How to tax housing? Property versus rental taxation*

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Abstract

Starting from the problem of a local government raising taxes to finance its expenditures, we investigate the welfare effects of different housing taxation instruments local governments have at hand, to derive an optimal tax mix. We mainly focus on property tax and rental income tax, in a model featuring both a rental and an owner-occupied housing sector, allowing for imperfect pass-through of the rental tax burden from landlords onto renters.

We analyze budget-neutral reforms that raise property taxes while lowering rental income taxes. Owners face a welfare loss from higher property taxes, partly offset by lower housing prices that reduce the tax base. Renters' welfare effects depend on the extent to which landlords pass rental taxes onto tenants: higher property taxes increase rental burdens, but these are offset by reductions in rental income taxes and lower housing prices; the net effect on renters is ultimately shaped by the pass-through of the tax burden from landlords onto renters.

Eventually, using a tractable application of the model, we characterize how the optimal tax mix varies with the pass-through rate on renters. The optimal property tax is zero when pass-through is low, rising monotonically as pass-through increases. The optimal rental income tax follows an inverse U-shape, increasing at low pass-through—when renters face limited incidence and the optimal property tax is zero—then declining at high pass-through where incidence shifts onto tenants. Under certain conditions, subsidizing rental housing through negative rental income taxation can be optimal at high pass-through levels.

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1 Introduction

Financing local governments' expenditures is a central concern in public finance, particularly during periods of fiscal tightening. In most developed economies, local governments rely heavily on housing and land taxation to fund services[1]. While the literature has extensively studied the optimal provision of local public goods and the effects of housing policy programs, comparatively little attention has been paid to the design of local tax instruments—with their full welfare implications—using the tools of modern public economics. In particular, heterogeneity in housing tenure—between owners and renters within the same locality—poses distinct challenges for the design and incidence of housing taxation. Understanding how local tax instruments affect welfare, how they are passed through to households, and how they interact with the housing market is crucial for assessing their efficiency and equity. This paper aims to shed light on these issues and to characterize the optimal local housing tax mix in the presence of housing tenure heterogeneity.

Housing taxation can take various forms. The most common is the property tax (e.g., *taxe foncière* in France), typically levied as a proportion of an estimated property value.[2] Rental housing, by contrast, may also be subject to taxation through levies on landlords' rental income for instance. While other housing-related taxes exist—such as user-based taxes (e.g., *taxe d'habitation*, largely phased out in France) or taxes on land and capital gains—this paper focuses on the two central instruments associated with tenure status: property taxes and rental income taxation. The analysis is restricted to residential housing markets and abstracts from multi-property ownership, which raises distinct issues related to wealth taxation, as well as other forms of local taxation that have been studied elsewhere (e.g., George 1879; Poterba 1984; Bonnet et al. 2021). This focus allows us to isolate the differential effects of these two forms of taxation within local housing markets.

Understanding the welfare implications of housing tax instruments requires careful attention to their economic incidence. Indeed, statutory incidence - who legally pays taxes - often differs from effective economic incidence - who bears the economic burden of taxation. This distinction is particularly relevant in housing markets, where households may either own or rent their dwellings. Owner-occupiers typically pay property taxes directly, but for rental units, the statutory burden often falls on landlords, who may partially or fully pass the tax on to tenants. The extent of this pass-through is a central determinant of the welfare effects of rental taxation. These considerations are especially salient for local taxes, since landlords and tenants may differ systematically—both geographically and socioeconomically. Accordingly, a key focus of this paper is the welfare implication of the distribution of the tax burden between landlords and renters, and therefore its interaction with the optimal tax mix.

To explore these dynamics and their welfare implications, we consider a static partial equilibrium model in which agents derive utility from non-durable (numéraire) consumption, housing,

[1] Property taxes account for approximately 73% of local tax revenue in the United States (U.S. Census Bureau, 2006).

[2] Note that in a country like France, property values for tax purposes are administratively assessed and may deviate substantially from market values. We abstract from this consideration in this study.

and wealth transmission. The model features both owner-occupied and rental housing markets, a local construction sector composed of investor firms (endogenizing housing prices), and a local government that uses property and rental taxation as revenue tools. Crucially, we allow for flexible, imperfect, tax pass-through in the rental sector, generating potentially non-standard incidence patterns.

Within this framework, we analyze budget-neutral tax reforms. To this end, we study a property tax change, and the subsequent mechanical adjustment of the rental income tax, to keep budget balanced. We derive and decompose the aggregate welfare impact—accounting for both the direct effect and the indirect effect via the mechanical adjustment of the rental tax rate. We show how the mechanical adjustment of the rental tax rate depends on the responsiveness of housing prices and quantities, which in turn affect the tax base. Specifically, when the tax base is highly sensitive to property taxation but less responsive to rental taxation, a given increase in the property tax raises less revenue and requires a smaller reduction in the rental tax rate to maintain budget neutrality.

We eventually provide a non-functional theoretical expression for the aggregate welfare effect, which highlights key channels. Following a marginal property tax increase, owner-occupiers suffer a mechanical welfare loss, due to the impact of the tax increase on their budget, and a mitigating net price effect. Indeed, a marginal increase in the property tax rate may lead to a decrease in housing prices, therefore deflating the value of the property tax base of owner-occupiers. Furthermore, the associated decrease in the rental income tax rate may also lead to lower housing prices, further contributing to this mitigating net price effect. Overall, these lower prices would alleviate the tax burden of the owner-occupiers by decreasing the value of the tax base. Then, the effect on renters goes through the change in their real tax burden. It is made of the reaction of the aggregate burden on rental housing to a property tax increase, both through a direct effect and a mitigating net price effect, as for owner-occupiers. It is then complemented by the effect of a subsequent rental income tax decrease, made of a direct channel and a strengthening price effect. Indeed, lower rental income tax rates mechanically reduce the tax burden on rental housing. This effect is even more important if it implies a decrease in housing prices. Eventually, this overall effect is scaled by the pass-through of rental taxation from landlords onto renters, to become the real tax burden adjustment which is affecting the welfare of renters. Indeed, if the pass-through rate is 0, then renters *effectively* pay no tax, and tax reforms do not impact their welfare in any way.

We then propose a quantitative application using specific functional forms for preferences and construction costs. The model is simulated to characterize the optimal tax mix and its sensitivity to the pass-through of rental housing taxation from landlords onto renters, which is captured by a parameter α. We find that the optimal property tax rate is steadily equal to zero for low pass-through, and increases monotonically with higher values of α, while the rental tax rate follows an inverted U-shape: initially rising with pass-through, then declining. This reflects a key trade-off: higher pass-through increases renters' direct tax burden, negatively affecting their welfare, but also amplifies their behavioral response, requiring offsetting tax adjustments. Indeed, as they pay a higher share of the tax burden, they have to reduce the size of their dwellings. This contraction shrinks the rental tax base and government revenue, creating pressure for offsetting tax adjustments. When it is suboptimal to raise the property tax—typically at low pass-through—the government must rely on increasing rental taxation. At higher pass-through levels, however, the welfare cost to renters dominates, making it optimal to increase property taxes while lowering rental income taxes.

We further show that the optimal mix leans more heavily on property taxation when housing prices are more elastic, renters are assigned higher welfare weights, or fiscal pressure is lower. Indeed, higher price elasticity strengthens the mitigating net price effect of a property tax increase, making it relatively less harmful for owner-occupiers. In some cases, and when these conditions are met, the optimal policy includes a negative rental tax rate, effectively subsidizing rental housing. This crucially requires low fiscal pressure, so that it is affordable for the government, and high enough relative welfare weights on renters, such that it is welfare relevant.

As a final step, we extend the analysis by allowing the local government to directly tax the construction sector. This extension enables us to assess how the introduction of an upstream tax instrument affects the optimal housing tax mix. We find that, under plausible conditions, it becomes optimal to tax construction while subsidizing rental housing. In this scenario, the optimal property tax rate is always zero. The construction tax acts like a "free lunch" for the government—raising revenue that can be used to subsidize renters and maintain a zero property tax rate.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 introduces the model setup, and Section 4 presents its solution and individual welfare analysis. Section 5 analyzes the aggregate welfare implications of budget-neutral housing tax reforms. Section 6 and 7 develop a tractable version of the model, and present numerical simulations to characterize optimal tax rates. Section 8 discusses the incidence and determinants of tax pass-through in the rental housing sector. Finally, Section 9 extends the analysis by exploring the implications of taxing the construction sector directly.

2 Related Literature

This study relates to different strands of literature. First, by its focus on local housing taxation, it relates to the literature studying the theory of property and housing taxation, originally linked to debates surrounding land taxation. The foundational ideas date back to classical economists such as Henry George (1879), who famously argued for taxing land values due to their unearned and inelastic nature. Modern treatments of this question, including Mieszkowski (1972) and Zodrow (2001), explore the efficiency and incidence of property taxation under a variety of assumptions about housing supply, mobility, and local government behavior.

Relatedly, a large body of work builds on the early contribution of the Tiebout (1956) model, which conceptualizes individuals as sorting across jurisdictions based on local bundles of taxes and public services. In this framework, property taxes serve not just as a revenue tool but also as a mechanism for shaping spatial sorting and interjurisdictional competition. The theory of local public goods is central to this discussion: jurisdictions that offer a more attractive combination of taxes and services can attract higher-income households, thereby competing for residents. Hamilton (1975, 1976) extended this model, showing that under perfect mobility and a fixed housing supply, property taxes are fully capitalized into house prices, which implies that property taxes are non-distortionary. However, relaxing these assumptions introduces regressivity and incidence effects, particularly when renters and owners face different burdens.

This classical framework has been extended to examine the effects of various components of housing taxation, such as land, structures, and rental income, on investment decisions, housing supply, and tenure outcomes. Studies by Oates and Schwab (1997) and Palmon and Smith (1998) show how the burden of property taxes can shift between owners and renters depending on supply elasticities and institutional features, highlighting the complex distributional consequences of property tax systems. We build on this literature by focusing on local property taxes and their implications for both owner-occupied and rental housing markets. Our work departs from the classical tradition by explicitly incorporating rental housing and corresponding taxation and allowing for imperfect pass-through of rental taxes, as well as building on more recent model developments. This enables us to study the distributional effects of local taxes more thoroughly, particularly in the context of tenure heterogeneity.

We also draw on the more recent literature on housing as an asset and optimal taxation. A seminal contribution to this literature is Poterba (1984), who introduced an asset-market perspective on owner-occupied housing, emphasizing its dual role as both a consumption good and an investment vehicle. Subsequent contributions embedded housing in dynamic general equilibrium models with heterogeneous agents to explore long-run efficiency and equity trade-offs. Skinner (1996) and Gervais (2002) investigated whether housing should be taxed like other forms of capital and how consumption-based versus investment-based taxation affects welfare. More recently, Eerola and Maattanen (2013) and Nakajima (2020) explored optimal taxation of housing versus non-housing capital, under different model specifications. These models typically aim to characterize efficient and equitable tax systems in the long run.

A recent contribution by Kragh-Sørensen (2022) quantifies the welfare effects of shifting the tax burden from capital income to housing, showing that such a reform can increase labor supply and redistribute resources toward younger and lower-income households. However, this line of work rarely addresses rental housing or local taxation, instead focusing on national-level tax design. Our work shares with this literature the focus on housing's dual role and concern for tax efficiency and equity, but departs from it by explicitly incorporating rental housing and local governments, which are central to the actual implementation of housing taxes. We also account for the impact of potentially non-standard tax incidence.

A third set of contributions evaluates existing housing tax policies and their distributional and behavioral consequences. The U.S. mortgage interest deduction is often studied, as in Sommer and Sullivan (2018) estimating its impact on prices, rents, tenure, and welfare. Chambers et al. (2009) study the effect of differential tax treatment for owner-occupied and rental housing in a model with endogenous tenure choice and progressive income taxation. They show that favoring homeownership can distort investment and worsen income inequality. These studies underscore the importance of housing taxation for both aggregate outcomes and distributional equity. However, they typically take observed tax instruments as given and do not analyze the optimal design of local tax systems, especially under imperfect tax pass-through or endogenous housing market responses.

Our contribution lies in explicitly modeling a richer local housing market that incorporates both owner-occupied and rental housing, allows for imperfect pass-through of rental taxes, and studies the optimal local tax mix under these conditions. This enables us to better understand how housing market features, tenure status, and tax design interact in a local context—precisely where housing taxes are determined and implemented. In contrast, much of the existing literature abstracts from meaningful distinctions between owner-occupied and rental housing, often treating housing as a homogeneous good or assuming perfect substitution and full tax pass-through. In some cases, rental housing is implicitly modeled as equivalent to owner-occupied housing, thereby avoiding tenure-specific institutional frictions and distributional implications. However, when rental housing is directly taxed and pass-through to tenants is potentially incomplete, such simplifications become untenable. This calls for a more detailed framework that explicitly distinguishes tenure types, allows for differential tax treatment, and models the allocative and distributional effects of partial tax shifting. Our framework addresses this gap and yields novel insights for the design of equitable and efficient local housing tax systems.

3 Model and Set Up

We study a local jurisdiction inhabited by a unit mass of households who derive utility from the consumption of a non-durable numéraire good and from housing services. In addition, they derive utility from holding wealth in the future, as in Hellwig and Werquin (2024) or Coven (2024). This can be rationalized in several ways, including a bequest motive or simply future utility from savings[3] All households consume the same non-durable good, but they differ in their access to housing services. A share $1-\phi$ of them are owner-occupiers, while the remaining share ϕ rent their dwelling from investor-landlords. This housing tenure status is exogenous and does not depend on the household's choices. Households choose only the quality-adjusted quantity (or size) of housing services they consume, but not the tenure type. As a result, they face two distinct optimization problems.

[3]As it generates income for future consumption or relax credit constraints.

3.1 Housing stock, prices and taxes

Consequently, there are two types of housing services: owner-occupied housing H_O, which is priced at P, and rental housing H_R, the price of which is normalized to 1.[4]

Every housing unit is taxed, proportionally to its value, at a rate τ_O. This can be seen as a standard property tax rate. Furthermore, every rental housing unit is paying an additional tax rate τ_R, on rental revenue. Because the rental housing units are therefore subject to an overall tax burden $\tau_O P + \tau_R$, it is essential to understand who *effectively* bears it between the landlord or the tenant. If these taxes are formally paid by the landlords, their effective incidence is based on the respective bargaining power of landlords and tenants. This is captured by a parameter α, indicating the share of the total due taxes that the landlords pass on to the tenants. As a result, the effective tax rate for renters is $\widetilde{\tau_R} = \alpha(\tau_O P + \tau_R)$. This can be rationalized by thinking about it as a Nash bargaining process between landlords and their tenants over the rental tax burden[5], which will be discussed more in-depth in section 8.

3.2 Owner-occupiers Problem

There are two types of households in this economy : owner-occupiers and renters. Let us start with the problem of owner-occupiers, living in a house they own after buying it at a price $P \equiv P(\tau_O, \tau_R)$. We use this expression for the price here to explicit its sensitivity to both taxes, but will then drop it for readability purposes. As we introduced earlier, they derive utility from numéraire consumption and housing in the present, through a standard concave utility function $U(C, H)$. They additional gain utility from holding wealth in the future, through a future utility (or bequest) function $B(W)$, also assumed to be concave. Owner-occupiers are faced with the following problem :

$$V_O(Y, A_O, h_O) = \max_{A_O, h_O} U(C_O, h_O) + \beta B(W) \tag{1}$$

$$\text{s.t. } C_O + A_O + (1 + \tau_O)P(\tau_O, \tau_R)h_O = Y \tag{2}$$

$$W = (1 + r)A + P(\tau_O, \tau_R)h_O(1 - \delta) \tag{3}$$

They maximize their utility, choosing levels of savings A_O, non-durable consumption C_O and housing h_O, to keep their budget balanced with their exogenous endowment level Y. Future wealth is composed of two elements : the (net of depreciation) housing stock that is transmitted to the future, and savings in a safe asset A, yielding a return $(1+r)$. Note that h_O matters both today, as

[4]The price P can therefore be interpreted as a relative price; only the ratio of these two prices will matter.
[5]See Appendix E1

it yields utility from owning a house, and tomorrow, as it provides additional wealth. This feature allows us to capture the multifunctional nature of housing, which "is held for the dual purpose of consumption and savings" (Nakajima, 2020).

3.3 Renters problem

On the other hand, renters live as tenants in the housing unit they rent. As a result, they do not own it, which has a major implication in terms of wealth : it is not transmitted into future wealth. Therefore, their future wealth is only made of their asset savings. The tenants have to choose consumption C_R, savings A_R, and quality-adjusted rental housing services h_R, whose price is normalized to 1 as mentioned earlier. Finally, rental housing is taxed at an effective rate $\widetilde{\tau_R} = \alpha(\tau_R + \tau_O P)$. Their problem therefore writes as :

$$V_R(Y, A_R, h_R) = \max_{A_R, h_R} U(C_R, h_R) + \beta B(W_R) \tag{4}$$

$$\text{s.t. } C_R + A_R + (1 + \widetilde{\tau_R})h_R = Y \tag{5}$$

$$W_R = (1 + r)A_R \tag{6}$$

The expression for their wealth comes from the absence of transmission of housing to next period. Their problem is therefore really close to the owner-occupiers' problem, except that they only benefit from one aspect of the multifunctional nature of housing : its direct utility component. We should also note that taxes enter their problem only indirectly, through the real tax rate $\widetilde{\tau_R}$, that is passed on them by their landlords. This real tax burden depends both directly on these taxes, and indirectly via the potential price adjustment they may induce.

3.4 Housing sector

Housing demand

Let us introduce heterogeneity in the endowments of owner-occupiers and tenants. If they respectively represent a share $1-\phi$ and ϕ of the population, we assume this share to be a priori uncorrelated with the endowment's distribution. Let then the distribution of endowment among owner-occupiers be $F_O(Y)$, and $F_R(Y)$ the distribution among the population of renters. Because the individual housing choice will depend on the endowment level Y we can denote them $h_O \equiv h_O(Y, \zeta)$ and $h_R \equiv h_R(Y, \zeta)$, where ζ represents all other determinants of housing choice. Let then the aggregate housing demands be respectively :

$$H_O = \int h_O(Y, \zeta) dF_O(Y)$$

and

$$H_R = \int h_R(Y, \zeta) dF_R(Y)$$

Construction firm

The total housing stock is therefore $H = (1 - \phi)H_O + \phi H_R$. It is initially owned and constructed by an investor construction firm that has two roles : (1) it is building the housing stock H to face demand, and (2) it is deciding the amount to sell to owner-occupiers (H_O) and the stock it keeps to rent, as a landlord, to some tenants (H_R). Internalizing housing demand, from the aggregation of the solutions of the households' problem, their profits can be written as a function of prices as :

$$\pi(P) = P(1 - \phi)H_O + (1 - \widetilde{\tau}_I)\phi H_R - c(H) \tag{7}$$

Indeed, they sell H_O to the proportion $(1 - \phi)$ of owner-occupiers, at a price P, and rent H_R to a proportion ϕ of tenants. In this case, they pay a real tax rate $\widetilde{\tau}_I = (1 - \alpha)(\tau_O P + \tau_R)$ on the rental housing unit. Indeed, they pay the share of the rental tax burden that is not passed onto the renters, that is $1 - \alpha$.

