capital levy associated with an increase in consumption taxation applies to housing wealth in the same manner as it applies to financial wealth. This is because households owning a house may always continue to live in their current house regardless of changes in taxation, i.e. the value of their current housing wealth will always be enough to buy the same house. In addition, if only new houses are subject to VAT, as is the case in many European countries, the real market value of the existing housing stock is likely to increase permanently following the introduction of VAT. Since housing wealth makes up a large fraction of overall wealth and is distributed very differently from financial wealth, these differences are likely to be important for both the efficiency and distributional implications of consumption tax reforms. Second, changes in the after-tax interest rate will affect households differently depending how

[1] More generally, however, there are also other ways of moving towards expenditure taxes. See e.g. the discussion in Altig. et al. (2001). Our analysis doesn't cover all the different reform proposals.

[2] Ventura (1999) who conducts a steady state analysis employing a life-cycle economy with borrowing constraints. Altig et al. (2001) consider several different tax reforms in a life-cycle model taking into account transitional dynamics.

much financial wealth they have relative to their net wealth.[3]

We use a similar dynastic model with wealth and income heterogeneity as Correia (2010). The model allows us to match any joint distribution of financial wealth and housing wealth. In order to capture the fact that housing and financial wealth are very differently distributed among US households, we consider total wealth deciles together with the top one percent of the wealth distribution. Households in the first total wealth decile have negative financial wealth while the top one percent owns a large fraction of the overall financial wealth. Relative to financial wealth, housing wealth is much more evenly distributed. Households' permanent labor income is inferred using the model, together with the distribution of and financial wealth (per consumption unit).

We use the calibrated model to analyze the efficiency and distributional effects of consumption taxation and to highlight the importance of distinguishing between housing and financial wealth in this context. Our results suggest that most households would benefit from reforms which increase consumption taxation in a manner that allows significant reductions in labor income tax burden. The reforms can also be progressive in the sense that households in the top of the wealth distribution benefit the least or may even be harmed by the reforms. This is because the financial wealth holdings are relevant for determining the incidence of the capital levy.

When we compare our two asset model economy to a model economy with a single asset represented by households' total wealth, we find that the special role of housing wealth makes the tax reforms much more progressive than what one would expect based on a model with a single asset. However, both the distributional and efficiency implications of the tax reforms depend on the tax treatment of housing.

The paper proceeds as follows: In the next section, we describe the model. In section 3, we discuss the wealth distributions. Section 4 discusses calibration and section 5 results. Section 6 concludes.

[3] Several studies have assessed the welfare consequences of the tax favored status of owner housing relative to other forms of saving. Berkovec and Fullerton (1992), Skinner (1996), and Gervais (2002), among others, have shown that a tax reform imposing the same tax rate on housing and business capital would lead to substantial efficiency gains. The optimal tax system in a dynamic setting taking into account the transitional dynamics is studied in Eerola and Määttänen (2013).

# 2 Model

The model economy follows that in Correia (2010) with one important difference: we distinguish between financial wealth and housing wealth and allow the households to derive utility from housing.

The model economy features infinitely lived households that derive utility from non-housing consumption, housing services, and leisure. Households consume housing services through owner-housing and can save through a financial asset and housing wealth.

The production side consists of a representative firm that employs business capital and labor to produce output goods.

The government finances a fixed level of public spending. The tax system consists of flat-rate taxes on non-housing consumption, residential construction, labor income and the return to financial wealth.

As is usual in the related literature, we consider fully unanticipated permanent tax reforms. That is, we abstract from issues related to repetition and anticipation. For a discussion of these issues, see e.g. Kaplow (2006) and the references therein.

## 2.1 Household's problem

Each household is endowed with one unit of time every period, supply labor $n$ and derive utility from non-housing consumption $c$, stock of housing capital $h$, and leisure. The households have two savings vehicles: housing capital and financial wealth $a$.

Households have GHH preferences[4] and differ in terms of labor productivities and asset positions. There are $I$ different household types, indexed by $i = 1, 2, ..., I$. The problem of a household of type $i$ in period 1 is to maximize lifetime utility

$$\max_{\{c_{i,t}, n_{i,t}, a_{i,t+1}, h_{i,t+1}\}_{t=1}^{\infty}} \sum_{t=1}^{\infty} \beta^{t-1} \frac{\left(C_{i,t} - \chi n_{i,t}^{\varphi}\right)^{1-\sigma}}{1-\sigma} \tag{1}$$

where $\beta$ is the discount factor, $\sigma > 0$ is the parameter governing the intertemporal elasticity of substitution, $\chi > 0$ measures the importance of leisure relative to consumption, and $\varphi > 0$ is related to the Frisch elasticity of labor supply. $C$ is a composite good consisting of housing

[4]This class of utility functions was introduced by Greenwood, Hercowitz and Huffmann (1988). For more discussion on the advantages and drawbacks of assuming these preferences, see e.g. Correia (2010) and Correia (1999).

and non-housing consumption:

$$C_{i,t} = \left(\gamma c_{i,t}^{r} + (1-\gamma) h_{i,t}^{r}\right)^{\frac{1}{r}},$$

where the weight of non-housing consumption is $0 < \gamma \leq 1$ and the elasticity of substitution between non-housing and housing consumption is $\frac{1}{1-r}$. If $\gamma = 1$ and $r = 1$, the model becomes identical to the one discussed in Correia (2010).

Utility maximization is subject to a sequence of periodic budget constraints:

$$\left(1+\tau_t^c\right) c_{i,t} + \left(1+\tau_t^h\right) q_t h_{i,t+1} + a_{i,t+1} = \left(1-\tau_t^n\right) w_t \epsilon_i n_{i,t} + b_{i,t} \quad (2)$$

$$b_{i,t} = R_t a_{i,t} + \left(1+\tau_t^h\right) q_t \left(1-\delta_h\right) h_{i,t} \quad (3)$$

where

$$R_t = 1 + \left(1-\tau_t^a\right) r_t.$$

In the budget constraint, $q_t$ is the price of one housing unit in period $t$ excluding the tax on residential construction and $\delta_h$ is the depreciation rate of housing capital. The taxes on non-housing consumption, residential construction, labor income and the return to financial wealth are denoted by $\tau^c$, $\tau^h$, $\tau^n$ and $\tau^a$, respectively.

The left hand side of the budget constraint includes expenditures on non-housing consumption, investment in housing, and financial wealth. The terms in the right hand side are the after-tax labor income, the return to financial wealth and the value of the house net of depreciation. We will discuss below how the value of housing wealth $q_t$ is determined.

Note that financial wealth can be negative. In that case, the household holds a mortgage. If mortgage interest payments are not fully tax deductible, the user cost of housing depends on whether housing is financed with equity or debt. With full deductibility, households are indifferent between using debt or own savings. The above budget constraint implies that this is indeed the case.

## 2.2 Aggregation

The total mass of households equals one and the mass of households of type $i$ is $\eta_i > 0$. Aggregate non-housing consumption, housing wealth, financial wealth and aggregate efficient labor can be written as

$$
\begin{aligned}
c_t &= \sum_{i=1}^{I} \eta_i c_{i,t}, \\
h_t &= \sum_{i=1}^{I} \eta_i h_{i,t}, \\
a_t &= \sum_{i=1}^{I} \eta_i a_{i,t}, \\
n_t &= \sum_{i=1}^{I} \eta_i \epsilon_i n_{i,t}.
\end{aligned}
$$

It can be shown that in the steady state, the ratio of non-housing-to-housing consumption does not depend on individual characteristics. That is, regardless of wealth or labor productivity, housing and non-durables will be consumed in equal shares by all household types. In addition, as in Correia (2010), labor supply is linear in $\epsilon_i^{\frac{1}{\varphi-1}}$ and non-housing and housing consumption are both linear in initial wealth $b_{i,1}$ and $\epsilon_i^{\frac{\varphi}{\varphi-1}}$. Hence, aggregate demands and aggregate efficient labor do not depend on the distributions of initial wealth or labor productivity. These features of the model economy are useful when calibrating the model.[5]

However, unlike in Correia (2010), the economy does not feature a representative household. The reason is related to housing being both an asset and a durable consumption good. The unanticipated tax reforms have distributional effects. Therefore, even in the absence of changes in relative prices, the households would wish to re-optimize their housing and non-housing consumption following a reform. But because housing consumption cannot be adjusted immediately, the aggregate consumption and labor supply depend on the wealth distribution.[6] This means that aggregate dynamics and the efficiency effects of the different reforms cannot be analyzed relying on a representative household. We will discuss this issue in more detail below.

[5] See the appendix for details.

[6] We make this timing assumption so as to guarantee comparability with the single asset economy where, in each period, the entire capital stock is predetermined in the previous period. The model would feature a representative household if housing consumption could be instantaneously adjusted.

## 2.3 Housing supply

Whether changes in taxation or other factors affecting housing demand capitalize into house prices or not will be important for the discussion of the distributional effects of tax reforms. Therefore, when discussing how changes in the demand for housing feed into $q_t$, it is important to be more specific on the supply conditions of housing.

In this respect one can think of two extremes: If the supply of new housing units is completely elastic, the price of housing tends to reflect the construction cost. If this is the case, tax changes will affect the house prices only through the cost of residential construction. If, on the other hand, housing supply is perfectly inelastic, all changes in the demand for housing capitalize into house prices.

The set-up we have described above is compatible with these two very different approaches. Consider first the situation where any increase in housing demand is matched by new housing construction. Assuming that output can be freely converted into one unit of housing capital, the price of one unit of housing satisfies

$$q_t = 1.$$

If, in turn, housing supply is completely inelastic, increases in housing demand cannot fuel new construction. If the housing stock is fixed at $\overline{h}$ in all periods, the price of housing units must be such that

$$\overline{h} = h_t = \sum_{i=1}^{I} \eta_i h_{i,t}.$$

In this case, we can think of the parameter $\delta_h$ as determining a maintenance cost that must be paid every period.

## 2.4 Firms

Every period $t$, a representative firm employs business capital, $k$, and labor, $n$, to produce output goods, $y$. The production function isen

$$y_t = f(k_t, n_t). \tag{4}$$

Production function exhibits constant returns to scale. The firm's first-order conditions for profit maximization imply that the before-tax returns to business capital and labor are determined by marginal productivities, that is,[7]

$$r_t = f_{k_t} - \delta_k \tag{5}$$

$$w_t = f_{n_t}. \tag{6}$$

## 2.5 Government

The government finances an amount $g$ of public consumption in each period, collects taxes and may issue one period bonds. The government faces a periodic budget constraint stating:

$$\tau_t^c c_t + \tau_t^n w_t n_t + \tau_t^a r_t a_t + \tau_t^h q_t \left[h_{t+1} - h_t \left(1 - \delta_h\right)\right] + B_{t+1} \geq g + R_t^B B_t$$

where $R_t^B - 1$ is the gross rate of return on the government bonds from period $t-1$ to period $t$.[8] These periodic budget constraints can be used to formulate an intertemporal budget constraint for the government. We require that this intertemporal budget constraint holds with equality.