Furthermore, following Favilukis (2017) and Kragh-Sorensen (2022), the price is set such that firm's profit is zero. This zero profit condition derives from the assumption of free-entry on the construction sector market, which prevents permanent positive profit.[6] The induced endogenous price elasticity to taxes will mechanically derive from equation 7, and is fully derived in Appendix A. Finally, this firm is seen as an investor that comes from outside the local jurisdiction, or is at least owned from abroad (as in Floettoto et al., 2016). As a result, the government does not take into account the potential welfare implications on (foreign) investors of its tax policy.

3.5 Government problem and budget constraint

The local government needs to raise a monetary amount of tax revenue equal to its expenditure level G, to finance its diverse activities and provisions. It levies the two taxes presented earlier : property tax and rental income tax. Therefore, the government budget constraint (GBC) is :

$$G = \tau_O P H + \tau_R \phi H_R \tag{8}$$

[6] This is a standard assumption in the urban economics literature, such as Duranton and Puga (2015)

where PH is the total value of the housing stock, subject to property taxation, and ϕH_R is the aggregate rental revenues in the economy (recalling that the net-of-tax rent is normalized to 1), subject to rental income taxation.

4 Solutions and individual-level welfare implications of tax changes

Now that we have introduced the set up of the model economy, let us derive theoretical solutions to the owners' and renters' problem, and use them to compute the direct welfare effects of marginal tax adjustments. It will then allow us to study the aggregate welfare implications of a property tax reform, in section 5. From this section on, let us drop the indices on the variables of interest, for the sake of clarity and readability.

4.1 Owner-occupiers

Solution of the problem

Owner-occupiers are faced with the problem introduced in equation 1. Maximizing their utility, with respect to A_O and h_O, and integrating the budget constraint, yields the following first-order conditions :

$$\begin{cases} U'_C(C_O, h_O) = \beta B'(W)(1+r) & (9) \\ (1+\tau_O)PU'_C(C_O, h_O) = U'_H(C_O, h_O) + \beta B'(W)P(1-\delta) & (10) \end{cases}$$

This allows us to re-write an interesting trade-off condition between nondurable consumption and housing :

$$PU'_C(C_O, h_O)\left(\tau_O + \frac{\delta + r}{1+r}\right) = U'_H(C_O, h_O) \tag{11}$$

It appears clearly that, as long as utility is concave, housing consumption is decreasing with price P, the depreciation rate δ, the safe asset interest rate r[7], and the property tax τ_O. Overall, the term $P\left(\tau_O + \frac{\delta+r}{1+r}\right)$ can be seen as the net present cost of housing, and the right-side parenthesis is therefore the net marginal cost. Indeed, each value-adjusted property PH is taxed at a rate τ_O in the present period, before being depreciated by δ in the future. In the future, it also yields no additional revenue, while the safe asset yields r. Eventually, the last two discounting elements are adjusted by $(1+r)$ to obtain a net present value of the discounting net marginal cost multiplicator. We can also write a forward-looking trade-off equation for housing and wealth, combining equations 9 and 11 :

[7]Indeed, a higher interest rate r makes the asset more profitable and hence relatively more interesting than housing (substitution effect)

$$U'_H(C_O, h_O) = P\beta B'(W)\left(r + \delta + (1+r)\tau_O\right) \tag{12}$$

This expression additionally makes it clear that the lower the future discount rate β, the higher the share of housing in total wealth. Once again, this comes from the multifunctional nature of owned housing, which is both providing immediate consumption utility, and future wealth utility. The lower β, the more important the weight put on its first present consumption use, relative to wealth, where it could be substituted for by saving safe asset[8].

Welfare effect of a change in τ_O

Now that we have solved for the equilibrium conditions of the owners' problem, we can use them to study the direct welfare effect of a change in τ_O on owner-occupiers. To do so, let us first recall the problem they were facing :

$$V_O(Y, A_O, h_O) = \max_{A_O, h_O} U(C_O, h_O) + \beta B(W) \tag{13}$$

$$\text{s.t. } C_O + A_O + (1+\tau_O)P(\tau_O, \tau_R)h_O = Y \tag{14}$$

$$W = (1+r)A + P(\tau_O, \tau_R)h_O(1-\delta) \tag{15}$$

It is then possible to compute the direct effect of a marginal change in τ_O on their welfare[9] :

$$\frac{\partial V_O}{\partial \tau_O} = -U'_C(C_O, h_O)\left(P + (1+\tau_O)\frac{\partial P}{\partial \tau_O}\right)h_O + \beta B'(W)(1-\delta)\frac{\partial P}{\partial \tau_O}h_O$$

We can see that the individual welfare effect is made of three channels : (1) the tax change mechanically increases the level of taxes paid, proportionally to the tax base Ph_O, which reduces household's budget. (2) Prices respond to the tax change, therefore affecting the tax base in the present. (3) Then, future wealth is also affected by the price response, as it changes the value of W. As we can see, the price effect is appearing twice, both in current consumption and future wealth related marginal utilities. Therefore, we can now use equation 9 to replace $B'(W)$ and get an expression which fully depends on the marginal utility of consumption. Finally, let $\varepsilon^P_{\tau_O} \equiv \frac{dP}{d\tau_O}\frac{1}{P}$ be the semi-elasticity of the housing price to τ_O.

[8]Indeed, safe asset saving is a more profitable form of wealth, with a return of $(1+r)$ instead of $(1-\delta)$

[9]Using the envelope theorem and replacing C_O using the budget constraint

Proposition 1 : *The direct marginal effect of a change in property tax rate on owner-occupiers' welfare is :*

$$\frac{\partial V_O}{\partial \tau_O} = -U'_C(C_O, h_O)\left(1 + \underbrace{\left(\tau_O + \frac{(\delta + r)}{(1 + r)}\right)\varepsilon^P_{\tau_O}}_{\textit{Net Price effect}}\right) Ph_O \tag{16}$$

The negative welfare effect on owner-occupiers operates through a direct, mechanical channel: an increase in the property tax rate τ_O reduces their disposable income by an amount proportional to the tax base Ph_O, causing an immediate welfare loss. It is then mitigated by an indirect net price effect, whose magnitude depends both on the semi-elasticity of price to τ_O and on the net marginal cost of housing, as defined in section 2.

Intuitively, a permanent decrease in housing prices lowers the future wealth of homeowners—this effect is discounted by both the subjective discount rate δ and the interest rate r. At the same time, lower prices decrease the current value of the tax base, which reduces the tax burden today. This latter effect prevailing over the former, these two opposing effects determine the net price effect's magnitude. Because the price semi-elasticity to property tax is generally negative (higher taxes tend to reduce prices), the net price effect usually mitigates the initial direct welfare loss. In other words, lower prices reduce the tax base and hence soften the impact of the higher tax rate, partially cushioning owner-occupiers against the full mechanical income loss.

Welfare effect of a change in τ_R

We can perform a similar analysis to understand the welfare effect of a rental income tax change on owner-occupiers. This yields the following proposition :

Proposition 2: *The marginal welfare effect on owners of a change in τ_R can be expressed as :*

$$\frac{\partial V_O}{\partial \tau_R} = -U'_C(C_O, h_O)\underbrace{\varepsilon^P_{\tau_R}\left(\tau_O + \frac{\delta + r}{1 + r}\right)}_{\textit{Net Price Effect}} Ph_O \tag{17}$$

We are left with only a net price effect: the whole effect now goes through the price adjustment channel. Indeed, owner-occupiers do not pay τ_R and the only way in which it can affect them is through the potential effect on prices. Therefore, if prices are increasing in τ_R, then an increase in rental income tax rates, ceteris paribus, would yield an increase in prices that would mechanically lower the welfare of owner-occupiers, by inflating the value of their tax base, and reversely.

4.2 Renters

Solution of the problem

The renters face the problem exposed in equation 4. It differs from that of owner-occupiers only in that they do not transmit housing into future wealth. The first-order conditions for housing and asset savings respectively yield :

$$\begin{cases} (1+\tilde{\tau_R})U'_C(C_R,h_R) = U'_H(C_R,h_R) & (18) \\ U'_C(C_R,h_R) = \beta(1+r)B'(W_R) & (19) \end{cases}$$

The first one gives us the trade-off condition between non-durable and housing consumption. As one would expect, when the housing tax burden increases, renters reduce h_R and substitute for numéraire consumption. The trade-off between housing and wealth does not depend on prices or depreciation rate, but only on the real tax rate, the safe interest rate and the future discount factor, as there is no longer any link between current housing and future wealth.

Welfare effect of a tax change

The welfare impact of a tax change on renters' welfare can then be computed, once again starting from their problem, exposed in (2). The only issue one should care about and keep in mind is that they do not pay directly τ_O or τ_R but only $\widetilde{\tau_R}$, which is itself a function of the two tax instruments.

Proposition 3 : *The direct welfare impact of a change in $\tau_j \in \{\tau_O, \tau_R\}$ can be expressed as*

$$\frac{\partial V_R}{\partial \tau_j} = \frac{\partial V_R}{\partial \widetilde{\tau_R}} \frac{\partial \widetilde{\tau_R}}{\partial \tau_j} = -U_C^{'}(C_R,h_R)h_R\frac{\partial \widetilde{\tau_R}}{\partial \tau_j} \tag{20}$$

Note that it is simpler than for owners, as renters do not own the place where they live, and therefore do not transmit it into future wealth.

Overall, the direct welfare effect of a change in property tax and rental income tax rates can be written respectively as[10] :

$$\frac{\partial V_R}{\partial \tau_O} = -U'_C(C_R,H_R)Ph_R\alpha\left(1+e^P_{\tau_O}\right) \tag{21}$$

$$\frac{\partial V_R}{\partial \tau_R} = -U_C^{'}(C_R,H_R)h_R\alpha\left(1+\tau_O P\varepsilon^P_{\tau_R}\right) \tag{22}$$

where $e^P_{\tau_O} = \frac{dP}{d\tau_O}\frac{\tau_O}{P}$ is the full price elasticity to τ_O and $\varepsilon^P_{\tau_R} = \frac{dP}{d\tau_R}\frac{1}{P}$ its semi-elasticity to τ_R

[10] Note that taking $\widetilde{\tau_R} = \alpha(\tau_O P + \tau_R)$, we have $\frac{\partial \widetilde{\tau_R}}{\partial \tau_R} = \alpha\left(1+\tau_O\frac{\partial P}{\partial \tau_R}\right)$ and $\frac{\partial \widetilde{\tau_R}}{\partial \tau_O} = \alpha\left(\tau_O\frac{\partial P}{\partial \tau_O}+P\right)$

Each time, the overall effect is scaled by α, as it is driving the extent to which tax changes are passed onto renters and therefore affecting their welfare. If it was equal to 0, then renters' welfare would remain unchanged whatever the tax change. Then there are two effects, a mechanical one, and a price effect that contains the price response to tax changes. In the case of a change in τ_R, the price channel is scaled by $\tau_O P$ which is the tax amount collected through the other tax (τ_O). Indeed, after an increase of the rental tax rate, the tax burden of renters mechanically increases one-to-one. It then also increases by the amount of the induced price increase, adjusted by the property tax rate it is paying on this adjusting property tax base.

Note on the responsiveness of h_R to P

There is an interesting feature of the model to be introduced here. Let us examine how the real tax burden borne by the tenants depends on housing price P. This is all the more important as it is the only way in which P may affect h_R. Considering budget-neutral reforms, where τ_R adjusts to keep government budget balanced, the real tax burden depends on prices in the following way :

$$\frac{d\widetilde{\tau_R}}{dP} = \alpha \left(\tau_O + \frac{d\tau_R}{dP} \right)$$

Following a marginal price increase, there will mechanically be an increase, scaled by τ_O, in the tax burden of rental units, that will be complemented by the readjustment in τ_R to keep budget balanced. This is in turn scaled by the parameter α governing the pass-through of this tax change onto tenants. We therefore need to compute $\frac{d\tau_R}{dP}$, starting form the government budget constraint, as stated in equation 8. Differentiating it with respect to P yields the following expression :

$$\frac{d\tau_R}{dP} = -\frac{(1-\phi)\tau_O H_O(1+e_P^H) + \phi\tau_O \left(H_R + \tilde{\tau}_R \frac{dH_R}{d\tilde{\tau}_R} \right)}{\phi \left(H_R + \tilde{\tau}_R \frac{dH_R}{d\tilde{\tau}_R} \right)} \tag{23}$$

$$\frac{d\tau_R}{dP} = -\tau_O \left(1 + \frac{(1-\phi)H_O(1+e_P^H)}{\phi H_R \left(1 + e_{\tilde{\tau}_R}^{H_R} \right)} \right) \tag{24}$$

It will be an important feature of our functional and tractable model, due to the specific form taken by the elasticity of H_O to price[11]. We can decompose it into two parts, related to the two parts of the governmental revenue, that corresponds to the two parts of the housing sector. First, when housing prices increase, τ_R can mechanically be reduced by τ_O as $\tau_O P$ and τ_R are perfect substitutes in the tax revenue from rental housing. Then, the right-hand side term corresponds to

[11]Indeed, we will have $e_P^H = -1$, ultimately implying that the overall effect is equal to 0 : the effective tax rate of tenants is unaffected by the price.

the additional adjustment, related to the taxation of owner-occupiers. It shows that the higher the relative share of owner-occupied housing the more can τ_R adjust following a price change, as they represent a more important share of the aggregate tax base. Finally, this effect is reduced by the elasticity of the housing stock to price, which reflects the amount by which the tax base is going to shrink after the price increase. It is, on the other hand, amplified by the elasticity of H_R to the effective rental tax rate, as it makes any adjustment less costly by expanding the tax base.

5 Welfare analysis of budget-neutral tax reforms

We are now interested in analyzing the welfare implications of a budget-neutral tax reform, where the government needs to raise an amount G, through its two tax instruments. Let us focus on a marginal change in property tax rate τ_O, and the subsequent budget-balancing readjustment of the rental income tax rate τ_R. Let aggregate welfare be :

$$W = (1-\phi)\int V_O(Y, A_O, h_O)\omega_O(Y)dF_O(Y) + \phi\int V_R(Y, A_R, H_R)\omega_R(Y)dF_R(Y) \tag{25}$$

The aggregate welfare is therefore simply the aggregation of owner-occupier's and renter's welfare, all along their endowment distribution, weighted by $\omega_O(Y)$ and $\omega_R(Y)$, their marginal welfare weights. Note that $\omega_O(Y)$ and $\omega_R(Y)$ are indexed by type of tenure and are not necessarily equal, as they may consist of two parts : (1) marginal welfare weight of households with endowment Y, (2) absolute relative welfare preference for owners or renters. If the government weighs the welfare of one of these groups in a consistently different way, then it enters the second channel we mentioned and is therefore accounted for in the type-specific marginal welfare weights. This may arise if the government tends to favor owner-occupiers, as may be heard in the political debate or if they are considered to be more attached to the local municipality. On the other hand, it may prefer to favor renters, for labor mobility reasons for instance. In what follows, let us simply call the individual welfare functions V_O and V_R for the sake of readability. As a result, the welfare change following a marginal tax adjustment can be written as :

$$\frac{dW}{d\tau_O} = (1-\phi)\int \frac{dV_O}{d\tau_O}\omega_O(Y)dF_O(Y) + \phi\int \frac{dV_R}{d\tau_O}\omega_R(Y)dF_R(Y) \tag{26}$$

$$\frac{dW}{d\tau_O} = (1-\phi)\int \left(\frac{\partial V_O}{\partial \tau_O} + \frac{\partial V_O}{\partial \tau_R}\frac{d\tau_R}{d\tau_O}\right)\omega_O(Y)dF_O(Y) + \phi\int \left(\frac{\partial V_R}{\partial \tau_O} + \frac{\partial V_R}{\partial \tau_R}\frac{d\tau_R}{d\tau_O}\right)\omega_R(Y)dF_R(Y) \tag{27}$$

It appears that the welfare effect goes through the "direct" impact of a change in τ_O on the welfare of owners and renters, and through an indirect impact of the mechanical re-adjustment of τ_R. Indeed, in the case of a budget-neutral reform, any change in one tax rate, will trigger a mechanical adjustment of the other tax instrument (keeping the government budget balanced). Let us thus start by studying this mechanical adjustment, following a change in τ_O.

5.1 Budget-neutral mechanical tax adjustment

Using the government budget constraint that was introduced in equation 8, we can deduce a simple expression for the implied rental tax rate :

$$\tau_R = \frac{G - (1-\phi)\tau_O P H_O}{\phi H_R} - \tau_O P \tag{28}$$

Then, applying the implicit function theorem[12] , we can derive the mechanical adjustment of the rental tax rate following a marginal change in the property tax rate[13].

Proposition 4 : *The mechanical tax adjustment of τ_R following a marginal change in τ_O is :*

$$\frac{d\tau_R}{d\tau_O} = -\frac{PH\left(1 + \tau_O \varepsilon^P_{\tau_O} + \tau_O \varepsilon^H_{\tau_O}\right) + \phi \tau_R H_R \varepsilon^{H_R}_{\tau_O}}{\tau_O PH\left(\varepsilon^H_{\tau_R} + \varepsilon^P_{\tau_R}\right) + \phi H_R\left(1 + \tau_R \varepsilon^{H_R}_{\tau_R}\right)} \tag{29}$$

where the ε stand for semi-elasticities

Let us decompose this mechanical tax adjustment, that arises from a trade-off between the revenue effect of raising τ_O, and the indirect revenue effect of subsequently lowering τ_R. The numerator represents the direct revenue effect of raising τ_O on government revenue. The first term, PH, reflects the mechanical increase in revenue from the tax base. This effect is adjusted by the semi-elasticities of price, $\varepsilon^P_{\tau_O}$ and aggregate housing stock, $\varepsilon^H_{\tau_O}$, which capture how the tax base responds to changes in τ_O. The second term captures the mechanical loss in rental income tax revenue caused by the behavioral response of rental housing stock, H_R, to τ_O, holding τ_R fixed.

The denominator captures the indirect revenue effect induced by adjusting τ_R to maintain budget neutrality. It includes the mechanical loss in revenue from reducing τ_R, given by the rental tax base ϕH_R, corrected by its adjustment through the elasticity of rental housing stock with respect to τ_R, $\varepsilon^{H_R}_{\tau_R}$. It also includes adjustments due to changes in the property tax base resulting from the elasticities of aggregate housing and price with respect to τ_R, $\varepsilon^H_{\tau_R}$ and $\varepsilon^P_{\tau_R}$.