As in Correia (2010), we wish to consider tax reforms which increase consumption taxation and reduce income taxation. In a setting with a single composite consumption good, this is a straightforward reform as $\tau^c$ trivially applies to all consumption. The same is not true in our setting with housing and non-housing consumption. Therefore, if the tax reform changes the relative prices of the different consumption goods, it will have additional distortionary effects that are not present in a model with a single consumption good. This will necessarily happen, if the reform treats housing and non-housing consumption differently.

## 2.6 Equilibrium

In the case where the housing supply is perfectly elastic, the market equilibrium can be defined as follows: For a given initial distribution of housing and financial assets, aggregate government debt and a sequence of tax rates that satisfies the intertemporal government budget constraint, a competitive equilibrium consists of individual policies and prices such

[7] We denote $\frac{\partial}{\partial k_t} f(k_t, n_t) = f_{k_t}$ and similarly for other derivatives throughout the paper.

[8] We assume that the return to government bonds is taxed at the same rate as the return to business capital. This assumption is innocuous for the bond exchanges between the government and the households. However, it is clear that in this setting investment in business capital and government bonds must give the same after-tax return.

that the individual policies solve the household's problem in (1) and (2), the interest rate and wage rate are given by (5) and (6), and the aggregate resource constraint

$$c_t + k_{t+1} + h_{t+1} + g = f(k_t, n_t) + (1 - \delta_k) k_t + (1 - \delta_h) h_t$$

is satisfied in all periods.

In the case where the housing supply is fixed, the equilibrium also includes a sequence of house prices (relative to the price of the consumption good) such that the aggregate demand of housing equals its fixed supply in every period.

# 3 Housing, financial wealth and earnings distributions in the data

We are mainly interested in the distributional consequences of tax reforms that consist of moving towards a consumption tax and reducing income taxation. As discussed above, the distributional effects are likely to depend on the initial joint distribution of housing, financial wealth and earnings. In order to calibrate the distributions, we use the 2013 wave of the Survey of Consumer Finances (SCF). The SCF is useful for our purposes, because wealth in general, and financial wealth in particular, is highly concentrated, and the SCF is designed to overcome this by performing substantial oversampling at the top.[9]

For the moment, we consider only homeowners between 25 and 65 years of age (the age of the household head). We abstract from older households because our model abstracts from life cycle features. We also exclude homeowners for whom the value of the primary residence is less than 10,000 dollars. This leaves us with roughly 2,900 households. The home ownership rate in the entire data is 65% and 63% in the age group we focus on.

Using this data set, we construct two variables for the analysis: 'housing wealth' and 'financial wealth'. We define housing wealth as the value of primary residence and the value of other residential real estate. Financial wealth is defined as the sum of all financial assets, the net equity in non-residential real estate, and the value of net equity in businesses less all debt (including mortgages).[10] We also define 'total wealth' as the sum of housing and

[9] Bricker et al. (2015) discuss the sampling strategy in more detail.

[10] That is, housing wealth includes variables 'houses' and 'oresre' and financial wealth includes variables 'fin', 'nnresre', 'bus' and 'debt'.

financial wealth. We then employ the OECD equivalence scales to adjust wealth and income variables for household size and age composition.[11]

We sort households according to their total wealth. Specifically, we sort the households into 11 groups, representing total wealth percentiles 1-10, 11-20,...,81-90, 91-99, and 99-100. For each group, we calculate the average housing wealth, financial wealth, total wealth and earnings from our data. Table 1 shows these distributions relative to the sample mean in our data.

| | Total wealth percentiles | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1-10 | 11-20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | 91-99 | 99-100 |
| Earnings | 0.61 | 0.50 | 0.52 | 0.68 | 0.71 | 0.80 | 0.93 | 1.1 | 1.39 | 2.31 | 7.00 |
| Fin wealth | -0.53 | -0.28 | -0.24 | -0.23 | -0.17 | -0.10 | 0.06 | 0.40 | 1.09 | 5.71 | 50.38 |
| Hous. wealth | 0.41 | 0.32 | 0.36 | 0.46 | 0.55 | 0.68 | 0.85 | 1.04 | 1.57 | 3.06 | 10.32 |
| Total wealth | -0.07 | 0.01 | 0.05 | 0.11 | 0.18 | 0.28 | 0.45 | 0.71 | 1.32 | 4.43 | 30.89 |

Table 1: Relative distributions in the data.

The first nine columns contain households in the first nine total wealth deciles. The tenth column contains households in the wealthiest decile excluding the top one percent. The last column contains the top one percent of the households. For instance, figures 0.61 and 0.41 in the first column show that, in the first total wealth decile, the earnings of the households are 61% of the average earnings in the data and their housing wealth is 41% of the average housing wealth in the data.

One very clear pattern in the table is that financial wealth is extremely unevenly distributed across these groups. The average financial wealth in the top one percent is about 50 times the average financial wealth. Even though households are sorted according to their total wealth, total wealth is much less unevenly distributed than financial wealth across these groups. This is because housing wealth is relatively evenly distributed.

[11] We use the OECD scale which assigns value 1 to the first household member, 0.7 to each additional adult and 0.5 to each child.

# 4 Calibration

In this section, we describe the calibration of the model. We first discuss the calibration of our two asset model with housing. After that, we consider the calibration of a single asset model the results from which can be compared with those based on the two asset model.

## 4.1 Model economy with housing and financial wealth

We calibrate the model so that the initial steady state replicates certain aggregate moments as well certain distributional features. We consider eleven household types representing households in different total wealth percentiles shown in table 1. Since the models allows for a representative agent in the steady state (see section 2.2), we may consider aggregate moments separately from the distributional features.

For now, we assume that housing supply is completely elastic. As a result, the house price equals $q_t = 1$ in each period.

The model period corresponds to one year. The production technology is Cobb-Douglas. We first set the technology parameters, the elasticity parameters $\sigma$, $r$ and $\varphi$, and some of the tax parameters exogenously at reasonable or conventional values. Specifically, we set the capital share at $\alpha = 0.3$, the depreciation rate of business capital at $\delta_k = 0.12$ and depreciation rate of housing capital at $\delta_h = 0.03$. We set $\sigma = 1.0$ (the inverse of the intertemporal elasticity of substitution). We set the elasticity of substitution between housing and non-housing consumption to 0.5, which implies $r = -1$.[12] Following Correia (2010), we set $\varphi = 1.8$ and $\tau^a = 50\%$ and abstract from existing consumption taxes in the initial steady state.

We are then left with the preference parameters $\{\beta, \gamma$ and $\chi\}$, government expenditures $g$, and the labor income tax rate $\tau^n$. We determine these parameters by targeting the following moments: i) aggregate business capital-to-GDP ratio equal to 2.96; ii) housing-to-business

[12] There exists little consensus on the magnitude of this elasticity. Using a structural life cycle model, Li et al. (2015) find an elasticity of substitution equal to 0.487 and cite estimates in the range of 0.15 and 0.60 from previous studies using household-level data. On the other hand, much of the related literature uses Cobb-Douglas preferences implying an elasticity of substitution equal to 1. Davis and Ortalo-Magné (2011) provide evidence for this assumption by documenting that for households renting the expenditure shares on housing have been constant over time and across US metropolitan statistical areas. Stokey (2009) considers elasticities in the range of 0.15 and 1.25 when analyzing the portfolio choices of owner-occupiers and shows that over a relatively broad range of elasticity values the behavioral effects are quite similar.

capital ($h/k$) ratio equal to 0.95; iii) aggregate efficient labor $n$ equal to 0.25; iv) government consumption-to-GDP ratio equal to 0.19; v) the government budget is balanced and there is no government debt. The first target is based on National Income and Product Accounts.[13] The second target is from our data and the third from Correia (2010). In the model, we define GDP as $y + (r + \delta_h)h$, where $y$ stands for aggregate output and $h$ for aggregate housing ($r + \delta_h$ can be interpreted as the imputed rent).

We have the same number of endogenously calibrated parameters and targets and can exactly match the targets. The resulting preference parameters are $\beta = 0.975$, $\gamma = 0.64$ and $\chi = 1.27$. The calibrated labor income tax rate is $\tau^n = 24\%$.

We now turn to the calibration of the distributional features. We consider 11 household types representing the groups in Table 1 above. We need to define the labor productivities of the different household types $\{\epsilon_i\}_{i=1}^I$, the initial financial wealth holdings $\{a_{i,0}\}_{i=1}^I$, and initial housing wealth $\{h_{i,0}\}_{i=1}^I$. When replicating the joint distribution of financial wealth and housing wealth, we first assign financial wealth holdings $\{a_{i,0}\}_{i=1}^I$ for each household type, so that the relative financial wealth distribution across the different household types matches that shown in table 1. We then choose the labor productivities of the different household types $\{\epsilon_i\}_{i=1}^I$ so that household optimization leads them to choose the amount of (relative) housing wealth shown in table 1.[14]

An alternative approach would be to match the observed relative labor income distribution. The problem with this approach is that annual labor income observed in a given year may be a poor proxy for permanent labor income. In matching housing wealth and financial wealth distributions, our underlying assumption is that given a household's financial wealth position, its housing wealth reflects its expectations about its future average labor income, or permanent labor income.

Table 2 below compares the distribution of earnings in the data and the model. For instance, in our sample, households that belong to the first total wealth decile earn on average 61 percent of the average labor income of all households. In the model, the corresponding figure is 63 percent. Except for the households in the top one percent of the total wealth distribution, the inferred relative earnings in the model are quite close to those in the empirical distribution of annual labor earnings.

[13] These are actually averages for 2000-2008.

[14] See the Appendix for details.

| | Total wealth percentiles | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1-10 | 11-20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | 91-99 | 99-100 |
| Data | 0.61 | 0.50 | 0.52 | 0.68 | 0.71 | 0.80 | 0.93 | 1.10 | 1.39 | 2.31 | 7.00 |
| Model | 0.63 | 0.45 | 0.48 | 0.61 | 0.71 | 0.85 | 1.03 | 1.18 | 1.68 | 2.48 | 1.41 |

Table 2: Relative earnings distribution in the data and the model.

## 4.2 Model economy with a single asset

When considering an economy with a single asset, we assume that total wealth of the households equals their financial wealth and housing wealth. In addition, we will assume that $\gamma = 1$, i.e. that there is only a single consumption good, and that $r = 1$. With these asumptions, our single asset economy becomes identical to that in Correia (2010).

Households are heterogenous in total wealth and labor productivity. As in Correia (2010), we will be able to perfectly match both distributions. More specifically, we will match the total wealth distribution shown in table 1 and the labor productivity distribution shown in the first row of table 2. That is, the single asset model is calibrated so that it features exactly the same earnings and total wealth distributions as our two asset model. (Given the scaling of the labor productivity distribution, the single asset economy will feature a representative household with productivity $\bar{\epsilon} = 1$.)