Overall, the numerator and denominator compare the revenue effects of changes in the two tax rates. The numerator captures how prices and the housing stock respond to an increase in τ_O, thereby determining the net revenue gain from raising the property tax. Intuitively, if the taxable

[12] Indeed, note that the right-hand side also depends on τ_R

[13] See Appendix for detailed computations

housing stock responds strongly to an increase in τ_O, then the revenue gain from raising τ_O is limited, restricting the scope to lower τ_R. Conversely, the denominator reflects the responsiveness of prices and housing stock to a decrease in τ_R. If the housing stock responds strongly to a decrease in τ_R, reducing τ_R becomes less costly because the resulting behavioral response expands the tax base, mitigating revenue losses.

Note on the adjustment of H_R

Note that the semi-elasticity of H_R to τ_O and τ_R depends on the extent to which renters are *effectively* affected by these taxes. Therefore, these elasticities depend on the parameter α. Indeed, taking the example of τ_R :

$$\varepsilon_{\tau_R}^{H_R} = \frac{1}{H_R}\frac{\partial H_R}{\partial \tau_R} = \frac{1}{H_R}\frac{\partial H_R}{\partial \widetilde{\tau_R}}\frac{\partial \widetilde{\tau_R}}{\partial \tau_R} = \varepsilon_{\widetilde{\tau_R}}^{H_R}\alpha\left(1+\tau_O\frac{\partial P}{\partial \tau_R}\right) \tag{30}$$

The semi-elasticity of rental housing demand to τ_R indeed depends on the actual semi-elasticity of H_R to the real tax burden, the effect of a change in τ_R on the tax burden, and the transmission or pass-through of this tax burden to the renters.

5.2 Aggregate welfare change

Now that we have explicited all the required elements of equation 27, we can compute the aggregate welfare change, following a marginal property tax change. The following proposition decomposes this aggregate welfare change into different channels.

Proposition 5: *The aggregate welfare change following a marginal property tax change is:*

$$\begin{aligned}\frac{dW}{d\tau_O} = -(1-\phi)P&\left(1+\underbrace{\left(\tau_O+\frac{(\delta+r)}{(1+r)}\right)\left(\varepsilon_{\tau_O}^P+\varepsilon_{\tau_R}^P\frac{d\tau_R}{d\tau_O}\right)}_{\textit{Owners' aggregate net price effect}}\right)\underbrace{\int g_O(Y)h_O dF_O(Y)}_{\textit{Owners' welfare weight}}\\ &-\phi\,\underbrace{\alpha\left(P\left(1+\tau_O\varepsilon_{\tau_O}^P\right)+\left(1+\tau_O P\varepsilon_{\tau_R}^P\right)\frac{d\tau_R}{d\tau_O}\right)}_{\textit{Renters' real tax burden change}}\underbrace{\int g_R(Y)h_R dF_R(Y)}_{\textit{Renters' welfare weight}}\end{aligned} \tag{31}$$

where $g_O(Y) = U_C'(C_O,h_O)\omega_O(Y)$ and $g_R(Y) = U_C^{'}(C_R,h_R)\omega_R(Y)$ are the social marginal utility of income of owner-occupiers and renters respectively.

This expression follows directly from aggregating the individual welfare changes derived in Section 3. For owner-occupiers, the welfare change consists of two components: a *direct mechanical effect*, and a *net aggregate price effect.* The mechanical effect is the same as in the individual welfare change analysis of Proposition 1, coming from the mechanical increase in the tax burden of owner-occupiers. The price effect captures how the reform alters housing prices and therefore the tax base value[14].

More specifically, the net aggregate price effect combines two channels : (1) the direct net price effect of a property tax change and (2) the net price effect induced by a change in τ_R scaled by the mechanical adjustment of τ_R compensating a property tax change. Indeed, housing prices are going to react to the two tax changes. A property tax increase, and a subsequent rental tax decrease, should lead to lower housing price. Then, as we saw, the net marginal cost of housing $\left(\tau_O + \frac{\delta+r}{1+r}\right)$ indicates the marginal welfare gain from a price change. It is therefore scaling the aggregate price reaction to a property tax reform, which is composed of the direct price reaction to the change in τ_O and the indirect price change that follows the adjustment of τ_R to keep budget balanced. Overall, this aggregate net price effect mitigates the mechanical welfare loss. The total impact on owner welfare is weighted by the social marginal utility of housing across the distribution of owner-occupiers.

For renters, the welfare impact arises through changes in their real tax burden. This real burden change first depends on the change in the aggregate tax burden on rental housing. This one is made of the two channels introduced in Proposition 3. An increase in the property tax rate τ_O mechanically raises the tax burden and induces a mitigating price decrease. It is then complemented by the effect of a subsequent rental income tax decrease, made of a direct channel and a strengthening price effect. Indeed, lower rental income tax rates mechanically reduce the tax burden on rental housing. This effect is even more important if it implies a decrease in housing prices. Together, these two effects determine the change in the overall rental housing tax burden. However, this change only translates into a welfare impact for renters if it is passed through to them by the landlords. Hence, the overall effect is scaled by the pass-through rate from landlords to renters α. If this pass-through is zero, renters effectively bear no tax burden, and the reform has no impact on their welfare. As with owner-occupiers, this effect is weighted by an aggregate welfare weight on renters, stemming from the distribution of their social marginal value of income and housing consumption along the endowment distribution.

We can observe that if housing prices do not respond to changes in τ_R, then the welfare effect on owners operates solely through the mechanical channel and the direct price response to τ_O, since owner-occupiers are not directly affected by the rental income tax. In that case, the mechanical adjustment of τ_R only influences renter welfare. Similarly, if $\alpha = 0$, meaning there is no pass-through of rental taxation to renters, then the entire renter-related component drops out, and the welfare effect is borne exclusively by owners. This limiting case, along with its counterpart $\alpha = 1$—where the full tax burden is passed through—will be studied in more detail in Section 7 to make explicit how different channels shape the overall welfare response and, ultimately, the optimal tax mix.

Finally, at the optimal tax mix, the marginal welfare change must be equal to zero, as in stan-

[14] We saw that it also alters the value of future wealth, but that this effect is dominated by the tax base adjustment.

dard optimal taxation theory. This condition reflects that no marginal reform—i.e., no infinitesimal reallocation of tax burdens between property and rental income taxes—can lead to a welfare improvement. In other words, the optimal tax mix is characterized by setting equation (30) equal to zero. This condition will serve as the basis for the application in Section 7, where we solve for the welfare-maximizing combination of τ_O and τ_R.

Empirical applications

These results are particularly useful for empirical work, as they summarize the key statistics and elasticities required to quantify the welfare effects of changes in housing taxation. With estimates of these key components in hand, researchers can evaluate (1) the welfare impact of housing tax reforms, and (2) the optimal combination of property and rental income taxes.

In particular, implementing this framework empirically requires assumptions or estimates of the social marginal utility of income, along with observable quantities such as average housing consumption (e.g., quality-adjusted dwelling size) for renters and owner-occupiers. A study that estimates how rental and owner-occupied housing markets respond to taxation—especially the price elasticities with respect to τ_O and τ_R—would therefore be well-equipped to assess the welfare implications of any proposed tax reform. Moreover, by setting the marginal welfare change equal to zero, such a study could directly characterize the optimal tax mix.

6 Application and Tractable Model

In this section, let us now apply our fully theoretical and non-parametric formula for welfare change analysis, specifying functional forms for the preferences of households and the construction costs of the investor firm. It will allow us to re-write the mechanical tax adjustment and the welfare change induced by a marginal property tax change. It will also allow us to discuss the evolution of housing prices with property tax rates. In a second step we will use this tractable model and simulate it numerically, in order to derive optimal tax mixes and their interaction with the pass-through parameter of rental taxation as well as other key parameters in section 7.

6.1 Tractable households problem and application to welfare change

First of all, let us introduce simple functional forms into the households problem. Let us recall that it is generally written as :

$$V(Y, A, H) = \max_{A,H} U(C, H) + \beta B(W)$$

Following Iacoviello (2013), let the instantaneous utility function be written as:

$$U(C,H) = \log(C) + \theta \log(H) \tag{32}$$

where θ is the parameter that governs the intensity of relative preference for housing relative to non-durable consumption. Then, following Coven et al. (2024) let

$$B(W) = \psi \log(W) \tag{33}$$

where ψ can here be seen as the intensity of the wealth accumulation motive[15].

These model specifications yield tractable solutions for the expressions presented in sections 4 and 5, as well as the demand elasticities of the model. They are presented in Appendix C, along with detailed computations. This, along with the functional solutions and marginal utilities, allows to rewrite both the mechanical tax adjustment induced by a change in τ_O in a budget-neutral reform, and the aggregate welfare effect of such a reform.

Mechanical tax adjustment The mechanical tax adjustment, replacing the specified functional forms, becomes :

$$\frac{d\tau_R}{d\tau_O} = -\underbrace{\frac{\left(1+\tau_O\varepsilon^P_{\tau_O}\right)}{\left(\frac{1}{P}+\varepsilon^P_{\tau_R}\tau_O\right)}}_{\textit{substitution effect}} - \underbrace{\frac{(1+\tilde{\tau}_R)}{\left(\frac{1}{P}+\varepsilon^P_{\tau_R}\tau_O\right)}\frac{(1-\phi)H_O}{\phi H_R}\frac{r+\delta}{(r+\delta+(1+r)\tau_O)}}_{\textit{weighted behavioral responses}} \tag{34}$$

This expression can be decomposed into two distinct components, that illustrates the theoretical tax adjustment described in Proposition 4 slightly differently :

1. *Direct Substitution Effect*

   The first term captures the mechanical substitution between the two tax instruments in the rental housing overall tax burden. Intuitively, since $\tau_O P$ enters government revenue similarly to τ_R (at least absent behavioral responses), a change in one should offset a change in the other. The numerator, reflects both the direct mechanical effect and the responsiveness of housing prices to the property tax (through its elasticity). If prices decrease in response to a higher τ_O, this reduces revenue collection from owner-occupied housing, and thus permits a lower reduction in τ_R. However the adjustment of τ_R may itself affect housing price. The denominator incorporates this feedback, showing how sensitive the revenue is to price movements when adjusting τ_R.

   Overall, this part reflects the static, quasi-mechanical trade-off between the two tax bases, filtered through price elasticities. Absent these price changes, it would be equal to P, the

[15] It is simply a bequest motive intensity in a paper such as Coven et al. (2024)

pure mechanical substitution effect between τ_O and τ_R.

2. *Behavioral Adjustment of the overall tax base*

   The second term captures behavioral responses in housing demand and how they affect the overall tax base, subject to a tax rate τ_O. The relative aggregate housing demands of owner-occupiers and renters matter. Indeed, a larger share of owner-occupied housing raises this ratio and hence eases the mechanical adjustment in τ_R. The other terms arise from the responsiveness of rental and owner-occupied housing, combining the level and elasticity of housing demand. The larger τ_O becomes, the more it depresses housing investment returns, reducing the present value of future tax revenue and thus limiting the extent to which τ_R can fall.

   It is worth noting that these terms reflect both the level of housing demand and its responsiveness. Indeed, this behavioral reaction affects the revenue collected. That dual role may obscure interpretation: while a higher H_O amplifies the adjustment effect, a more elastic H_O tempers it by reducing the taxable base. The reverse argument can be made regarding H_R, as in Proposition 4.

Aggregate welfare change We can now rewrite the formula for the aggregate welfare change. First of all, let us remark that our utility function specification introduces an interesting feature, as the endowment level disappears from the product of the marginal utility of non-durable consumption and the level of housing consumption ($U'_C \times H$). As this was the only element of heterogeneity in the welfare change, there is no element left to account for, except pure welfare weight on renters relative to owner-occupiers[16]. Let this relative welfare weight be accounted for by Ω such that :

$$\Omega = \frac{\bar{\omega}_R}{\bar{\omega}_O} \tag{35}$$

where $\bar{\omega}_R = \int \omega_R(Y) dF_R(Y)$ is the average marginal welfare weight put on renters, and $\bar{\omega}_O$ the average weight on owner-occupiers, which fully depends on the distribution of endowment among these two populations. We can therefore write the fully tractable form of the aggregate welfare change, where we can now replace the marginal utility and housing stock for owner-occupiers and renters.

[16]The full proof is provided in Appendix C3

$$\frac{dW}{d\tau_O} = -(1-\phi)\underbrace{\frac{\theta(1+r)}{(\tau_O(1+r)+r+\delta)}}_{\mu_{H_O}}\left(1+\underbrace{\left(\tau_O+\frac{(\delta+r)}{(1+r)}\right)\left(\varepsilon_O^P+\frac{d\tau_R}{d\tau_O}\varepsilon_R^P\right)}_{\text{owners' aggregate net price effect}}\right)$$
$$-\Omega\phi\underbrace{\frac{\theta}{1+\tilde{\tau_R}}}_{\mu_{H_R}}\underbrace{\alpha\left(P(1+e_{\tau_O}^P)+\frac{d\tau_R}{d\tau_O}\left(1+\tau_O P\varepsilon_R^P\right)\right)}_{\text{renters' real tax change}} \tag{36}$$

where μ_{H_O} and μ_{H_R} are respectively the marginal utility weights of H_O and H_R

This expression is very similar to the theoretical one, except that we now get rid of any heterogeneity, and the social marginal welfare weights are now replaced by the marginal utility of H_O and H_R, indicating the weight of housing in the marginal utility of owners and renters, and therefore its weight in the welfare change, hence the presence of the housing preference parameter θ. Indeed, if housing matters a lot in the individual welfare of owners (or renters), it will mechanically amplify the effect of a change in housing taxation. The relative welfare weight also appears, capturing the normalized tradeoff between owners' and renters' welfare. Then, the same effects as in Proposition 5 play their role, namely (1) the mechanical and (2) aggregate net price effect on owners, and (3) the real tax change for renters. The second and the last effect account for the adjustment in τ_R, and are the two channels possibly counterbalancing the direct negative welfare effect of an increase in τ_O. The optimal tax mix is eventually the one induced by the property tax rate τ_O that is balancing perfectly these effects, such that the aggregate welfare change equals zero.

6.2 Construction firm and price-setting

The last functional form we need to impose is on the construction cost function of the investor firm. Let us remind that pricing happens through the following zero-profit condition :

$$\pi(P) = P(1-\phi)H_O + \phi(1-\widetilde{\tau}_I)H_R - c(H) = 0 \tag{37}$$

We therefore need to specify the form of the construction cost function $c(H)$. Let

$$c(H) = \kappa H^\gamma \tag{38}$$

Where κ is a (marginal) cost shifter, due to some proportional costs (that may be linear land or inputs prices, or some other classical multiplicative costs). Then, $\gamma > 1$ is a shape parameter,

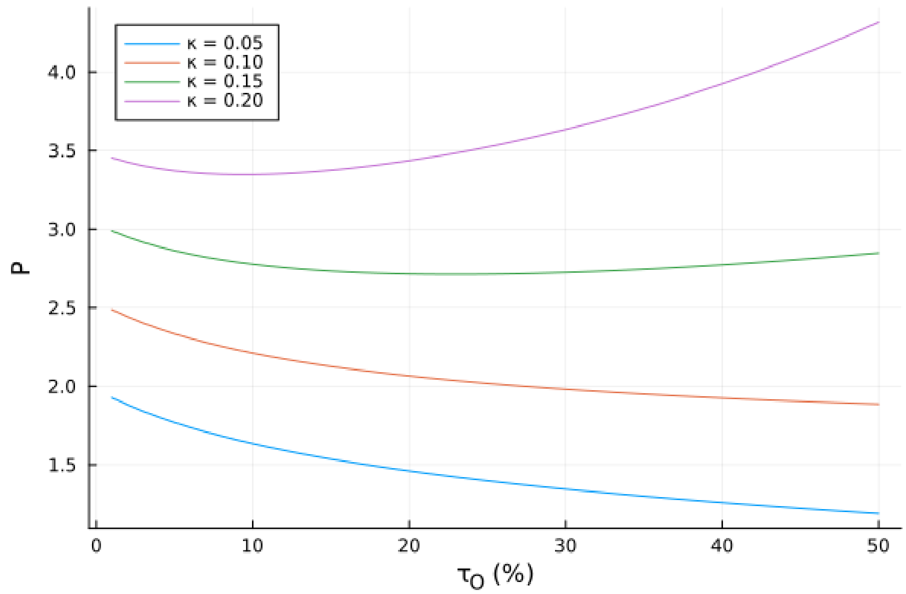


Figure 1: Price evolution with τ_O, for different values of κ

determining the convexity of the cost function[17].

Price response to tax changes

We can then simulate the price that is set depending on the value of τ_O, in a budget-neutral setting where τ_R adjusts accordingly. We can do that for a set of different values of the marginal construction cost parameter κ. The result is displayed in Figure 1.

Clearly, we can see that the response of prices to changes in τ_O (in a budget-neutral reform, taking into account the adjustment margin of τ_R), depend on the marginal construction cost. It even influences the *direction* of price elasticity to changes in property tax rates.

To understand why this is the case, we need to look at the zero-profit condition (equation 37) in the construction sector, that is governing price-setting. This condition accounts for the respective demands H_O and H_R. But, as we will see, only H_O reacts to price changes under our specification. Indeed, let us recall that the impact of a price change on the tax burden of rental housing writes as

$$\frac{d\widetilde{\tau_R}}{dP} = \alpha\left(\tau_O + \frac{d\tau_R}{dP}\right) \tag{39}$$

[17]note that it is the natural counterpart of a production function displaying decreasing returns to scale (standard in the literature) such as $H = f(L) = AL^\eta$, with a price φ of land L. Our specification is therefore equivalent to having $\kappa = \varphi A^{-\frac{1}{\eta}}$ and $\gamma = \frac{1}{\eta}$

Furthermore, we had

$$\frac{d\tau_R}{dP} = -\tau_O \left(1 + \frac{(1-\phi)H_O(1+e_P^{H_O})}{\phi H_R \left(1+e_{\tilde{\tau}_R}^{H_R}\right)}\right) \tag{40}$$

Because the elasticity of H_O to price changes is $e_P^{H_O} = -1$ under this specification, the right handside term washes out and we are left with $d\tau_R/dP = -\tau_O$. This, in turn, implies that this effect fully compensates the mechanical increase in the tax burden implied by an increase in price, and in net this is a wash : tenants do not react to a change in housing prices.

This has a direct implication for price setting : only H_O adjusts as a reaction to changing prices, therefore the trade-off is between the responsiveness of H_O and the marginal cost of construction. Overall, an increase in τ_O reduces the profits, which has to be compensated, either by increasing revenues or reducing costs. Let us then look at two situations, that explain the difference in *direction* of price adjustment :

1. Low marginal cost : It is costless to maintain a high H and H_O . Consequently, P decreases as τ_O increases to keep H_O quite high, and reduce the "substitution" towards H_R. This is the standard capitalization effect of higher property tax rates into lower house prices, often discussed in the literature.

2. High marginal cost : It is too costly to maintain a high level of H_O and H. As a result, P increases in order to further decrease H_O and hence H. This is particularly true for high values of τ_O, as H_O becomes less responsive to property tax increases, strengthening the need to raise prices in order to lower H_O.