In order to be able to compare the two economies, we also aim at retaining the same $\beta$ when recalibrating the model economy. We assume that the depreciation rate of business capital is the weighted average of the depreciation rate of housing and business capital in our two asset economy and set $\delta_k = 0.069$. In addition, we choose a higher capital share, $\alpha$, to reflect the fact that the stock of business capital accounts for a larger share of aggregate output in the single asset economy and set $\alpha = 0.39$. The exact value for $\alpha$ is chosen so as to guarantee that $\beta$ remains same as in the two asset economy. We target the same aggregate business capital-to-GDP ratio, aggregate efficient labor $n$ and government consumption-to-GDP ratio as in our two asset economy. These targets imply preference parameters $\beta = 0.975$ and $\chi = 1.09$ and an initial labor income tax rate $\tau^n = 18\%$.

# 5 Reform analysis

In this section, we report our main results. Starting from the initial steady state in period 1, we consider different unanticipated tax reforms which consist of setting new constant tax rates. The reform is announced and implemented in the beginning of period 1, before households have done any choices in that period. In all cases, we fix other tax rates and choose the labor income tax rate so that the government's intertemporal budget constraint is balanced. We follow Correia (2010) in considering four alternative tax reforms: the first reform abolishes the capital income taxation without introducing a tax on consumption. This reform requires increasing the tax burden on labor income relative to the status quo. The other three reforms gradually increase the tax rate on consumption (from 10% up to 30%) and, as a result, lower the tax burden on labor income relative to the first reform.

For each of the tax reforms, we consider two alternative scenarios regarding the tax treatment of housing. In the first scenario, the tax rate on residential construction always equals the tax rate on non-housing consumption, i.e. $\tau^c = \tau^h$. In the second scenario, the government does not tax housing at all, $\tau^h = 0$.

We measure the welfare effects of the reforms by computing for each household type the change in non-housing consumption in the initial steady state that would make the household indifferent between the status quo and the reform. If the consumption change is positive, the reform increases household's welfare. Since the model economy with housing does not feature a representative household, we determine the aggregate effects of each reform in the following manner: We first calculate the absolute consumption compensation for each household type, then sum over different household types taking into account their masses and finally express this average consumption compensation as the share of the average non-housing consumption in the initial steady state.

It is important to emphasize that we calculate the consumption compensation using non-housing consumption only both in the single asset and in the two asset economy. This means that in the two asset economy, we include only part of overall consumption of the households to the calculation. As a result, the welfare effects in the two asset economy and the single asset economy are not directly comparable.

Table 3 summarizes the tax reforms by showing the tax rates as well as the efficiency effects of the reforms. The first set of results are related to the scenario where the tax rate on non-housing consumption and residential construction are always the same. The results in the middle of the table are related to the scenario where housing is not taxed. The bottom of the table shows the results for the single asset economy.

| | Status quo | $\tau^c$= 0 | $\tau^c$= 0.1 | $\tau^c$= 0.2 | $\tau^c$= 0.3 |
|---|---|---|---|---|---|
| | Two asset economy with $\tau^c = \tau^h$ | | | | |
| $\tau^k$ | 0.5 | 0 | 0 | 0 | 0 |
| $\tau^n$ | 0.24 | 0.30 | 0.21 | 0.13 | 0.05 |
| Aggregate ECC | 0 | 0.2% | 0.8% | 1.3% | 1.7% |
| | Two asset economy with $\tau^h = 0$ | | | | |
| $\tau^k$ | 0.5 | 0 | 0 | 0 | 0 |
| $\tau^n$ | 0.24 | 0.30 | 0.22 | 0.14 | 0.07 |
| Aggregate ECC | 0 | 0.2% | 1.0% | 1.5% | 1.9% |
| | Single asset economy | | | | |
| $\tau^k$ | 0.5 | 0 | 0 | 0 | 0 |
| $\tau^n$ | 0.18 | 0.30 | 0.20 | 0.11 | 0.01 |
| Aggregate ECC | 0 | −0.1% | 1.0% | 1.8% | 2.4% |

Table 3: Tax rates and aggregate equivalent consumption compensation in the different reforms.

Let us first discuss the tax rates in the different reforms. Obviously, abolishing capital income taxation without introducing a tax on consumption leads to substantially higher labor income tax rate than in the status quo. The difference is much larger in the single asset economy where the tax base of the capital income tax is roughly twice as large as in the two asset economy. Similarly, the comparison of the different columns involving a consumption tax in table 3 shows that setting a higher consumption tax rate always leads to lower tax rate on labor income. Again the differences are bigger in the single asset economy. Actually, setting $\tau^c = 30\%$ almost allows abolishing the labor income tax altogether.

Comparison between the two different reforms in the two asset economy shows that the reform with $\tau^c = \tau^h$ always allows for a somewhat larger reduction in the labor income tax rate than a reform with the same $\tau^c$ but $\tau^h = 0$. However, the differences are quite small. Residential construction accounts only for a small fraction of overall housing consumption which means that the tax base of the tax on residential construction is quite small.

Thinking about the efficiency gains is straightforward with a single asset and a single composite consumption good: a higher tax rate on consumption always implies that a larger share of the tax burden falls on existing capital. Because a tax on the existing capital is non-distortionary, the efficiency gains will be largest when the labor income taxation is entirely replaced by consumption taxation. With two assets and two consumption goods, the interpretation is less straightforward. This is because housing wealth and financial wealth are not subject to the capital levy in the same manner. In addition, depending on the details of the tax reforms, relative prices may change. For instance, when setting a tax on non-housing consumption and residential construction, the government does not change the relative price of consumption.

Figure 1 shows the transitional dynamics (relative to the initial steady state) of aggregate housing, business capital and labor supply in the two asset economy following a reform which sets $\tau^k = 0$ and $\tau^c = \tau^h = 0.2$. Business capital increases on impact while housing capital is reduced. This asymmetry follows from the abolishment of the capital income tax which leads to large temporary increase in the interest rate. As financial wealth delivers temporarily abnormally high returns relative to investment in housing wealth, households trade off housing wealth to financial wealth. After the impact effect both housing capital and business capital gradually increase towards a new higher steady state level. This is because of the capital levy which is essentially a lump sum tax and therefore reduces the distortions caused by the tax system.