Overall, under the calibrated parameters, the standard **capitalization effect** is predominant, leading to lower house prices in areas with higher property tax rates. The only instances in which we seem to depart from that is when construction costs are particularly high and convex, which does not match earlier estimates from the literature.

6.3 Calibration

Before presenting the simulation results, we briefly describe the calibration of the model's parameters. Table 1 summarizes the values used in the numerical exercise in Section 7. Most parameter values are taken from the literature, from the papers mentioned in the table. We then verify that the model produces outcomes and moments that are broadly consistent with observed data.

The discount factor β and the interest rate r take standard values commonly used in the macroeconomic literature[18]. The wealth transmission (or bequest) utility shifter ψ is taken from Kragh-Sørensen (2022), while the housing preference parameter θ is drawn from Coven et al. (2024),

[18] This specific value of r comes from Coven et al. (2024)

Table 1: Calibration of main parameters

	Parameter	Value	Source
β	Discount rate	0.96	Standard
r	Safe interest rate	0.024	Standard
θ	Housing relative preference	0.57	Coven et al. (2024)
δ	Depreciation rate	0.023	Kragh Sorensen (2022)
ϕ	Share of renters	0.403	INSEE
G	Government expenditures	5.7	INSEE
ψ	Wealth utility shifter	1.3	Kragh Sorensen (2022)
γ	Construction cost convexity	1.7	Kragh Sorensen (2022)
κ	Marginal cost shifter	0.15	See text

normalizing the weight on non-durable consumption to unity, consistent with the functional form of the instantaneous utility function introduced earlier in this section.

The government spending parameter G reflects the scale of local public expenditures. In the model, only the ratio G/Y matters. Because we normalize $Y = 100$, we calibrate $G = 5.7$ to match the share of French GDP allocated to local spending financed through local taxation, based on INSEE data for 2023. For robustness exercises, we also consider two alternative values: a lower bound of $G = 3.01$, capturing only municipality-level spending, and an upper bound of $G = 7.03$, reflecting total local expenditures without adjusting for the share financed through local taxes.

The convexity of the construction cost function is governed by γ, for which we use the estimate of 1.7 from Kragh-Sørensen (2022) as a baseline. For sensitivity analysis, we also consider the lower value of $\gamma = 1.4$ from Floetotto et al. (2016). The parameter κ is then calibrated to ensure that the implied elasticity of housing supply aligns with the values targeted in these studies. Because a lower γ implies lower marginal construction costs, κ must be adjusted accordingly to isolate the effect of convexity.

The depreciation rate δ is also taken from Kragh-Sørensen (2022) and lies within the standard range used in the literature. Finally, the share of renters $\phi = 0.403$ is calibrated to match INSEE data, indicating that 40.3% of French households are tenants. For robustness, we explored alternative values for parameters with varying estimates in the literature. Crucially, while quantitative outcomes may vary slightly, none of the key qualitative findings presented in Section 7 depend on the specific parameter values. The main insights are robust to reasonable variations in the calibration.

7 Numerical results for the optimal tax mix

We can now numerically simulate the optimal tax mix, under a variety of specifications. We are particularly interested in understanding how α, which determines the tax pass-through from landlords to their tenants, affects the optimal tax mix. We are going to start by considering two extreme cases ($\alpha = 0$ and $\alpha = 1$), in order to make the relevant channels more explicit and to understand the interaction with the optimal tax mix. We will also be able to understand, in a second time, how the optimal tax mix is evolving over the whole incidence spectrum, and how this interacts with construction costs (shaping price elasticity). We will see that the optimal τ_O increases monotonically with α, while τ_R follows an inverted U-shape, first increasing and then declining. Finally, we will see that lower fiscal pressure (the amount that the government needs to raise) and higher welfare weight put on tenants, relative to owner-occupiers, lead to lower rental income tax rates. To do so, we simulate budget-neutral reforms, where the government is choosing $\tau_O \in [0;1]$, and τ_R adjusts accordingly, to keep budget balanced. We will also see that when we relax this restriction, it may be optimal to set a negative property tax rate, for low values of α. This will also enlighten the phenomenon at play in the optimal tax mix setting.

7.1 Studying two particular cases

Extreme Case 1 : No tax pass-through to renters

Let us first study the case where the tax burden is fully borne by those who statutorily pay these taxes. In the absence of tax pass-through from the landowners to the tenants, $\alpha = 0$. The aggregate welfare change from Proposition 5 therefore becomes :

$$\frac{dW}{d\tau_O} = -(1-\phi)P\left(1 + \left(\tau_O + \frac{(\delta + r)}{(1+r)}\right)\left(\varepsilon^P_{\tau_O} + \varepsilon^P_{\tau_R}\frac{d\tau_R}{d\tau_O}\right)\right)\int g_O(Y)h_O dF_O(Y) \tag{41}$$

In this setting, the welfare impact is concentrated entirely on owner-occupiers, the left part of the expression derived in Proposition 5. As in Proposition 5, it consists of a mechanical component and a net price effect, which reflects the responsiveness of housing prices to changes in both taxes. Notably, the rental income tax τ_R affects welfare only indirectly, through its influence on prices. This weak indirect channel suggests that the optimal rental income tax rate is likely to be relatively high compared to the property tax rate τ_O, since its direct incidence on renters is muted.

Moreover, we can note that the mechanical τ_R adjustment is also affected, because renter housing demand H_R does not respond to tax changes. The resulting optimal tax mix is reported in the left column of Table 2.

Extreme Case 2 : Full pass-through to renters

We can now study the opposite situation, when landlords are passing the whole tax burden onto their tenants. In this situation $\alpha = 1$, and we can rewrite the aggregate welfare change as :

$$\frac{dW}{d\tau_O} = -(1-\phi)P\left(\left(\tau_O + \frac{(\delta+r)}{(1+r)}\right)\left(\varepsilon_{P\tau_O} + \varepsilon_{P\tau_R}\frac{d\tau_R}{d\tau_O}\right) + 1\right)\int g_O(Y)h_O dF_O(Y)$$
$$-\phi P\left(1 + e^P_{\tau_O} + \left(\frac{1}{P} + \tau_O\varepsilon_{P\tau_R}\right)\frac{d\tau_R}{d\tau_O}\right)\int g_R(Y)h_R dF_R(Y) \qquad (42)$$

In this case, renters bear the full incidence of the overall rental tax burden. As a result, τ_R enters directly into the welfare of tenants. The aggregate welfare change now incorporates both the owner and renter components, with τ_R playing a more prominent role. Importantly, increasing the property tax rate τ_O becomes more desirable, as it enables a reduction in τ_R, which now yields substantial welfare gains for renters, by lowering their tax burden. Consequently, this case favors a lower optimal rental income tax relative to the no pass-through scenario, reflecting the greater welfare cost of taxing renters when they fully absorb the tax burden. The corresponding optimal tax mix is reported in the right column of Table 2.

Optimal tax mix

Table 2 presents the optimal tax mix under both specifications in the first row. The following rows present the optimal tax mix for alternative specifications of the construction cost function, that will be discussed in the following section. Note that we study a marginal property tax change and set its welfare effect equal to 0 to find the optimal rate τ_O. Then, because we study a budget-neutral reform, the optimal rate τ_R is deduced from the optimal rate τ_O through the government budget constraint.

Table 2: Optimal tax mix

Pass-through	$\alpha = 0$		$\alpha = 1$	
	τ_O	τ_R	τ_O	τ_R
Baseline	**0%**	**72.9%**	**3.17%**	**11.1%**
Low costs	0%	72.9%	3.92%	4.95%
High costs	0%	72.9%	2.76%	16.2%
Low elasticity	0%	72.9%	2.62%	22.8%
High elasticity	0%	72.9%	3.70%	2.25%

Baseline takes $\gamma = 1.7$ and $\kappa = 0.15$. Low costs uses $\kappa = 0.05$ and high uses $\kappa = 0.25$. Low elasticity is $\{\gamma = 1.4, \kappa = 0.5\}$. High elasticity is $\{\gamma = 2, \kappa = 0.05\}$

As expected, when $\alpha = 0$, the optimal property tax rate is zero, while the optimal rental income tax rate is high ($\tau_R = 72.9\%$), since the entire tax burden can be imposed on landlords without affecting tenants. In contrast, when $\alpha = 1$, the rental income tax rate is substantially lower, as renters bear the full incidence of the tax. To offset this reduction and maintain revenue neutrality, the property tax rate must increase, reaching 3.17%. Although the required increase in τ_O may appear modest, this is due to the broader tax base of the property tax, which is paid by all homeowners.

Note that under all specifications, the optimal tax mix at $\alpha = 0$ is always the same. This arises from the fact that the optimal property tax rate is 0. Remember that the implied τ_R can be written as :

$$\tau_R = \frac{G - (1-\phi)\tau_O P H_O}{\phi H_R} - \tau_O P \tag{43}$$

When $\tau_O = 0$ the optimal, budget-adjusting, τ_R is therefore equal to the ratio of the government expenditure to the aggregate rental housing stock, which is constant across specification when $\alpha = 0$ as the renters are not affected by any tax or price difference. Table 2 also shows that the optimal mix depends on construction costs, through their effect on price levels and responses. Indeed, higher price levels mechanically shift a higher share of the overall tax burden onto owner-occupiers, while higher price elasticity strengthens their mitigating net price effect. This will be discussed in more details in the next subsection.

7.2 Optimal tax mix, pass-through and construction costs

Now that we have studied the two extreme cases of pass-through, we can turn to the whole spectrum of tax incidence. This is shown in Figure 2

For low values of α, the optimal property tax rate remains at zero ($\tau_O = 0$), and the optimal rental income tax rate τ_R increases with α. This is because, as α rises, renters bear a larger share of the tax burden ceteris paribus, leading to a decline in rental housing demand H_R.[19]. Since the property tax rate remains fixed at zero, τ_R must adjust upward to satisfy the government's budget constraint.

This pattern shifts once α exceeds a threshold—determined by model specification—beyond which it becomes optimal to begin raising τ_O. From that point onward, further increases in α lead to higher optimal values of τ_O and correspondingly lower optimal values of τ_R. In some specifications, this rebalancing goes so far that the optimal rental income tax becomes negative, implying a subsidy to rental housing.

[19] Recall $\tilde{\tau}_R = \alpha(\tau_O P + \tau_R)$, so if α increases, renters are mechanically paying more, for given tax rates

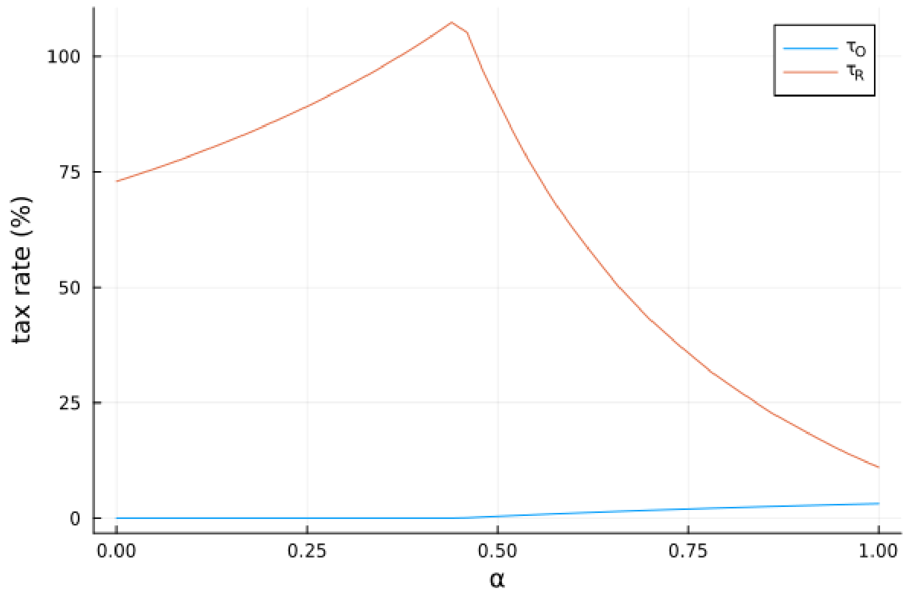
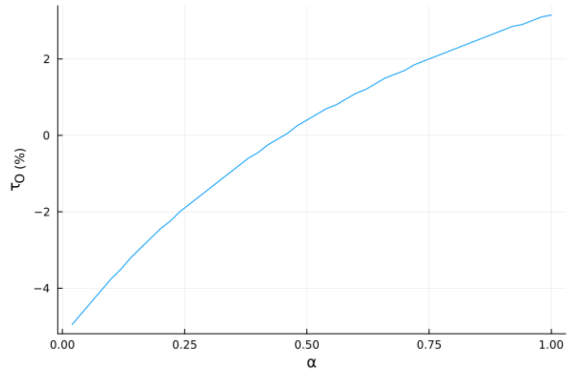


Figure 2: Optimal mix by value of pass-through α, baseline

This result stems from the increasing welfare relevance of the rental tax as α rises. The more of the tax burden is passed through to renters, the more distortionary a high rental income tax becomes. To mitigate these distortions, the optimal tax mix shifts towards a greater reliance on property taxation. Overall, two opposing forces shape the relationship between α and the optimal rental income tax: (1) The increase in the real tax burden on renters reduces their welfare at a given τ_R; (2) This increased burden induces a behavioral response—specifically, a decline in H_R—which lowers the tax base and therefore reduces revenues for the government. As a result, the government has to raise one of the two tax rates, in a welfare-maximizing way. When $\tau_O = 0$, implying that raising τ_O is suboptimal, only the second channel operates, and tax adjustments are driven entirely by behavioral responses. Once τ_O becomes positive, however, renters' welfare considerations begin to dominate the optimal tax mix, and τ_R starts declining.

To see why this is the case as long as τ_O is equal to 0, we can look at the same specifications without any restriction on the value of the property tax rate, thus allowing it to be negative (Figures 3 and 4). In such a case, we see that τ_O starts from negative optimal values, for low values of α and increases monotonically, while τ_R starts from a much higher level and decreases monotonically. Now that the property tax rate is no longer constrained at zero, it can become negative while τ_R peaks, and it becomes positive at the same inflection point as in Figure 2. It does so because low values of α indicate that there is (almost) free lunch, and the government can heavily tax the investor in order to subsidize owner-occupiers. This may be seen as an organized redistribution of resources from the investor to the owner-occupiers. In fact, when $\alpha = 0$, the only



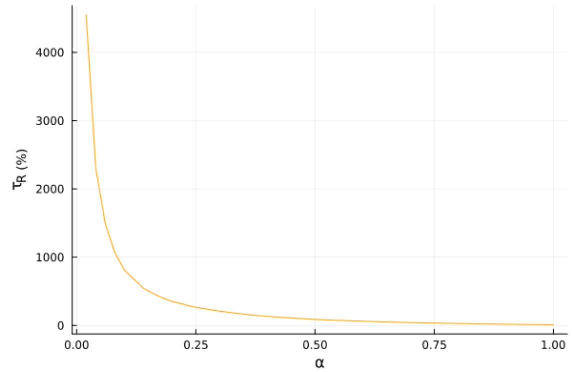


Figure 3: Optimal τ_O, unrestricted

Figure 4: Corresponding optimal τ_R

reason preventing the government from setting infinite rental tax rate is that the construction firm reacts by raising housing prices, hurting owner-occupiers' welfare.

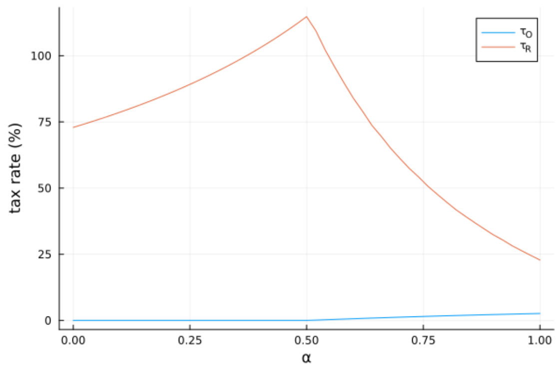
Still, note that these extremely low values of α are highly unlikely to be observed in practice, especially in the presence of very high tax rates, as they imply that the landlords cannot pass a single dollar of the tax burden onto their tenants, which seems hardly credible.

Construction costs

Eventually, as we mentioned in the analysis of the extreme pass-through values, construction costs affect the optimal tax mix. Figures 5 and 6 allow us to understand this differential impact. The optimal tax mix depends on construction costs through the price elasticity and price levels, affecting the *aggregate net price effect* on owners, and the *real tax burden effect* on renters. First, in terms of level, when construction costs increase, the equilibrium prices will tend to be higher. As a result, the real tax rate paid by owner-occupiers increases mechanically relative to that of renters. This leads to a relative shift from τ_O to τ_R in order to keep welfare relatively balanced, as we can see in the second and third rows of Table 2.

Then, more interestingly, construction costs also affect price elasticity, through their convexity. With higher γ and lower κ, there is a higher price elasticity to τ_O so it is possible to have higher property tax rate. Indeed, this cost convexity is driving the size and direction of price response to tax changes, and therefore affects the optimal tax mix, through the price elasticity entering the owners' aggregate net price effect and the renters' real tax burden change. The higher γ, the more convex the construction costs function, and therefore the more responsive the price adjustments to tax changes[20]. This can be seen in Figures 7and 8 displaying the evolution of prices as a function of

[20]Indeed, H being less responsive to price changes, a given demand change has to be faced with a more important price adjustment



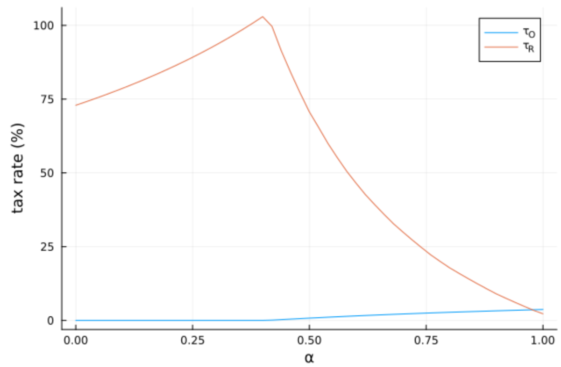
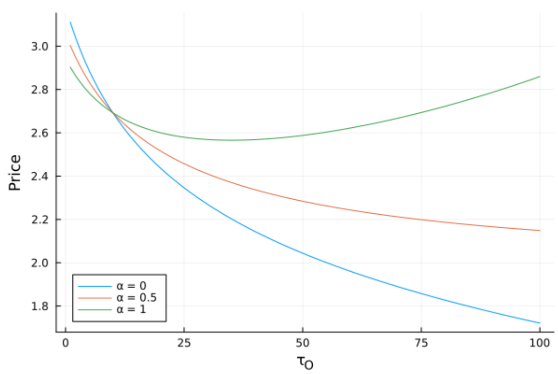


Figure 5: Optimal mix, low price elasticity

Figure 6: Optimal mix, high price elasticity

τ_O, for different values of α. These two specifications yield close housing prices at equilibrium, along different values of α, but significantly different price elasticity. As a result, they imply different levels of property tax rate. The higher the magnitude of the price elasticity, and the more the optimal tax mix leans toward property tax. Indeed, higher price elasticity implies a more important important mitigating net price effect for the welfare of owners, who are only taxed through property tax, which therefore allows to charge higher property tax rates.



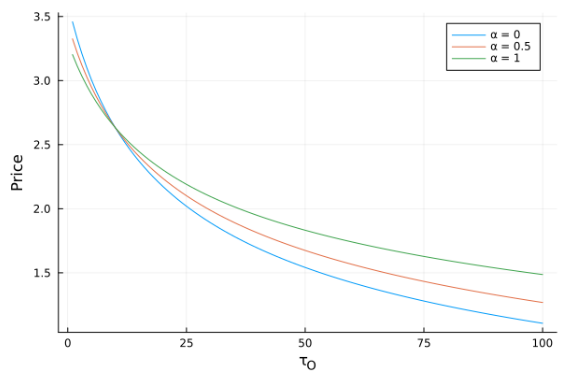


Figure 7: Price response to property tax rate by α ($\kappa = 0.3$, $\gamma = 1.4$)

Figure 8: Price response by property tax rate by α ($\kappa = 0.05$, $\gamma = 2$)

7.3 Effect of endowment inequality, welfare weights and fiscal pressure

We can now test for changes in the optimal tax mix under alternative relative endowment levels and welfare weights. These can enlighten the equity-efficiency trade-off arising from potential (endowment) heterogeneity between owners and renters. We will see that higher relative welfare weight on renters leads to lower tax rate τ_R. On the other hand, pure endowment inequality, keeping welfare weights constant, does not significantly affect the optimal tax mix. Finally, we will see that fiscal pressure is driving the levels of both taxes, and when sufficiently low may make it optimal to subsidize rental housing.

Inequality and endowment heterogeneity

Until this point, we have only considered a relative welfare weight between owner-occupiers and renters $\Omega = 1$. But as we have seen in equation 36 the welfare implications of a tax reform, and therefore the optimal tax mix, depend on the relative welfare weight that is put on renters relative to owner-occupiers, mainly arising from endowment inequality across groups. Let us therefore look at the optimal mix and how it varies when the government weighs renters' welfare relatively less ($\Omega = 0.75$) or more ($\Omega = 1.25$) than owners'.

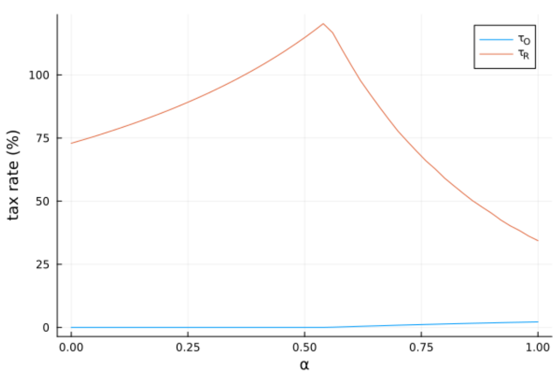


Figure 9: Optimal mix with $\Omega = 0.75$

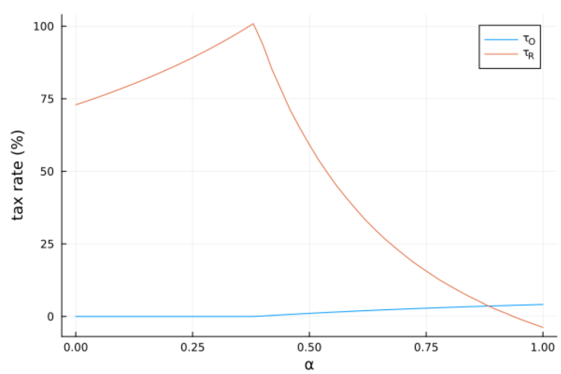


Figure 10: Optimal mix with $\Omega = 1.25$

The results of these numerical simulations are presented in Figures 9 and 10. As one would expect, the higher the welfare weight on renters, the more the optimal τ_R decreases with α, in order to make their tax burden lighter. Consequently, τ_O has to increase to compensate for this lower τ_R and keep the budget balanced. Furthermore, this effect is more pronounced as α increases. Indeed, if $\alpha = 0$, then the renters do not pay any tax, so the welfare weights become irrelevant for the optimal tax mix as only owners' welfare is affected by taxes. Once α starts increasing, the importance of the welfare weights kicks in and begins to matter increasingly. As a result, the discrepancy between the optimal tax rates corresponding to different welfare weights is increasing in α.

Finally, we could study what happens when endowments are heterogeneous and unequally distributed between renters and owner-occupiers, keeping relative welfare weights constant. We can see this as a way to characterize the *efficiency* side of the endowment inequality and how it affects the optimal tax mix. The results are only displayed in Appendix, for overall the results are little changed in terms of tax mix. The equilibrium prices are slightly affected (being lower when renters are relatively more endowed).

Fiscal pressure

Finally, as the fiscal pressure increases, the optimal tax rates are both higher. Indeed, the government needs to raise higher tax revenues. As a result, it has to increase both taxes in a welfare-maximizing way. Symmetrically, this allows to make subsidizing rental housing affordable, and optimal, for relatively low fiscal pressure and high α. Indeed, when α is so high that the government wants to subsidize rental housing, it needs to have the budget to do so, which translates into relatively low fiscal revenue needs.

We can also see that the slope of the optimal rental tax rate is steeper with higher fiscal pressure, which comes from the higher behavioral response of renters. Indeed, a higher fiscal pressure implies higher rental tax rates, for any value of α. Therefore, for the low values of α, when $\tau_O = 0$ is optimal, any increase in α yields an increase in the tax burden that is all the more important as G is high. As a result, the behavioral response is also greater. The marginal increase in the tax burden (due to a marginal increase in α), and therefore the marginal behavioral response, increases with G, which must be compensated for by a greater marginal increase of the rental tax rate.

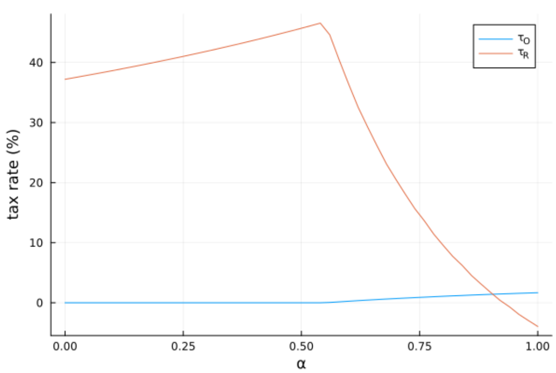


Figure 11: Low fiscal pressure ($G = 3.01$)

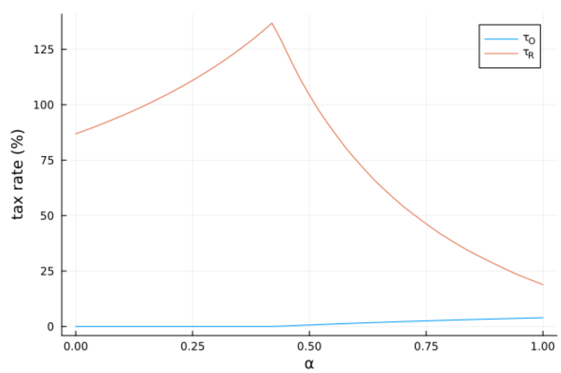


Figure 12: High fiscal pressure ($G = 7.03$)

Should the government subsidize rental housing ?

To conclude these simulations, let us briefly discuss the sign of τ_R. Indeed, there are a bunch of restrictions under which it appears to be optimal to subsidize rental housing ($\tau_R < 0$). The first is, very logically, a condition on α. It is optimal only when α is very high, meaning that these subsidies (negative taxes) will be passed-through entirely to the renters[21]. Then, it needs to be *feasible* for the government, meaning that fiscal pressure needs not to be too high, otherwise the need for tax revenues is too important to allow for negative rental taxation. It also means that the lower the construction costs, and the more elastic the price is, the easier it is to lower τ_R for the government. Finally, it needs to be seen as *fair*, meaning that the relative welfare weight on tenants needs to be high enough, so that it is welfare-relevant for the government to sustain them through transfers.

8 Discussion

In the previous sections, we developed a model—first in theoretical form and then with a more tractable application—that underlined how the pass-through of rental taxation to tenants, along with other key parameters, influences the welfare implications of a budget-neutral property tax reform, and eventually the optimal local tax mix. A central insight of the model is the crucial role played by this degree of pass-through. In all specifications, the welfare-maximizing value of the pass-through parameter α was zero. Indeed, in such a situation there is a sort of "free lunch" for the government, which can tax heavily the construction investor firm, which is paying the whole rental tax, and consequently decrease τ_O. The resulting higher prices are not enough to compensate for the direct beneficial welfare effect of (1) lower property tax for owner-occupiers and (2) the zero tax burden on the renters. The government can thus lower the property tax on homeowners without worsening affordability for renters. This makes it essential to understand exactly what determines pass-through - what lies behind α - and how it can vary across space and policy environments.

8.1 The rental taxation pass-through and its estimates in the literature

First of all, let us remind that we defined α as a bargaining power parameter, governing the pass-through of the tax burden from landlords onto renters. As mentioned in Section 3, it can be seen as arising from a Nash bargaining process where α captures the share of the surplus falling on the tenant, and $(1 - \alpha)$ the landlord's share. The full derivations are presented in Appendix F1. Importantly, this means that any change to the total surplus will be shared according to this fixed rule—regardless of who legally pays the tax. In theory, then, statutory incidence is irrelevant to economic incidence.

However, let us note that, in practice, one might argue that what matters is the *effective* bargaining power, which can be distorted by institutional and market frictions. This is shown

[21] This requires assuming symmetric pass-through, which does not necessarily hold in practice, see Benzarti (2020)

and discussed in more details in Appendix F2. For example, if the mechanism through which landlords shift the tax is rent, then anything affecting rent negotiation or rent-setting power can shift effective bargaining power. Positive rent taxation would then increase the *effective* bargaining power of landlords, and therefore the share of the tax burden they can pass onto renters.

Eventually, to have a more precise idea of this key parameter α, one may look at its empirical estimates. As noted by Loeffler and Siegloch (2024), empirical estimates of pass-through vary widely. As they put, "The previous literature has offered a wide range of estimates for the pass-through of property taxes on rents: Orr (1968, 1970, 1972), Heinberg and Oates (1970), Hyman and Pasour (1973), Dusansky et al. (1981), and Carroll and Yinger (1994) estimate that between 0–115 percent of the tax is shifted onto renters". The two authors, themselves, find evidence of incomplete pass-through in the short-term, and estimate that it reaches 83% of the tax burden 3 years after the tax change. In our baseline specification, $\alpha = 0.83$ would imply the following optimal tax mix : $\{\tau_O = 2.31\%, \tau_R = 24.5\%\}$. This vast heterogeneity highlights the role of local factors and suggests that α is not universal—it depends on market structure, regulation, and mobility.

8.2 Determinants of the pass-through

Let us therefore discuss its determinants in more details. The pass-through is the share of the tax burden, usually legally paid by the landlords, that is in the end borne by the tenant. It therefore depends on the extent to which the landlords manage to make their renters *effectively* pay the taxes, usually through higher rents.

A key determinant is the elasticity of supply and demand, rooted in classical tax incidence theory (Harberger, 1962). When housing supply is more elastic (e.g., in areas with flexible construction sector), the housing supply can be more easily adjusted, leading to higher pass-through. Conversely, in areas with inelastic supply—due to zoning restrictions or limited land for instance—landlords can pass less of the tax burden onto renters. Similarly, when demand is inelastic (e.g., in dense urban areas), renters are less able to avoid rent increases, allowing landlords to shift more of the tax burden. In contrast, if demand is elastic, tenants can avoid rent hikes, reducing pass-through. Thus, pass-through is typically higher in markets with elastic supply and inelastic demand — for example, in constrained urban areas where tenants have few alternatives.

Therefore, labor mobility may reduce demand elasticity, as people can relocate in response to rent increases. Areas with rigid land use policies or physical development constraints make rental supply inelastic, decreasing landlords' ability to shift taxes. Recent work by Loeffler and Siegloch (2024) confirms these hypotheses, documenting that pass-through is lower in large cities and in areas with higher shares of already developed or "undevelopable land". They also find that in areas with more public housing, incidence is lower—suggesting that public housing may act as a competitive pressure that reduces landlords' ability to shift taxes to tenants.

Legal constraints can also play a role. For example, in France, landlords are legally prohibited from passing property taxes onto renters. However, if landlords anticipate tax hikes, they might still incorporate expected costs into rent levels over time. So legal incidence rules usually do not fully prevent economic pass-through. For instance, Fack (2006) showed that increases in French housing benefits to renters were eventually followed by rent increases, amounting to about 80% of the subsidy amount.

Eventually, market structure is another potentially important factor. Watson and Ziv (2024) show that when marginal costs are non-decreasing, concentrated land ownership can raise markups and rents across all parcels, increasing landlords' pricing power. Similarly, zoning restrictions and regulations tend to limit supply and thus increase pass-through and equilibrium rents.

8.3 Construction costs

In addition, it is clear that the supply elasticity, which is probably playing a role in setting the pass-through level, is affected by the shape of construction costs. Indeed, more convex construction costs — where marginal costs increase steeply with output — reduce supply elasticity, thereby lowering the pass-through of property taxes to rents. In addition, steeper cost curves tend to raise housing prices, reducing welfare. However, we also find that more convex costs make prices more responsive to property tax changes, which can help dampen the welfare losses from such taxes.

In turn, construction costs are shaped by a combination of input prices, technological constraints, and regulatory factors, all of which influence supply elasticity and housing prices. A key driver is land availability and pricing. In urban areas where land is scarce—due to either physical constraints or restrictive zoning—land prices rise, increasing overall construction costs and making them more convex (assuming decreasing returns to scale). This reduces supply elasticity and pass-through. Studies such as Gyourko and Molloy (2015) and Duranton and Puga (2015) show that land use regulations (e.g., minimum lot sizes, height restrictions) substantially raise development costs and limit housing supply responses.

Regulatory constraints such as complex permitting processes, parking minimums, or environmental review requirements also contribute to raising costs. These rules increase marginal costs, especially for larger or denser projects, and reduce developers' ability to respond to tax changes by expanding supply. Input costs (e.g., labor, materials, infrastructure connections) rise with scale, especially in tight labor markets or supply-constrained sectors, contributing to convex construction costs. In particular, Albouy, Ehrlich, and Liu (2022) find that construction cost growth is especially steep in cities with strong demand and heavy regulation. Finally, although returns to scale in construction could theoretically lower costs for larger developments, in practice, these efficiencies are often offset by engineering complexity or regulatory frictions in dense settings—limiting supply responsiveness and contributing to incomplete pass-through.

9 Extension : What if we could tax the investor firm?

So far, we have been interested in only two tax instruments, and their optimal combination. We have also seen that the pass-through parameter α determines who is paying the taxes between landlords and their tenants. As one could expect, we saw that lower values of α implied higher aggregate welfare, as they were a way to make the investor firm contribute to most of (if not all) the tax revenue. But there is something even stronger that we could do, why not taxing directly the investor firm? As an extension, let us therefore imagine we were to introduce a housing sales tax on investor, paid whenever a house is sold. The zero-profit condition for the construction sector becomes :

$$\pi(P) = (1 - \tau_F)(1 - \phi)PH_O + (1 - \widetilde{\tau}_I)\phi H_R - c(H) = 0 \tag{44}$$

Furthermore, this new tax instrument is another tool in the hands of the government to raise tax revenues. The budget constraint of the government becomes :

$$G = (1 - \phi)H_O P(\tau_O + \tau_F) + \phi H_R(\tau_O P + \tau_R) \tag{45}$$

This new tax can be seen as a substitute for the property tax rate paid by owners, as they have the same tax base. Because it is fully borne by the investor firm, it may come out as a sort of free lunch for the government, which can levy this tax instrument to raise revenues without affecting directly the welfare of owner-occupiers. We can simulate the optimal tax mix, between these three instruments, along different values of the pass-through parameter α.

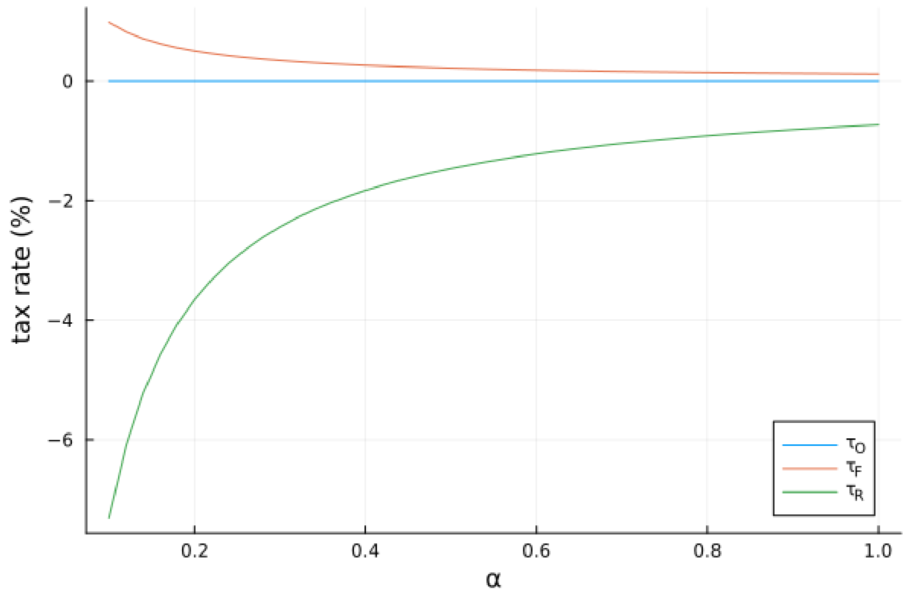


Figure 13: Optimal tax mix with τ_F, by value of the pass-through

The results of these simulations are displayed in Figure 13. Note that it starts at $\alpha = 0.1$, because for lower pass-through values τ_F and τ_R optimally become extremely high, and extremely negative, respectively. We will see why it is the case below. As we expected, the optimal property tax rate is stuck at 0. Indeed, it can be substituted for by τ_F for owner-occupied housing, and τ_R for rental housing. The introduction of τ_F therefore allows to impose a zero tax burden on owner-occupiers. It then also allows to subsidize rental housing, and all the tax revenues required to balance the budget are collected through housing transaction tax. Intuitively, this comes from the fact that τ_F may affect welfare only through the price channel, as it should lead the investor firm to charge higher housing prices. This negative welfare effect is discounted by the net marginal cost of housing (as it is beneficial to future wealth value) and it allows to mechanically raise more revenues. On the other hand, changing τ_R would directly affect renters, in addition to raising prices. Therefore, it is optimal to use τ_F to raise all tax revenues, and subsidize rental housing.