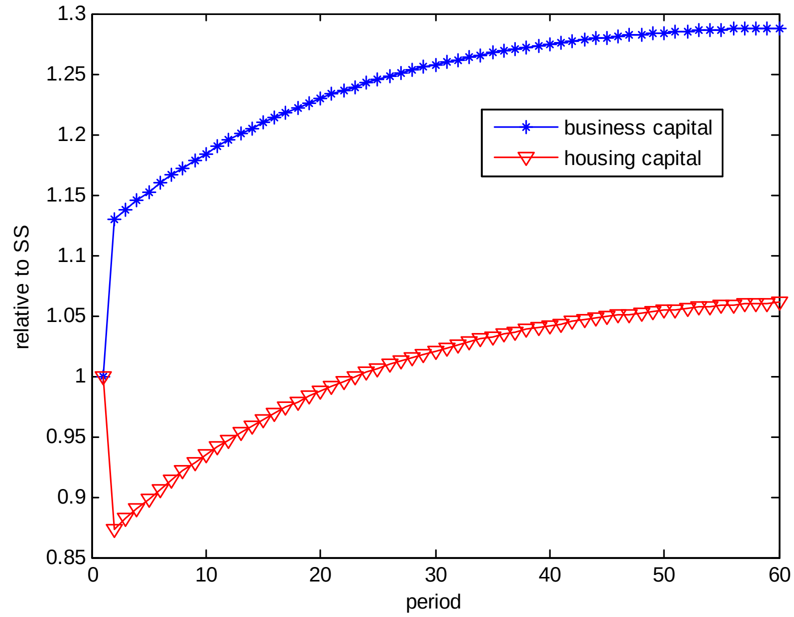


Figure 1: Aggregate dynamics relative to the initial steady state in the two asset economy with tax reform $\tau^c = \tau^h = 0.2$.

We next consider the distributional effects of the reforms. In a single asset economy with a single consumption good, the welfare effects for different household types will depend on their wealth-to-earnings ratio. The intuition is straightforward: those that have high earnings relative to wealth are not hit by the capital levy but benefit from higher net wage due to lower labor income tax rate. In constrast, those with a lot of wealth relative to earnings are hit by the capital levy but do not benefit from the reduced tax burden on labor.

In a two asset economy with two consumption goods, the mechanisms are less straightforward. As discussed above, the capital levy does not apply to housing wealth, at least not in the same way it applies to financial wealth. However, distributional effects may also depend on house price effects.

Figure 2 shows the equivalent consumption compensation (in terms of non-housing consumption) for the different reforms discussed above and all different household types. The top panel of the figure shows the reforms with $\tau^c = \tau^h$. The middle panel shows the reforms for which $\tau^h = 0$ and the bottom panel shows the results for the single asset economy. Each panel shows four different cases for each household type: the different bars from left to right relate to the cases from $\tau^c = 0$ to $\tau^c = 0.3$.

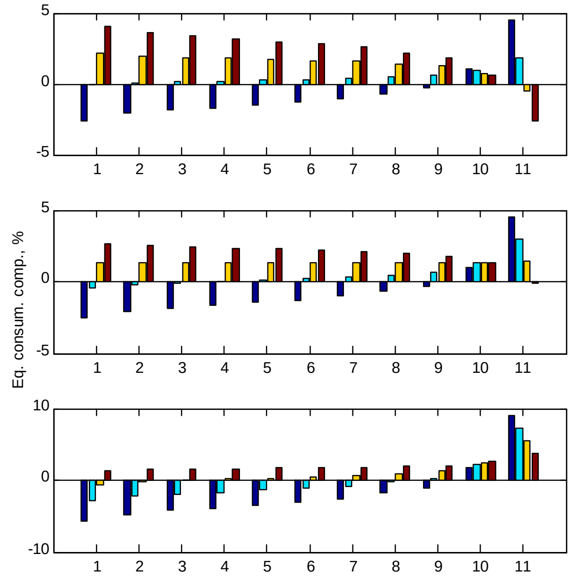


Figure 2: Welfare effects

When considering the two asset economy (top and middle panels), in all cases, most households are harmed by the first reform which abolishes the capital income taxation but does not set a tax on consumption. The main reason is that most households do not have much financial wealth and for these households the direct effect of the reform is lower after-tax wage rate. In addition, households with negative financial wealth are hurt be the temporary increase in the after-tax interest rate that follows the reforms. However, since the business capital stock increases following the reform, the wage rate also increases. These general equilibrium effects are not, however, strong enough to overturn the negative effects of the reform for the first eight net wealth deciles.

However, the two panels also show that increasing the tax rate on consumption quickly reduces the regressivity of the reform and a high enough consumption tax rate makes it progressive. This is especially true in the case where residential construction is also taxed (top panel). When the consumption tax rate is at least 0.2, it is the poorer households that benefit the most while the top one percent of the households are harmed by the reform. The reason is that poorer households have a higher earnings-to-financial wealth ratio than wealthier households. Hence, while they benefit from the lower labor income tax rate, they are not much affected by the capital levy. Since wealth is very unevenly distributed, the very wealthiest households effectively pay most of the capital levy. The results are similar but somewhat less progressive in the case where housing construction is not taxed. The reason is likely to be related to the fact that the tax on residential construction increases the house price level.

The result that increasing the consumption tax rate makes the reform more progressive is in line with Correia (2010). However, it is interesting to compare the results from the two asset model to those of the single asset model. In the single asset case, the welfare of the poorer households is never increased substantially while households in the top one percent of the total wealth distribution are better off following the reform even when the reform involves increasing the consumption tax rate to 0.3.

# 6 Conclusions and what next

We have studied the distributional effects of tax reforms that consist of increasing consumption taxation and lowering labor income taxation. Our preliminary results suggest that the special role of housing wealth makes such tax reforms much more progressive than what one would expect based on a model with a single asset. However, both the distributional and efficiency implications of the tax reforms depend on the tax treatment of housing.

The results of the paper are preliminary and only highlight some cases. We plan to extend the analysis into several directions. Perhaps most importantly, we wish to consider different assumptions regarding the elasticity of housing supply. When housing supply is inelastic, changes in aggregate housing demand will be capitalized into house prices. An inelastic housing supply also affects interest and wage effects by slowing down the adjustment of the business capital stock relative to the case where housing capital can be converted to business capital. These effects might be important for both the efficiency and distributional results.

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# Appendix

This appendix first describes the household problem and shows how the productivity distribution is inferred using the housing and financial wealth distributions in the data. After that it discusses the non-existence of a representative household. Finally, it shows that the inferred productivity distribution is nevertheless consistent with a representative household in the model economy without housing.

## The household problem

Consider the maximization problem of household $i$ in period 1. The problem can be written as

$$\max_{\{c_{i,t},n_{i,t},h_{i,t+1},a_{i,t+1}\}} \sum_{t=1}^{\infty} \beta^{j-1} u\left(c_{i,t}, n_{i,t}, h_{i,t}\right) \tag{7}$$

subject to

$$\left(1+\tau_t^c\right) c_{i,t} + \left(1+\tau_t^h\right) q_t h_{i,t+1} + a_{i,t+1} = \left(1-\tau_t^n\right) w_t \epsilon_i n_{i,t} + R_t a_{i,t} + \left(1+\tau_t^h\right) q_t \left(1-\delta_h\right) h_{i,t} \tag{8}$$

where

$$R_t = 1 + \left(1-\tau^a\right) r_t.$$

Maximizing (7) subject to (8) leads to the first-order conditions

$$c_{i,t} \ : \ \beta^{t-1} u_{c_{i,t}} - \lambda_t \left(1+\tau_t^c\right) = 0 \tag{9}$$

$$n_{i,t} \ : \ \beta^{t-1} u_{n_{i,t}} + \lambda_t \left(1-\tau_t^n\right) w_t \epsilon_i = 0 \tag{10}$$

$$h_{i,t+1} \ : \ \beta^{t} u_{h_{i,t+1}} - \lambda_t \left(1+\tau_t^h\right) q_t + \lambda_{t+1} \left(1+\tau_{t+1}^h\right) q_{t+1} \left(1-\delta_h\right) = 0 \tag{11}$$

$$a_{i,t+1} \ : \ \lambda_t - \lambda_{t+1} R_{t+1} = 0 \tag{12}$$

Plugging (9) into (10) and (11) and using (12) allows one to reformulate the first-order conditions as

$$\frac{u_{n_{i,t}}}{u_{c_{i,t}}} = -\frac{\left(1-\tau_t^n\right) w_t \epsilon_i}{\left(1+\tau_t^c\right)} \tag{13}$$

and

$$\frac{u_{c_{i,t}}}{u_{h_{i,t}}} = \frac{1+\tau_t^c}{\left(1+\tau_{t-1}^h\right) q_{t-1} R_t - \left(1+\tau_t^h\right) q_t \left(1-\delta_h\right)} \text{ for all } t > 1 \tag{14}$$

Taking into account that

$$u\left(c_{i,t}, n_{i,t}, h_{i,t}\right) = \frac{\left(C_{i,t} - \chi n_{i,t}^{\varphi}\right)^{1-\sigma}}{1-\sigma}$$

where

$$C_{i,t} = \left(\gamma c_{i,t}^r + (1-\gamma) h_{i,t}^r\right)^{\frac{1}{r}},$$

allows writing the marginal utilities as

$$\begin{aligned}
u_{c_{i,t}} &= \left(C_{i,t} - \chi n_{i,t}^{\varphi}\right)^{-\sigma} \left(\gamma c_{i,t}^r + (1-\gamma) h_{i,t}^r\right)^{\frac{1-r}{r}} \gamma c_{i,t}^{r-1} \\
u_{h_{i,t}} &= \left(C_{i,t} - \chi n_{i,t}^{\varphi}\right)^{-\sigma} \left(\gamma c_{i,t}^r + (1-\gamma) h_{i,t}^r\right)^{\frac{1-r}{r}} (1-\gamma) h_{i,t}^{r-1} \\
u_{n_{i,t}} &= -\left(C_{i,t} - \chi n_{i,t}^{\varphi}\right)^{-\sigma} \chi \varphi n_{i,t}^{\varphi-1}
\end{aligned}$$

Plugging $u_{c_{i,t}}$ and $u_{h_{i,t}}$ into (14) gives

$$\frac{h_{i,t}}{c_{i,t}} = \left[\frac{(1-\gamma)}{\gamma} \frac{1+\tau_t^c}{\left(1+\tau_{t-1}^h\right) q_{t-1} R_t - \left(1+\tau_t^h\right) q_t \left(1-\delta_h\right)}\right]^{\frac{1}{1-r}} \equiv A_t \text{ for all } t > 1. \tag{15}$$