Nevertheless, this subsidy is decreasing with α. This may be understood as a consequence of the behavioral effect that we highlighted when discussing the shape of the optimal tax mix in section 7. Indeed, as α increases, a higher share of the tax burden is borne by the tenants. Because $\tau_O = 0$ and $\tau_R < 0$, the real rental tax burden is negative, meaning that renters are subsidized. As a result, the higher α, the greater the share of the subsidy they receive, and therefore the higher H_R (behavioral response). Therefore, it becomes more costly to the government to subsidize all rental housing units, and the subsidy declines as α increases (the absolute value of τ_R decreases).

Finally, let us interestingly note that the welfare-maximizing value of the parameter α is no longer trivial at all. Indeed, a higher α now means that renters receive a higher portion of the subsidy, but it also implies lower subsidies. As a result the effect is non trivial. Eventually, we find that the aggregate welfare level is approximately constant across values of α; indicating that both effects perfectly compensate. Note that for $\alpha = 0$, there is not a unique optimal tax mix. Indeed, in this situation subsidizing rental housing is not welfare-improving, because no subsidy will be passed through onto renters. As a result, any combination of the firm and the rental tax are equivalent.

When the property tax rate is allowed to be negative, then it becomes optimal to set $\tau_O = -4\%$, across all values of the pass-through parameter α, effectively subsidizing home-ownership. This implies a corresponding slightly higher tax rate on the construction firm, in order to generate the required additional tax revenues for the government. The corresponding optimal tax mix is plotted in Appendix F. Once again, the government uses the construction firm to raise tax revenues that it can, in turn, redistribute to renters and owner-occupiers, through slightly negative property tax rates.

10 Conclusion

We have studied the welfare implications and optimal design of housing taxation through the lens of two central instruments: a property tax and a rental income tax. Our analysis highlights how differential taxation across owner-occupied and rental housing affects household welfare in the presence of tenure heterogeneity, focusing on the incidence of rental taxation and its pass-through from landlords to tenants.

We examined budget-neutral reforms that marginally increase the property tax rate while mechanically reducing the rental income tax rate. Owner-occupiers face a direct welfare loss from the higher property tax burden. However, this effect is mitigated by partial equilibrium price adjustments: higher property taxation capitalizes into lower housing prices, reducing the tax base and easing the net burden on owners. This price response is further amplified by the concurrent reduction in the rental income tax, which also affects overall housing demand and may lower housing prices. For renters, welfare effects depend on how the total rental tax burden changes and how much of it is passed through by landlords. While property tax increases raise the effective tax burden on rental units, this is usually offset by the reduction in rental income taxation, which applies only to rented properties. Importantly, renter welfare is sensitive to the degree of pass-through, as only the portion of taxes shifted onto tenants directly affects their utility.

Using a calibrated tractable model, we then characterized the optimal tax mix as a function of the pass-through rate. We find that the optimal property tax rate is zero when pass-through is low and rises monotonically thereafter. In contrast, the optimal rental income tax follows an inverse U-shape: it initially increases with pass-through when renters are relatively protected, but decreases as the incidence shifts more heavily onto them, compressing their housing consumption and the rental tax base. To maintain revenue neutrality, the government must then rely more heavily on property taxation. For instance, under the empirical estimate of the pass-through rate $\alpha = 0.83$ from Löffler and Siegloch (2020), the baseline implied optimal tax mix is $\tau_O = 2.31\%$ and $\tau_R = 24.5\%$.

We further show that when housing prices are lower or more elastic—due to lower or more convex construction costs—the optimal tax mix shifts toward property taxation. In addition, when fiscal needs are limited and renter welfare is prioritized, it may be optimal to subsidize rental housing. Such a policy can be implemented via an upstream instrument, such as a direct housing sales tax on the construction sector.

Finally, our results rely on the responsiveness of the property tax base to housing prices. Indeed, the mitigating net price effects on owners' welfare depended crucially on the direct link between house prices and tax base value. However, in practice, assessed property values may not fully track market prices. These deviations can weaken the mitigating role of price adjustments and may affect the optimal composition of housing taxes.

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Appendices

A Solution of households and investor problems

In this appendix section let us derive the full solutions of the households and investor problems.

A.1 Owner-occupiers

The problem of the owner-occupiers yields the following first-order conditions :

$$\begin{cases} U'_C(C_O, h_O) = \beta B'(W)(1+r) & (46) \\ (1+\tau_O)PU'_C(C_O, h_O) = U'_H(C_O, h_O) + \beta B'(W)P(1-\delta) & (47) \end{cases}$$

This allows us to re-write an interesting trade-off condition between nondurable consumption and housing :

$$(1+\tau_O)PU'_C(C_O, h_O) = U'_H(C_O, h_O) + \frac{U'_C(C_O, h_O)}{1+r}P(1-\delta)$$

$$PU'_C(C_O, h_O)\left(1 + \tau_O - \frac{(1-\delta)}{1+r}\right) = U'_H(C_O, h_O)$$

$$PU'_C(C_O, h_O)\left(\tau_O + \frac{\delta + r}{1+r}\right) = U'_H(C_O, h_O) \tag{48}$$

Individual welfare change Now that we have solved for the equilibrium conditions of the owners' problem, we can use it to study the direct welfare effect of a change in τ_O on owner-occupiers. To do so, let us first recall the problem they were facing :

$$V_O = \max_{A_O, h_O} U(C_O, h_O) + \beta B(W) \tag{49}$$

$$\text{s.t. } C_O + A_O + (1+\tau_O)P(\tau_O, \tau_R)h_O = Y$$

$$W = (1+r)A + P(\tau_O, \tau_R)h_O(1-\delta)$$

It is then possible to compute the effect of a marginal change in τ_O on their welfare[22] :

$$\frac{\partial V_O}{\partial \tau_O} = -U'_C(C_O, h_O)\left((1+\tau_O)\frac{\partial P}{\partial \tau_O} + P\right)h_O + \beta B'(W)(1-\delta)\frac{\partial P}{\partial \tau_O}h_O$$

$$= -\left(U'_C(C_O, h_O)\left((1+\tau_O)\frac{\partial P}{\partial \tau_O} + P\right) - \beta B'(W)(1-\delta)\frac{\partial P}{\partial \tau_O}\right)h_O$$

[22] Using the envelope theorem and replacing C_O with the budget constraint

We can now use equation (7) to replace $B'(W)$ and get an expression fully on $U_C^{'}(C_O, h_O)$:

$$\frac{\partial V_O}{\partial \tau_O} = -U_C'(C_O, h_O)\left(\left(\tau_O + \frac{(\delta+r)}{(1+r)}\right)\frac{\partial P}{\partial \tau_O} + P\right)h_O$$

$$\frac{\partial V_O}{\partial \tau_O} = -U_C'(C_O, h_O)\left(1 + \left(\tau_O + \frac{(\delta+r)}{(1+r)}\right)\varepsilon^P_{\tau_O}\right)Ph_O \tag{50}$$

Individual welfare change following τ_R adjustment

$$\frac{\partial V_O}{\partial \tau_R} = -U_C'(C_O, h_O)\left((1+\tau_O)\frac{\partial P}{\partial \tau_R}\right)h_O + \beta B'(W)(1-\delta)\frac{\partial P}{\partial \tau_R}h_O \tag{51}$$

$$\frac{\partial V_O}{\partial \tau_R} = -\left(U_C'(C_O, h_O)(1+\tau_O)\frac{\partial P}{\partial \tau_R} - \frac{U_C'(C_O, h_O)}{1+r}(1-\delta)\frac{\partial P}{\partial \tau_R}\right)h_O \tag{52}$$

$$\frac{\partial V_O}{\partial \tau_R} = -U_C'(C_O, h_O)\frac{\partial P}{\partial \tau_R}\left(\tau_O + \frac{\delta+r}{1+r}\right)h_O \tag{53}$$

A.2 Renters

Similarly, we can study the problem of the renters, as exposed in section 2. Solving this problem yields the following first-order conditions :

$$\begin{cases}(1+\tilde{\tau_R})U_C'(C_R, h_R) = U_H'(C_R, h_R) & (54)\\ U_C'(C_R, h_R) = \beta(1+r)B'(W_R) & (55)\end{cases}$$

Welfare effect of a tax change

The welfare impact of a tax change on renters' welfare can then be computed, once again starting from their problem, exposed in (2). The only issue one should care about and keep in mind is that they do not pay directly τ_O or τ_R but only $\widetilde{\tau_R}$, which is itself a function of the two tax instruments.

The direct welfare impact of a change in $\tau_j \in (\tau_O, \tau_R)$ can be expressed as :

$$\frac{\partial V_R}{\partial \tau_j} = \frac{\partial V_R}{\partial \widetilde{\tau_R}}\frac{\partial \widetilde{\tau_R}}{\partial \tau_j} = -U_C^{'}h_R\frac{\partial \widetilde{\tau_R}}{\partial \tau_j} \tag{56}$$

Note that it is simpler than for owners, as renters do not own the place where they live, and therefore do not transmit it into future wealth.

Note that taking $\widetilde{\tau_R} = \alpha(\tau_O P + \tau_R)$, we have

$$\frac{\partial \widetilde{\tau_R}}{\partial \tau_R} = \alpha \left(1 + \tau_O \frac{\partial P}{\partial \tau_R}\right)$$

and

$$\frac{\partial \widetilde{\tau_R}}{\partial \tau_O} = \alpha \left(\tau_O \frac{\partial P}{\partial \tau_O} + P\right)$$

We can therefore rewrite the direct welfare effect of a change in property tax and rental income tax rates respectively as :

$$\frac{\partial V_R}{\partial \tau_O} = -U_C^{'} P h_R \alpha \left(1 + e^P_{\tau_O}\right) \tag{57}$$

$$\frac{\partial V_R}{\partial \tau_O} = -U_C^{'} h_R \alpha \left(1 + \tau_O P \varepsilon^P_{\tau_R}\right) \tag{58}$$

where $e^P_{\tau_O} = \frac{dP}{d\tau_O}\frac{\tau_O}{P}$ *is the full price elasticity to* τ_O *and* $\varepsilon^P_{\tau_R} = \frac{dP}{d\tau_O}\frac{1}{P}$ *its semi-elasticity to* τ_R

A.3 Construction firm and housing price-setting

Finally, price adjustments (and ultimately its elasticity to taxes) are endogenous and can be derived, starting from the zero-profit condition of the construction sector. The zero-profit condition writes as :

$$\pi(P) = P(1-\phi)H_O(P) + \phi(1-\widetilde{\tau}_I)H_R(P) - c(H(P)) = 0 \tag{59}$$

To understand the response of price to a change in τ_O, we can simply differentiate this expression with respect to τ_O, using the implicit function theorem. This yields the following :

$$(1-\phi)\left(\frac{dP}{d\tau_O}H_O + P\frac{dH_O}{d\tau_O}\right) + \phi\left((1-\widetilde{\tau}_I)\frac{dH_R}{d\tau_O} - \frac{d\widetilde{\tau}_I}{d\tau_O}H_R\right) - c'(H)\left((1-\phi)\frac{dH_O}{d\tau_O} + \phi\frac{dH_R}{d\tau_O}\right) = 0$$

$$(1-\phi)\left(\frac{dP}{d\tau_O}H_O + (P - c'(H))\frac{dH_O}{d\tau_O}\right) + \phi\left((1-\widetilde{\tau}_I - c'(H))\frac{dH_R}{d\tau_O} - \frac{d\widetilde{\tau}_I}{d\tau_O}H_R\right) = 0$$

Let us recall/use that

$$\frac{d\tilde{\tau}_I}{d\tau_O} = (1-\alpha)\left(P + \tau_O\frac{dP}{d\tau_O} + \frac{d\tau_R}{d\tau_O}\right)$$

and

$$\frac{\partial H_R}{\partial \tau_O} = \frac{\partial H_R}{\partial \tilde{\tau}_R}\alpha\left(P + \tau_O\frac{dP}{d\tau_O} + \frac{d\tau_R}{d\tau_O}\right)$$

We can then rewrite :

$$\frac{dP}{d\tau_O} = -\frac{(1-\phi)H_O\left((P-c'(H))\varepsilon^{H_O}_{\tau_O}\right) - \phi\left(P + \frac{d\tau_R}{d\tau_O}\right)H_R\left((1-\widetilde{\tau}_I - c'(H))\varepsilon^{H_R}_{\widetilde{\tau}_R}\alpha - (1-\alpha)\right)}{(1-\phi)H_O\left(1 + (P-c'(H))\varepsilon^{H_O}_{P}\right) + \phi\tau_O H_R\left((1-\widetilde{\tau}_I - c'(H))\varepsilon^{H_R}_{\widetilde{\tau}_R}\alpha - (1-\alpha)\right)} \tag{60}$$

where $\varepsilon^{H_O}_{\tau_O}$ is the overall semi-elasticity of the owner-occupied housing demand to property tax (including the mechanical adjustment in τ_R) and $\varepsilon^{H_O}_{P}$ is its semi-ekasticity to housing price.

The sign and magnitude of the price adjustment is not clear at first sight. Nevertheless, we can see that it seems to be lower in magnitude with higher marginal costs, which would explain the importance of the convexity parameter in the application part. Indeed, more convex construction costs imply less responsive housing supply and therefore a need for more elastic price adjustments, as discussed in the application section.

B Budget-neutral reform analysis

Throughout this part we will use the following notations, for any variable X and any tax rate $\tau_j \in \{\tau_O, \tau_R\}$:

$$e^X_{\tau_j} = \frac{dX}{d\tau_j}\frac{\tau_j}{X} \tag{61}$$

is the full elasticity of variable X to tax τ_j.

$$\varepsilon^X_{\tau_j} = \frac{dX}{d\tau_j}\frac{1}{X} \tag{62}$$

is the semi-elasticity of variable X to τ_j.

B.1 Mechanical impact of τ_O change on τ_R

The full GBC writes $G = \tau_O P(\tau_O, \tau_R)H + \phi\tau_R H_R$. Also note that $\frac{dP}{d\tau_O} = \frac{\partial P}{\partial \tau_O} + \frac{\partial P}{\partial \tau_R}\frac{d\tau_R}{d\tau_O}$. Finally, note that, assuming that the endowment distribution is fixed and remains unaffected by tax changes,

$$\frac{dH_O}{d\tau_O} = \int \frac{dh_O}{d\tau_O} dF_O(Y) \tag{63}$$

and

$$\frac{dH_R}{d\tau_O} = \int \frac{dh_R}{d\tau_O} dF_R(Y) \tag{64}$$

We can therefore differentiate with respect to τ_O, which yields :

$$0 = \left(P(\tau_O,\tau_R)H(P,\tau_O,\tau_R) + \tau_O\frac{dP}{d\tau_O}H(P,\tau_O,\tau_R) + \tau_O P(\tau_O,\tau_R)\frac{dH}{d\tau_O}\right) + \phi\left(\frac{d\tau_R}{d\tau_O}H_R(P,\tau_O,\tau_R) + \tau_R\frac{dH_R}{d\tau_O}\right) \tag{65}$$

We can rewrite this expression and isolate the mechanical adjustment of the rental income tax in the following way :

$$-\frac{d\tau_R}{d\tau_O}\left(\phi H_R(P,\tau_O,\tau_R) - \tau_O P(\tau_O,\tau_R)\frac{\partial H}{\partial \tau_R} - \phi\tau_R\frac{\partial H_R}{\partial \tau_R}\right) - \frac{\partial P}{\partial \tau_R}\frac{d\tau_R}{d\tau_O}\left(\tau_O H(P,\tau_O,\tau_R) + \tau_O P(\tau_O,\tau_R)\frac{\partial H}{\partial P} + \phi\tau_R\frac{\partial H_R}{\partial P}\right) =$$

$$P(\tau_O,\tau_R)H(P,\tau_O,\tau_R) + \left(\frac{\partial P}{\partial \tau_O}\right)\left(\tau_O H(P,\tau_O,\tau_R) + \tau_O P(\tau_O,\tau_R)\frac{\partial H}{\partial P} + \phi\tau_R\frac{\partial H_R}{\partial P}\right) + \tau_O P(\tau_O,\tau_R)\left(\frac{\partial H}{\partial \tau_O}\right) + \phi\tau_R\left(\frac{\partial H_R}{\partial \tau_O}\right)$$

$$-\frac{d\tau_R}{d\tau_O}\left(\phi H_R(P,\tau_O,\tau_R) + \tau_O P(\tau_O,\tau_R)\frac{\partial H}{\partial \tau_R} + \phi\tau_R\frac{\partial H_R}{\partial \tau_R} + \frac{\partial P}{\partial \tau_R}\left(\tau_O H(P,\tau_O,\tau_R) + \tau_O P(\tau_O,\tau_R)\frac{\partial H}{\partial P} + \phi\tau_R\frac{\partial H_R}{\partial P}\right)\right) =$$

$$P(\tau_O,\tau_R)H(P,\tau_O,\tau_R) + \left(\frac{\partial P}{\partial \tau_O}\right)\left(\tau_O H(P,\tau_O,\tau_R) + \tau_O P(\tau_O,\tau_R)\frac{\partial H}{\partial P} + \phi\tau_R\frac{\partial H_R}{\partial P}\right) + \tau_O P(\tau_O,\tau_R)\left(\frac{\partial H}{\partial \tau_O}\right) + \phi\tau_R\left(\frac{\partial H_R}{\partial \tau_O}\right)$$

$$\frac{d\tau_R}{d\tau_O} = -\frac{P(\tau_O,\tau_R)H(P,\tau_O,\tau_R) + \frac{\partial P}{\partial \tau_O}\left(\tau_O H(P,\tau_O,\tau_R)\right) + \tau_O P(\tau_O,\tau_R)\left(\frac{\partial H}{\partial \tau_O} + \frac{\partial H}{\partial P}\frac{\partial P}{\partial \tau_O}\right) + \phi\tau_R\left(\frac{\partial H_R}{\partial \tau_O} + \frac{\partial H_R}{\partial P}\frac{\partial P}{\partial \tau_O}\right)}{\phi\left(H_R(P,\tau_O,\tau_R) + \tau_R\left(\frac{\partial H_R}{\partial \tau_R} + \frac{\partial H_R}{\partial P}\frac{\partial P}{\partial \tau_R}\right)\right) + \tau_O\left(P(\tau_O,\tau_R)\left(\frac{\partial H}{\partial \tau_R} + \frac{\partial H}{\partial P}\frac{\partial P}{\partial \tau_R}\right) + \frac{\partial P}{\partial \tau_R}H(P,\tau_O,\tau_R)\right)} \tag{66}$$

The first term of the numerator can be seen as the pure mechanical effect : the government marginally increases τ_O, allowing it to raise PH. Then, there is a first response in price adjustment, which may amplify the revenue collected, or decrease it. We can see that the numerator contains terms such as the derivative of H and H_R with respect to τ_O, both directly and through its direct price effect. On the other hand, the denominator contains terms associated to these responses to τ_R, both directly and through direct impact on price. This makes sense : If the taxable housing stock responds a lot to an increase in τ_O, then the tax revenue raised is relatively low, and we cannot decrease the other tax. On the other hand, if it responds a lot to a decrease in τ_R, then it expands the tax base, making it less costly for the government to adjust the rental tax rate τ_R.

Analysis of the denominator (rental tax-related channel)

Let us focus on the denominator for a moment :

$$\phi\left(H_R(P,\tau_O,\tau_R) + \tau_R\left(\frac{\partial H_R}{\partial \tau_R} + \frac{\partial H_R}{\partial P}\frac{\partial P}{\partial \tau_R}\right)\right) + \tau_O\left(P(\tau_O,\tau_R)\left(\frac{\partial H}{\partial \tau_R} + \frac{\partial H}{\partial P}\frac{\partial P}{\partial \tau_R}\right) + \frac{\partial P}{\partial \tau_R}H(P,\tau_O,\tau_R)\right)$$

$$= \phi\left(H_R(P,\tau_O,\tau_R) + \tau_R\left(\frac{\partial H_R}{\partial \tau_R} + \frac{\partial H_R}{\partial P}\frac{\partial P}{\partial \tau_R}\right)\right) + \tau_O PH\left(\frac{1}{H}\left(\frac{\partial H}{\partial \tau_R} + \frac{\partial H}{\partial P}\frac{\partial P}{\partial \tau_R}\right) + \varepsilon_{P\tau_R}\right)$$

$$= \phi H_R \left(1 + \tau_R \varepsilon_{H_R \tau_R}\right) + \tau_O PH \left(\varepsilon_{H,\tau_R} + \varepsilon_{P\tau_R}\right) \tag{67}$$

It depends on the current stock ϕH_R both directly, and through the elasticity of this supply to τ_R. Indeed, if a slight decrease in τ_R leads to a massive increase in H_R, it mechanically raises this part of the revenue. It also depends on $\tau_O PH$, indirectly, through the adjustment of P and H, as they may react to the decrease in τ_R. If this response is large, then the property tax base expands and the government raises more revenues, mitigating the decrease in the rental income tax rate.

Numerator analysis (property tax-related channel

Let us then focus on the numerator. Starting line 2, we omit the full specification of variables driving P and H, for the sake of readability :

$$P(\tau_O, \tau_R)H(P, \tau_O, \tau_R) + \frac{\partial P}{\partial \tau_O}\tau_O H(P, \tau_O, \tau_R) + \tau_O P(\tau_O, \tau_R)\left(\frac{\partial H}{\partial \tau_O} + \frac{\partial H}{\partial P}\frac{\partial P}{\partial \tau_O}\right) + \phi\tau_R\left(\frac{\partial H_R}{\partial \tau_O} + \frac{\partial H_R}{\partial P}\frac{\partial P}{\partial \tau_O}\right)$$

$$= PH\left(1 + \frac{1}{P}\frac{\partial P}{\partial \tau_O}\tau_O + \tau_O\frac{1}{H}\left(\frac{\partial H}{\partial \tau_O} + \frac{\partial H}{\partial P}\frac{\partial P}{\partial \tau_O}\right)\right) + \phi\tau_R\left(\frac{\partial H_R}{\partial \tau_O} + \frac{\partial H_R}{\partial P}\frac{\partial P}{\partial \tau_O}\right)$$

$$= PH\left(1 + \tau_O\left(\varepsilon_{P\tau_O} + \varepsilon_{H\tau_O}\right)\right) + \phi\tau_R H_R \varepsilon_{H_R\tau_O}$$

$$= PH\left(1 + e^P_{\tau_O} + e_{H\tau_O}\right) + \phi\tau_R H_R \varepsilon_{H_R\tau_O} \tag{68}$$

Overall mechanical tax adjustment, in a budget neutral reform

Overall, we can re-write it as :

$$\frac{d\tau_R}{d\tau_O} = -\frac{PH\left(1 + e^P_{\tau_O} + e_{H\tau_O}\right) + \phi\tau_R H_R \varepsilon_{H_R\tau_O}}{\tau_O PH\left(\varepsilon_{H,\tau_R} + \varepsilon_{P\tau_R}\right) + \phi H_R\left(1 + e_{H_R\tau_R}\right)} \tag{69}$$

It is clear that what matters above, is the mechanical PH-scaled adjustment, multiplied by a multiplicator related to elasticities of P and H with respect to τ_O (positively) and of H_R. On the contrary, the bottom depends on the mechanical adjustment ϕH_R, with a multiplicator term depending of the same terms as above, with respect to τ_R now. Note that $e_{H\tau_O}$ and $e_{H_R\tau_O}$ should be negative. The sign of $e^P_{\tau_O}$ is not clear *a priori*, and is let free.

Finally note that the elasticities of H (through H_R) and H_R depend on the incidence α !

Indeed,

$$\frac{\partial H_R}{\partial \tau_R} = \frac{\partial H_R}{\partial \tilde{\tau_R}} \frac{\partial \tilde{\tau_R}}{\partial \tau_R} = \frac{\partial H_R}{\partial \tilde{\tau_R}} \alpha \left(1 + \tau_O \frac{\partial P}{\partial \tau_R}\right)$$

.

As a result,

$$e_{H_R \tau_R} = \frac{1}{H_R} \frac{\partial H_R}{\partial \tau_R} = e_{H_R \tilde{\tau_R}} \alpha \left(1 + \tau_O \frac{\partial P}{\partial \tau_R}\right) \tag{70}$$

B.2 Aggregate welfare change

We can eventually derive the aggregate welfare change, using all the elements computed above. Following equation 27, it can be written in the following way :

$$\frac{dW}{d\tau_O} = (1-\phi) \int \left(\frac{\partial V_O}{\partial \tau_O} + \frac{\partial V_O}{\partial \tau_R} \frac{d\tau_R}{d\tau_O} \right) \omega(Y) dF_O(Y) + \phi \int \left(\frac{\partial V_R}{\partial \tau_O} + \frac{\partial V_R}{\partial \tau_R} \frac{d\tau_R}{d\tau_O} \right) \omega(Y) dF_R(Y) \tag{71}$$

We can then replace all individual welfare changes by their values derived earlier, which yields :

$$\begin{aligned} \frac{dW}{d\tau_O} = &-(1-\phi) \int P \left(1 + \left(\tau_O + \frac{(\delta + r)}{(1+r)}\right) \left(\varepsilon^P_{\tau_O} + \varepsilon^P_{\tau_R} \frac{d\tau_R}{d\tau_O}\right)\right) g_O(Y) h_O dF_O(Y) \\ &-\phi \int \alpha \left(P\left(1 + \tau_O \varepsilon^P_{\tau_O}\right) + \left(1 + \tau_O P \varepsilon^P_{\tau_R}\right) \frac{d\tau_R}{d\tau_O}\right) g_R(Y) h_R dF_R(Y) \end{aligned} \tag{72}$$

Eventually, noting that only $g_O(Y)$, $g_R(Y)$, $H_O(Y)$ and $H_R(Y)$ depend on Y, where $g_O(Y) = U'_C(C_O, h_O)\omega_O(Y)$ and $g_R(Y) = U^{'}_C(C_R, h_R)\omega_R(Y)$, we can rewrite it as in Proposition 5 :

$$\begin{aligned} \frac{dW}{d\tau_O} = &-(1-\phi) P \left(1 + \underbrace{\left(\tau_O + \frac{(\delta + r)}{(1+r)}\right) \left(\varepsilon^P_{\tau_O} + \varepsilon^P_{\tau_R} \frac{d\tau_R}{d\tau_O}\right)}_{\textit{Owners' aggregate net price effect}}\right) \underbrace{\int g_O(Y) h_O dF_O(Y)}_{\textit{Owners' welfare weight}} \\ &-\phi \underbrace{\alpha \left(P\left(1 + \tau_O \varepsilon^P_{\tau_O}\right) + \left(1 + \tau_O P \varepsilon^P_{\tau_R}\right) \frac{d\tau_R}{d\tau_O}\right)}_{\textit{Renters' real tax burden change}} \underbrace{\int g_R(Y) h_R dF_R(Y)}_{\textit{Renters' welfare weight}} \end{aligned} \tag{73}$$

This is the expression proposed in Proposition 5. We can remark that if prices do not respond to change in τ_R, then the effect on owners is only negative and goes through the mechanical channel plus the response of prices to τ_O. The mechanical adjustment of τ_R will then only play a role in the welfare of renters. We can also note that if $\alpha = 0$, then the effect on renters disappear, and only the effect on owners remain, logically. We can also see that P will tend to amplify the effect, be it negative or positive.

C Tractable Model

Using the functional forms introduced in the application, in Section 6, we can derive explicit and tractable expressions for the key elasticities and the formulas for Propositions 4 and 5. First, let us derive the solutions to owner-occupiers' and renters' problems, before computing their individual welfare changes after a tax reform and the key demand elasticities. Finally, we will look at their application to Proposition 4 and 5.

C.1 Solutions to households problem

Owner-occupiers

Going back to the trade-off condition between numéraire consumption and housing, we had :

$$PU'_C(C_O, h_O)\left(\tau_O + \frac{r+\delta}{1+r}\right) = U'_H(C_O, h_O) \tag{74}$$

Applying the tractable specification of the model and household preferences, this becomes :

$$Ph_O\left(\tau_O + \frac{r+\delta}{1+r}\right) = \theta C_O \tag{75}$$

This is key as it importantly implies that at equilibrium we can rewrite :

$$U'(C_O, h_O)h_O = \frac{h_O}{C_O} = \frac{\theta(1+r)}{P\left(\tau_O(1+r)+r+\delta\right)} \tag{76}$$

This product does not depend on the endowment level Y. This is crucial as it implies that we do no longer need to account for endowment heterogeneity in the welfare change analysis, except for the implied relative welfare weights. Eventually, solving for the tractable solutions for equilibrium numéraire consumption, housing and saving, using the FOCs and the budget constraint of the owner-occupier, we get :

$$h_O = \frac{\theta(1+r)}{P\left((1+r)\tau_O + r+\delta\right)(1+\beta\psi+\theta)}Y \tag{77}$$

$$C_O = \frac{Ph_O}{\theta}\left(\tau_O + \frac{r+\delta}{1+r}\right) = \frac{Y}{(1+\beta\psi+\theta)} \tag{78}$$

and

$$W = \beta\psi(1+r)C = \beta\psi(1+r)\frac{Y}{(1+\beta\psi+\theta)} \tag{79}$$

Renters

Turning to the problem of renters, we can solve it in a similar way, and similar conclusions and implications of the tractable model will hold. The first FOC of their problem gave us

$$(1+\widetilde{\tau_R})U'_C(C_R,h_R) = U'_H(C_R,h_R) \tag{80}$$

Under the tractable specification we introduced, it becomes :

$$(1+\widetilde{\tau_R})h_R = \theta C_R \tag{81}$$

Once again, it importantly implies that we can write :

$$U'(C_R,h_R)h_R = -\frac{h_R}{C_R} = -\frac{\theta}{1+\widetilde{\tau_R}} \tag{82}$$

For renters too, this product does not depend on the endowment level. As a result, the only degree to which heterogeneity matters is through its implications to (1) aggregate owner-occupied and rental housing stocks, and (2) the relative social welfare weights it may imply. Eventually, this implies the following equilibrium values of numéraire consumption, housing, and savings :

$$H_R = \frac{\theta}{(1+\beta\psi+\theta)(1+\tilde{\tau_R})}Y \tag{83}$$

$$C_R = \frac{(1+\tilde{\tau_R})}{\theta}H_R = \frac{Y}{(1+\beta\psi+\theta)} \tag{84}$$

$$A_R = \beta\psi C_R = \beta\psi\frac{Y}{(1+\beta\psi+\theta)} \tag{85}$$

Aggregate housing stock

As we briefly mentioned above, the housing stock still depends on the endowment level. We can now see that it does so in a linear way (implying an elasticity of 1, which is not far from the literature [23]). This implies that the aggregat housing stocks can simply be written as :

$$H_O = \int \frac{\theta(1+r)Y}{P\left((1+r)\tau_O + r + \delta\right)(1+\beta\psi+\theta)}dF_O(Y) = \frac{\theta(1+r)}{P\left((1+r)\tau_O + r + \delta\right)(1+\beta\psi+\theta)}\bar{Y}_O \tag{86}$$

[23] "Typically, income elasticity of demand for real estate are estimated to be near one (Glaeser, Kahn and Rappaport 2008)", Glaeser (2008)

and

$$H_R = \int \frac{\theta Y}{(1+\beta\psi+\theta)(1+\tilde{\tau_R})} dF_R(Y) = \frac{\theta}{(1+\beta\psi+\theta)(1+\tilde{\tau_R})}\bar{Y}_R \tag{87}$$

where $\bar{Y}_O$ and $\bar{Y}_R$ are respectively the average/aggregate endowment of owner-occupiers and renters.

Implied demand elasticities

We can now turn to the last element of interest for the welfare change expression, the elasticities of the housing stocks. Under the specified functional forms, the main housing elasticities are :

$$e^{H_O}_{\tau_O} = e^P_{\tau_O} + \frac{(1+r)\tau_O}{((1+r)\tau_O + r + \delta)} \tag{88}$$

$$e^{H_O}_{\tau_R} = e^P_{\tau_R} \tag{89}$$

$$e^{H_R}_{\tau_O} = \alpha \frac{\tau_O P}{1+\widetilde{\tau_R}} \left(e^P_{\tau_O} + 1\right) \tag{90}$$

$$e^{H_R}_{\tau_R} = \alpha \frac{\tau_R P}{1+\tilde{\tau_R}} \left(\frac{1}{P} + \tau_O \varepsilon^P_R\right) \tag{91}$$

C.2 Mechanical budget adjustment

We can now rewrite the mechanical, budget-neutral, tax adjustment following a property tax change as follows :

$$0 = \left(PH + \tau_O \frac{dP}{d\tau_O} H + \tau_O P \frac{dH}{d\tau_O}\right) + \phi\left(\frac{d\tau_R}{d\tau_O} H_R + \tau_R \frac{dH_R}{d\tau_O}\right) \tag{92}$$

$$0 = PH + \tau_O \frac{dP}{d\tau_O} H + (1-\phi)\tau_O P \frac{dH_O}{d\tau_O} + \phi\left(\frac{d\tau_R}{d\tau_O} H_R + (\tau_O P + \tau_R)\frac{dH_R}{d\tau_O}\right)$$

Letting $\eta = \tau_O H - (1-\phi)\tau_O H_O - \phi\tau_O \frac{\tilde{\tau_R} H_R}{(1+\tilde{\tau_R})}$:

$$\phi \frac{d\tau_R}{d\tau_O}\left(H_R - \frac{\tilde{\tau_R} H_R}{(1+\tilde{\tau_R})}\right) + \frac{\partial P}{\partial \tau_R}\frac{d\tau_R}{d\tau_O}\eta = -\left(PH + \frac{\partial P}{\partial \tau_O}\eta - (1-\phi)\tau_O \frac{H_O}{(r+\delta+(1+r)\tau_O)}(1+r)P - \phi \frac{\tilde{\tau_R} H_R}{(1+\tilde{\tau_R})} P\right)$$

$$\frac{d\tau_R}{d\tau_O} = -\frac{\frac{\partial P}{\partial \tau_O}\eta + (1-\phi)\frac{r+\delta}{(r+\delta+(1+r)\tau_O)}PH_O + \phi\frac{1}{(1+\tilde{\tau_R})}PH_R}{\phi\frac{H_R}{(1+\tilde{\tau_R})} + \frac{\partial P}{\partial \tau_R}\eta} \tag{93}$$

Finally, we can compute η :

$$\eta = \tau_O H - (1-\phi)\tau_O H_O - \phi\tau_O\frac{\tilde{\tau_R}H_R}{(1+\tilde{\tau_R})} = \tau_O H - (1-\phi)\tau_O H_O - \phi\tau_O H_R + \phi\tau_O H_R - \phi\tau_O\frac{\tilde{\tau_R}H_R}{(1+\tilde{\tau_R})} = \phi\tau_O\frac{H_R}{1+\tilde{\tau_R}}$$

Replacing in equation 93 we are left with :

$$\frac{d\tau_R}{d\tau_O} = -\left(\frac{(1+\epsilon_{PO}\tau_O)}{\left(\frac{1}{P}+\epsilon_{PR}\tau_O\right)} + \frac{(1-\phi)\frac{r+\delta}{(r+\delta+(1+r)\tau_O)}H_O}{\phi\frac{H_R}{(1+\tilde{\tau_R})}\left(\frac{1}{P}+\epsilon_{PR}\tau_O\right)}\right) \tag{94}$$

This is the expression presented in equation 34 and we refer to its discussion in Section 6.

C.3 Aggregate welfare change

We can eventually derive the aggregate welfare change, under the tractable specification of the model. Recalling that we had :

$$\frac{dW}{d\tau_O} = (1-\phi)\int\left(\frac{\partial V_O}{\partial \tau_O} + \frac{\partial V_O}{\partial \tau_R}\frac{d\tau_R}{d\tau_O}\right)\omega(Y)dF_O(Y) + \phi\int\left(\frac{\partial V_R}{\partial \tau_O} + \frac{\partial V_R}{\partial \tau_R}\frac{d\tau_R}{d\tau_O}\right)\omega(Y)dF_R(Y) \tag{95}$$

$$\begin{aligned}\frac{dW}{d\tau_O} = &-(1-\phi)P\left(1+\left(\tau_O+\frac{(\delta+r)}{(1+r)}\right)\left(\varepsilon^P_{\tau_O}+\varepsilon^P_{\tau_R}\frac{d\tau_R}{d\tau_O}\right)\right)\int U'_C(C_O,h_O)h_O\omega_O(Y)dF_O(Y)\\ &-\phi\alpha\left(P\left(1+\tau_O\varepsilon^P_{\tau_O}\right)+\left(1+\tau_O P\varepsilon^P_{\tau_R}\right)\frac{d\tau_R}{d\tau_O}\right)\int U'_C(C_R,h_R)h_R\omega_R(Y)dF_R(Y)\end{aligned} \tag{96}$$

Plugging in the solutions to the tractable model, this expression reduces to :

$$\begin{aligned}\frac{dW}{d\tau_O} = &-(1-\phi)P\left(1+\left(\tau_O+\frac{(\delta+r)}{(1+r)}\right)\left(\varepsilon^P_{\tau_O}+\varepsilon^P_{\tau_R}\frac{d\tau_R}{d\tau_O}\right)\right)\int\frac{\theta(1+r)}{P\left(\tau_O(1+r)+r+\delta\right)}\omega_O(Y)dF_O(Y)\\ &-\phi\alpha\left(P\left(1+\tau_O\varepsilon^P_{\tau_O}\right)+\left(1+\tau_O P\varepsilon^P_{\tau_R}\right)\frac{d\tau_R}{d\tau_O}\right)\int\frac{\theta}{1+\widetilde{\tau_R}}\omega_R(Y)dF_R(Y)\end{aligned} \tag{97}$$

$$\frac{dW}{d\tau_O} = -(1-\phi)\frac{\theta(1+r)}{(\tau_O(1+r)+r+\delta)}\left(1+\left(\tau_O+\frac{(\delta+r)}{(1+r)}\right)\left(\varepsilon^P_{\tau_O}+\varepsilon^P_{\tau_R}\frac{d\tau_R}{d\tau_O}\right)\right)\bar{\omega}_O(Y)$$
$$-\phi\alpha\frac{\theta}{1+\widetilde{\tau_R}}\left(P\left(1+\tau_O\varepsilon^P_{\tau_O}\right)+\left(1+\tau_O P\varepsilon^P_{\tau_R}\right)\frac{d\tau_R}{d\tau_O}\right)\bar{\omega}_R(Y) \tag{98}$$

Finally we can, without loss of generality, normalize $\Omega = \frac{\bar{\omega}_R(Y)}{\bar{\omega}_O(Y)}$ the relative welfare weight put on renters by the government. This finally implies the expression derived in Section 6 :

$$\frac{dW}{d\tau_O} = -(1-\phi)\frac{\theta(1+r)}{(\tau_O(1+r)+r+\delta)}\left(1+\left(\tau_O+\frac{(\delta+r)}{(1+r)}\right)\left(\varepsilon^P_{\tau_O}+\varepsilon^P_{\tau_R}\frac{d\tau_R}{d\tau_O}\right)\right)$$
$$-\Omega\phi\alpha\frac{\theta}{1+\widetilde{\tau_R}}\left(P\left(1+\tau_O\varepsilon^P_{\tau_O}\right)+\left(1+\tau_O P\varepsilon^P_{\tau_R}\right)\frac{d\tau_R}{d\tau_O}\right) \tag{99}$$

D Alternative rental tax, with deduction

To extend our analysis, it is possible to include tax deductions to rental tax. If most of them do not affect our problem as the tax rate can be understood as a "deduction-adjusted" rate, local tax-related deductions are not neutral. Indeed, in countries like France, it may be possible to deduct property tax from the taxes paid on rental income. In particular, the property tax paid by landlords is deductible from their rental income tax bill. In this Appendix, we look at how this changes the theoretical results of sections 4 and 5.