## Steady state

Consider then a steady state with constant prices and tax rates. This means that

$$\frac{h_i}{c_i} = A.$$

That is, the ratio of housing-to-non-housing consumption only depends on the relative prices and is independent of the asset position and productivity of the household. In addition, plugging the expressions for marginal utility into (13) gives

$$\begin{aligned}
\frac{n_i^{\varphi-1}}{\left(\gamma c_i^r + (1-\gamma) h_i^r\right)^{\frac{1-r}{r}} c_i^{r-1}} &= \frac{\gamma\left(1-\tau^n\right) w \epsilon_i}{\chi \varphi\left(1+\tau^c\right)} \\
n_i^{\varphi-1} &= \frac{\gamma\left(1-\tau^n\right) w \epsilon_i}{\chi \varphi\left(1+\tau^c\right)} \left(\gamma + (1-\gamma)\left(\frac{h_i}{c_i}\right)^r\right)^{\frac{1-r}{r}} \\
n_i &= B \epsilon_i^{\frac{1}{\varphi-1}}
\end{aligned} \tag{16}$$

where

$$B=\left\{\frac{\gamma\left(1-\tau^{n}\right)w_{t}}{\chi\varphi\left(1+\tau^{c}\right)}\left[\left(\gamma+\left(1-\gamma\right)\left(A\right)^{r}\right)\right]^{\frac{1-r}{r}}\right\}^{\frac{1}{\varphi-1}}.$$

As a result, for each type, efficient labor is linear in $\epsilon_i^{\frac{\varphi}{\varphi-1}}$ and aggregate efficient labor is

$$n=B\sum_{1=i}^{I}\eta_{i}\epsilon_{i}^{\frac{\varphi}{\varphi-1}}.$$

It therefore straighforward that the determination of the steady state prices it is sufficient to consider a representative household with $\overline{\epsilon}=1$ provided the distribution of labor productivities satisfies

$$\sum_{1=i}^{I}\eta_{i}\epsilon_{i}^{\frac{\varphi}{\varphi-1}}=1. \tag{17}$$

## Inferring productivity distribution

Rewriting the periodic budget constraint taking into account that $h_i=h_{i,1}$ and $a_i=a_{i,1}$, it follows that

$$\left(1+\tau^{c}\right)c_{i}=\left(1-\tau^{n}\right)w\epsilon_{i}n_{i}+\left(R-1\right)a_{i}+\left(1+\tau^{h}\right)q\left(1-\delta_{h}\right)h_{i}-\left(1+\tau^{h}\right)qh_{i}$$

Taking into account (15), further implies that

$$\left(1-\tau^{n}\right)w\epsilon_{i}n_{i}=\left[\frac{1+\tau^{c}}{A}+\left(1+\tau^{h}\right)q-\left(1+\tau^{h}\right)q\left(1-\delta_{h}\right)\right]h_{i}-\left(R-1\right)a_{i}.$$

By using (16) and rearranging this becomes

$$\begin{aligned}\left(1-\tau^{n}\right)w\epsilon_{i}B\epsilon_{i}^{\frac{1}{\varphi-1}} &= \left[\frac{1+\tau^{c}}{A}+\left(1+\tau^{h}\right)q\delta_{h}\right]h_{i}-\left(R-1\right)a_{i}\\ &\Longleftrightarrow\\ \epsilon_{i}^{\frac{\varphi}{\varphi-1}} &= \frac{1}{\left(1-\tau^{n}\right)wB}\left\{\left[\frac{1+\tau^{c}}{A}+\left(1+\tau^{h}\right)q\delta_{h}\right]h_{i}-\left(R-1\right)a_{i}\right\} \qquad (18)\end{aligned}$$

where

$$\begin{aligned}A &= \left[\frac{\left(1-\gamma\right)}{\gamma}\frac{1+\tau^{c}}{\left(1+\tau^{h}\right)q\left[R-\left(1-\delta_{h}\right)\right]}\right]^{\frac{1}{1-r}}\\ B &= \left\{\frac{\gamma\left(1-\tau^{n}\right)w}{\chi\varphi\left(1+\tau^{c}\right)}\left[\left(\gamma+\left(1-\gamma\right)\left(A\right)^{r}\right)\right]^{\frac{1-r}{r}}\right\}^{\frac{1}{\varphi-1}}\end{aligned}$$

Given the distribution of relative housing and financial wealth as well as the preference parameteres, condition (18) determines the distribution of relative productivities in the model.

It is straightforward to show that this productivity distribution satisfies (17). Note first that for the representative household with $\overline{\epsilon} = 1$, $\overline{h} = \sum_{1=i}^{I} \eta_i h_i$ and $\overline{a} = \sum_{1=i}^{I} \eta_i a_i$ condition (18) states that

$$\frac{1}{\left(1-\tau^{n}\right) Bw}\left[\left(\frac{1+\tau^{c}}{A}+\left(1+\tau^{h}\right) q\delta_{h}\right)\overline{h}-\left(R-1\right)\overline{a}\right]=1. \tag{19}$$

In addition, by (18)

$$\begin{aligned}\sum_{1=i}^{I}\eta_i\epsilon_i^{\frac{\varphi}{\varphi-1}} &= \frac{1}{\left(1-\tau^{n}\right) Bw}\left[\left(\frac{1+\tau^{c}}{A}+\left(1+\tau^{h}\right) q\delta_{h}\right)\sum_{1=i}^{I}\eta_i h_{i,1}-\left(R-1\right)\sum_{1=i}^{I}\eta_i a_{i,1}\right] \\ &= \frac{1}{\left(1-\tau^{n}\right) Bw}\left[\left(\frac{1+\tau^{c}}{A}+\left(1+\tau^{h}\right) q\delta_{h}\right)\overline{h}-\left(R-1\right)\overline{a}\right]=1 \end{aligned} \tag{20}$$

where the last line uses (19).