D.1 Set Up

Due to the tax deduction scheme, the real tax burden of landlords is reduced. In this case, the new rental income tax rate would be :

$$\tau_R\bar{R} = \tau_R\left(R-\tau_O P\right) \tag{100}$$

If we normalize R=1, then the overall tax rate paid on rental housing is :

$$\tau_O P + \tau_R\left(R-\tau_O P\right) = \tau_O P(1-\tau_R)+\tau_R \tag{101}$$

Therefore, we now have

$$\widetilde{\tau_R} = \alpha\left(\tau_O P(1-\tau_R)+\tau_R\right) \tag{102}$$

The government budget constraint now writes as :

$$G = (1-\phi)\tau_O P H_O + \phi\left(\tau_O P(1-\tau_R) + \tau_R\right) H_R \tag{103}$$

It can also be written (to have one homogeneous tax rate on owned properties, and then additional rental tax rate): $G = \tau_O P H + \phi H_R \tau_R (1 - \tau_O P)$

D.2 Mechanical tax adjustment

Using the GBC, we can differentiate and get :

$$0 = PH + \tau_O \frac{dP}{d\tau_O} H + \tau_O P \frac{dH}{d\tau_O} + \phi\left(\frac{dH_R}{d\tau_O}\tau_R(1-P\tau_O) + H_R \frac{d\tau_R}{d\tau_O}(1-P\tau_O) - H_R\tau_R\left(P + \frac{dP}{d\tau_O}\tau_O\right)\right)$$

$$-\phi H_R \frac{d\tau_R}{d\tau_O}(1-P\tau_O) = PH + \tau_O \frac{dP}{d\tau_O}\left(H - \phi H_R \tau_R\right) + \tau_O P \frac{dH}{d\tau_O} + \phi\left(\frac{dH_R}{d\tau_O}\tau_R(1-P\tau_O) - H_R\tau_R P\right)$$

$$\frac{d\tau_R}{d\tau_O} = -\frac{PH\left(1 + e^P_{\tau_O}\left(1 - \frac{\phi H_R \tau_R}{H}\right) + e_{H\tau_O}\right) + \phi\tau_R H_R\left(\varepsilon_{H_R\tau_O}(1-P\tau_O) - P\right)}{\phi H_R(1-P\tau_O)\left(1 + e_{H_R\tau_R}\right) + \tau_O P\left(\varepsilon_{P\tau_R}\left(H - \phi H_R\tau_R\right) + \frac{\partial H}{\partial \tau_R}\right)} \tag{104}$$

Note that the $(H - \phi H_R \tau_R)$ element comes from the price effect. Indeed, the price increase induced by a tax change was previously scaled by H, as it was affecting all housing units, while it now only affecting $H - \phi H_R \tau_R$, which is in a sense the "non-deducible" part of the housing stock.

D.3 Welfare effect

The only change compared to the earlier version in terms of direct welfare effect, is through $\widetilde{\tau_R}$, which is now different. Indeed, we now have $\widetilde{\tau_R} = \alpha\left(\tau_O P(1-\tau_R) + \tau_R\right)$, which is relatively lower than before. Then :

$$\frac{\partial \widetilde{\tau_R}}{\partial \tau_O} = \alpha\left(\left(P + \tau_O \frac{\partial P}{\partial \tau_O}\right)(1-\tau_R)\right)$$

and

$$\frac{\partial \widetilde{\tau_R}}{\partial \tau_R} = \alpha\left(1 + \tau_O\left(\frac{\partial P}{\partial \tau_R}(1-\tau_R) - P\right)\right)$$

Let us recall that the direct welfare impact of a change in $\tau_j \in (\tau_O, \tau_R)$ can be expressed as :

$$\frac{\partial V_R}{\partial \tau_j} = -U_C^{'} H_R \frac{\partial \widetilde{\tau_R}}{\partial \tau_j}$$

Aggregate welfare change

Considering a case without endowment heterogeneity, we can therefore write the full aggregate welfare change as :

$$\frac{dW}{d\tau_O} = (1-\phi)\left(\frac{\partial V_O}{\partial \tau_O} + \frac{\partial V_O}{\partial \tau_R}\frac{d\tau_R}{d\tau_O}\right) + \phi\left(\frac{\partial V_R}{\partial \tau_O} + \frac{\partial V_R}{\partial \tau_R}\frac{d\tau_R}{d\tau_O}\right)$$

$$\frac{dW}{d\tau_O} = -(1-\phi)PU_C'(C_O,H_O)H_O\left(\left(\tau_O + \frac{(\delta+r)}{(1+r)}\right)\left(\varepsilon_{P\tau_O} + \varepsilon_{P\tau_R}\frac{d\tau_R}{d\tau_O}\right)+1\right)$$
$$-\phi\alpha U_C^{'}(C_R,H_R)PH_R\left(\left(1+e_{P\tau_O}\right)(1-\tau_R) + \left(\frac{1}{P} + \tau_O\left(\varepsilon_{P\tau_R}(1-\tau_R)-1\right)\right)\frac{d\tau_R}{d\tau_O}\right) \tag{105}$$

The tax deduction is reducing the tax burden, and particularly the marginal tax burden, and therefore the direct (negative) welfare effect of a property tax increase. On the other hand, it is also probably reducing the amplitude of the mechanical τ_R decrease following a property tax increase in a budget-neutral reform.

Note that while the mechanical tax adjustment affects all agents, only the renters are affected by the tax deduction, which effect is therefore scaled by α.

E Nash bargaining process over the effective rental tax rate

There are several ways to interpret and rationalize the effective rental tax rates, which mainly depend on bargaining power parameter α. We can think of it as being a Nash bargaining process, where landlords and tenants bargain and try to maximize the tax burden of the other (as they are perfect substitutes). Indeed, the overall tax burden is $B_S = \tau_O P + \tau_R$, and has to be split between the landlord, statutorily bearing it, and the renters.

E.1 Standard Nash bargaining

We can write this standard problem in the following way :

$$B_I = \tau_O P + \tau_R - K \tag{106}$$

$$B_R = K \tag{107}$$

where K is the amount that the landlord manages to pass through to the renter/tenant. Letting α be the bargaining power of the landlords, and $1-\alpha$ that of the renters, the Nash bargaining process can then be expressed, in a standard way, as :

$$\max_K B_I^{1-\alpha} B_R^{\alpha} \tag{108}$$

It yields the FOC :

$$-(1-\alpha)B_I^{-\alpha}B_R^{\alpha} + \alpha B_R^{\alpha-1}B_I^{1-\alpha} = 0$$

$$(1-\alpha)B_R = \alpha B_I$$

$$(1-\alpha)K = \alpha(\tau_O P + \tau_R - K)$$

$$K = \alpha(\tau_O P + \tau_R) \tag{109}$$

We therefore get the sharing rule that was proposed throughout this study, where the tax burden borne by the renters is equal to a share α of the aggregate tax burden on rental housing. We also see that any deduction or additional tax on renters or landlords, would keep the bargaining power unchanged, and be shared. This would match the established stylized fact that housing subsidies to tenants are usually followed by an increase in rents (80% of subsidy according to Fack 2006).

E.2 Alternative form

It is possible to see this problem in a slightly more elaborated way, as the vehicle for transmitting the burden from the landlord to the tenant is actually the rent, which is itself taxed. As a result, the *effective* bargaining power are affected and the problem is modified. The sharing of the overall tax burden should then go through the "rent" R.

The respective burdens now write as :

$$B_I = \tau_O P + \tau_R - \tau_R R \tag{110}$$

$$B_R = R \tag{111}$$

This yields to the following problem :

$$\max_R B_I^{1-\alpha} B_R^{\alpha}$$

It now yields the FOC :

$$-(1-\tau_R)(1-\alpha)B_I^{-\alpha}B_R^{\alpha} + \alpha B_R^{\alpha-1}B_I^{1-\alpha} = 0$$

$$(1-\tau_R)\frac{(1-\alpha)}{\alpha}B_R = B_I$$

Therefore

$$B_S = B_R + (1-\tau_R)\frac{(1-\alpha)}{\alpha}B_R$$

$$B_R = B_S \frac{\alpha}{1-(1-\alpha)\tau_R}$$

We see that the *effective* bargaining power is indeed affected. If τ_R is equal to 0 there is no incidence on the effective pass-through. On the other hand, with positive τ_R, the burden share of the renters starts increasing. If τ_R reaches one, then renters bear the whole tax burden. This may discourage the government from charging too high tax rates on landlords... Overall, we can see that if we think of this Nash bargaining process over the tax burden sharing in this way, the government has to take into account potential feedback effects of the rental tax rate into the *effective* pass-through of the tax burden, ultimately affecting the real incidence of any tax reform. This would probably eliminate the possibility of low values of real incidence (as low values of α were associated with high τ_R). Furthermore, it also means that if the government started subsidizing rental housing, most of it would be kept by the landlord, who would also pass on a lower share of the property tax bill to their tenants.

We also see that any deduction or additional tax on renters or landlords, as soon as it does not affect R, would keep the bargaining power unchanged, and be shared. This would match the established stylized fact that housing subsidies to tenants are usually followed by an increase in rents (80% of subsidy according to Fack 2006).

F Additional figures

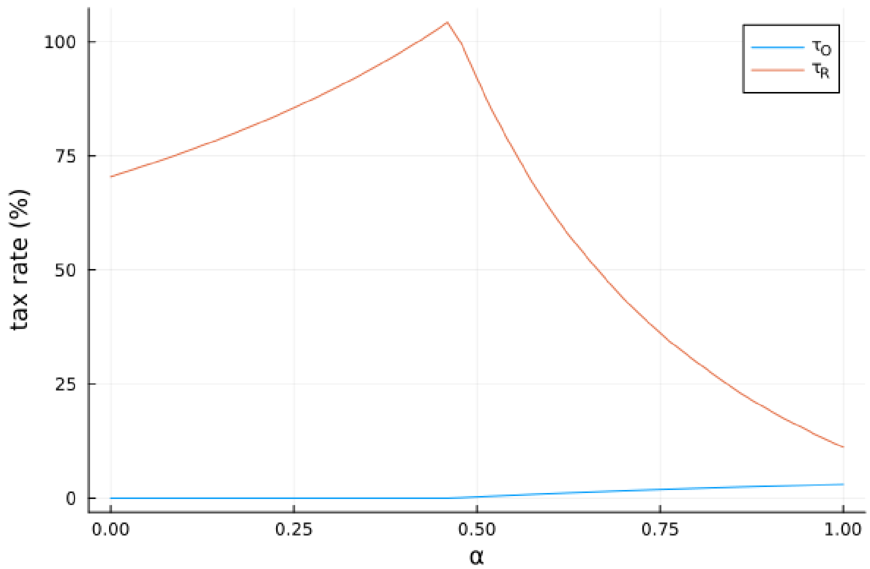

Figure 14: Optimal tax mix with $\bar{Y}_O = 80$

Note : This figure plots the optimal tax mix in the baseline case, with $\bar{Y}_O = 80$ and $\bar{Y}_R = 130$, to observe the effect of pure endowment heterogeneity, ensuring that the aggregate endowment level is still $Y = 100$.

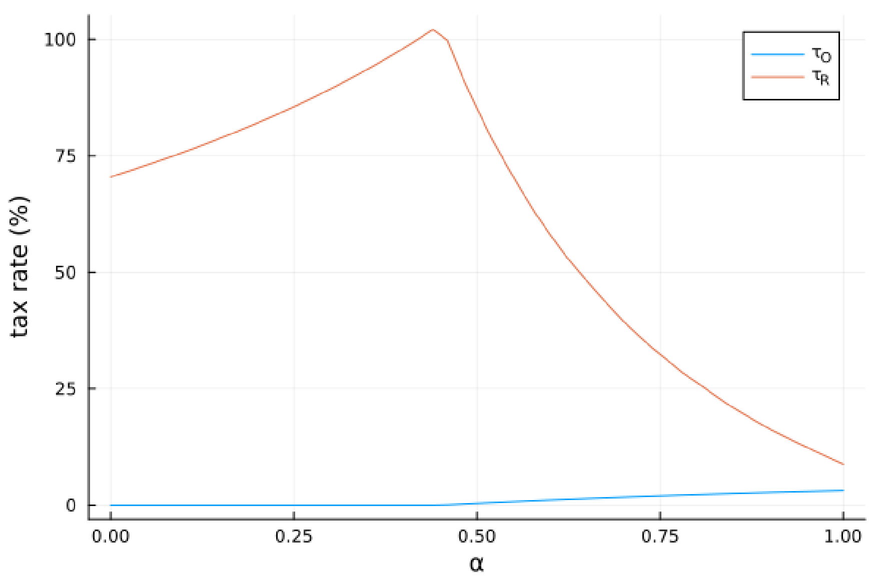

Figure 15: Optimal tax mix with $\bar{Y}_O = 120$

Note : This figure plots the optimal tax mix in the baseline case, with $\bar{Y}_O = 120$ and $\bar{Y}_R = 70$, to observe the effect of pure endowment heterogeneity, ensuring that the aggregate endowment level is still $Y = 100$.

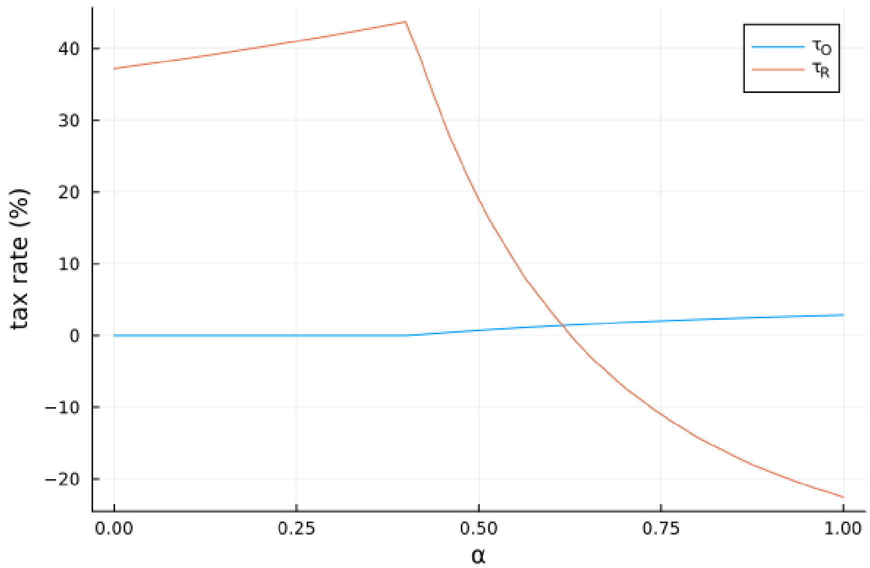

Figure 16: Optimal tax mix in a subsidy-favorable setting

Note : This figure plots the optimal tax mix in a setting taking the most favorable specifications to rental subsidies (low fiscal pressure, high welfare weight on renters, high price elasticity). It uses $G = 3.01$, $\Omega = 1.25$ and $\{\gamma = 2, \kappa = 0.05\}$, which are the specifications meeting the requirements listed in section 7 to make rental subsidies optimal

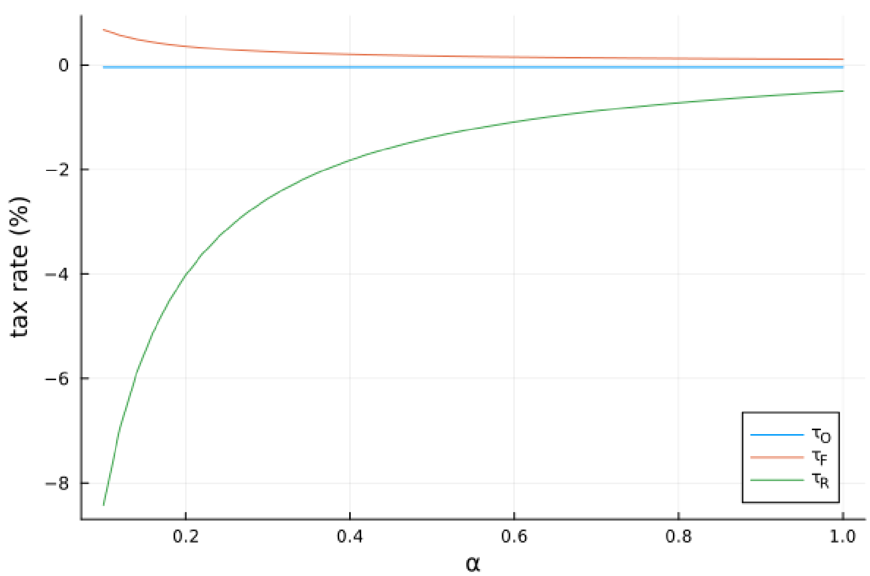

Figure 17: Optimal mix with direct firm taxation and unconstrained property tax rate

Note : This figure shows the optimal tax mix when the government can directly tax the construction investor firm and the property tax rate is allowed to be negative. As discussed in Section 9, this results in a slightly negative optimal property tax rate.