BANCA D'ITALIA

EUROSISTEMA

Temi di Discussione

(Working Papers)

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March 2017

Number 1105

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Number 1105 - March 2017

ISSN 1594-7939 (print)
ISSN 2281-3950 (online)

Printed by the Printing and Publishing Division of the Bank of Italy

TAXATION AND HOUSING MARKETS WITH SEARCH FRICTIONS

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Abstract

Housing taxation is an important policy instrument that shapes households' choices about homeownership and renting as well as the evolution of the housing market. We study the effects of housing taxation in a model with search and matching frictions in the property market and a competitive rental market. We show a new transmission channel for a housing tax reform that works through a 'shifting' effect from landlords to tenants. We calibrate the model in order to estimate the long-run effects of a recent housing market taxation reform and the extent of property tax capitalization on house prices. We show that property taxation on owner-occupied dwellings has a negative effect on property and rental prices, whereas taxes on second homes have opposite qualitative effects. The simultaneous increase in both these instruments may mitigate the dynamics of prices and rents as well as the change in the ratio between the share of owners and renters, leading to a partial capitalization taxation on prices.

JEL Classification: R21, R31, E62.
Keywords: housing market, matching, property taxation.

Contents

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1 Introduction[1]

In the housing market trade is not instantaneous, despite there are simultaneously many buyers and sellers. Potential buyers need a substantial period of time in order to find and buy a home they like, while sellers have to wait several months before they are able to sell their home. Houses are heterogeneous goods, somewhat unique, and they are traded in a market characterized by large uncertainty regarding trading opportunities. Consequently, as the assumption of instantaneous and costless coordination of trade is not suitable, the Walrasian paradigm seems inadequate to describe this market and a growing literature is resorting to search and matching models. Buyers and sellers should search for each other until they find a trading opportunity that satisfy both parties.

Search theory is not only more appropriate from a theoretical point of view but, as shown by many authors, it allows to rationalize several stylized facts of the housing markets: the observed natural vacancy rate (Wheaton, 1990), price momentum (Head et al., 2014) and seasonality of house prices (Ngai and Tenreyro, 2014), the correlation of prices with sales and time on market (Diaz and Jerez, 2013). Search and matching models have been also used to analyze the effects of policy tools, such as transactions taxes (Lundborg and Skedinger, 1999).

In this paper we propose an application of search and matching models to the analysis of the long-run effects of property taxation on the structure of the housing market. We also consider the effects of a rental income taxation's variation to landlords. We start from the seminal model by Wheaton (1990) and we explicitly include an active rental market with endogenous demand and supply in order to consider the household tenure choice. As discussed by Poterba (1984), this decision crucially depends on the user cost of owner-occupation which is related to depreciation, tax and maintenance costs. In an asset-pricing perspective, in equilibrium the price of a house is equal to the present discounted value of its future service stream, represented by its real rental service value minus the user cost of owning a home: this highlights the link between property taxes and house prices.

There is a large consensus about tax capitalization into prices. Nevertheless, the empirical literature fail to agree on the extent of this effect (Palmon and Smith, 1998).[2] Bai et al. (2014) find totally opposite effects of property taxation on home prices in different cities, depending on institutional details of the taxation framework other than tax rates. We believe that a major issue that hinders a sound assessment of housing property taxation is related to the possible presence of a preferential treatment

[1]We wish to thank Giorgio Albareto, Elisa Guglielminetti, Giovanna Messina, Libero Monteforte, Alfonso Rosolia, Giordano Zevi, Roberta Zizza and Francesco Zollino for their insightful comments and suggestions. The views expressed in this paper are those of the authors and do not reflect the views of Bank of Italy. Any residual errors are ours alone.

[2]Empirical papers face endogeneity issues well recognized in the literature and, in addition, the difficulty to control for all the components of housing services and user cost.

for owner-occupied dwellings in place in many countries (i.e. through lower tax rates). Another issue is that property taxation reforms could be associated with a more general review of the housing taxation framework. Indeed, this is the case of Italy. Here, tax rates on owner-occupied dwellings are lower than not owner-occupied dwellings. Furthermore, in the period 2011-2012 the reform of property taxes was almost simultaneous to the one on landlords rental income taxation. The almost contemporaneous change of different instruments and the inertia of house prices make the identification of the effects of the different policy tools very challenging, especially if, in principle, they can have opposite effects. We will try to overcome this issue by calibrating our model to reproduce some stylized facts related to the Italian housing market in the period 2007-2012. Therefore, we estimate the extent of tax capitalization on prices and the effects of each policy tool on the long-run equilibrium levels of the main variables.

In our model there is a continuum of families. Each of them should live in a house, which can be owned or rented, and derives utility from the type of tenure and idiosyncratic preferences. There are two markets for dwellings. The first one is a decentralized property market subject to matching frictions as in Wheaton (1990), where both buyers and sellers search for a counterpart and the transaction price is bilaterally determined by Nash bargaining. The second one is a frictionless rental market, where those who do not own a house meet landlords and stipulate one period contracts at a endogenous market price. Since the presence of the rental market is crucial for our research question, we explicitly model demand and supply: households who own two dwellings must choose between renting or searching for buyers, while only a fraction of all tenants are searching to buy (because of a search cost). This means that we allow for an endogenous participation from both the demand and the supply side, at the cost to giving up some degree of tractability of the model.

According to our calibration, the introduction of an active rental market provides new insights compared to a standard search model. On the one hand, an increase of property taxes on owner-occupied houses have a negative effect on housing demand and prices, as standard in the literature. On the other hand, the opposite effect results from an increase of property taxes on second homes: landlords who own two houses shift part of the tax burden on tenants. Since tenants have to pay a higher rent, it is more convenient to become homeowner. Consequently, demand for owner-occupied housing rises, putting an upward pressure on prices. In the long run the system adjusts to the permanent tax variation and in the new steady state the fraction of homeowners increases, as well as house prices and rents. Given that our model allows for an active rental market, we can also consider the effects of a reduction of the rental income taxation on landlords: the shifting effect works also in this scenario. As a matter of fact, there are more incentives for owners of a second home to rent this dwelling. As the offer increases, rental prices decrease, inducing households to rent instead to buy. By a mechanism similar to the one described above, both house prices and homeownership decrease.

Of course, we are aware that other features can be included. Nevertheless, we believe they do not qualitatively change our results.Assuming perfect capital markets can be handled by observing the positive relationship between the house prices dynamics and the amount of resources used a downpayment. Relaxing the assumption of fixed housing stock does not change our insights because the low elasticity of housing supply with respect to the home prices. Finally, our model is robust to the inclusion of vacant houses: we are able to show that if a vacant house have no flow utility, the implications in this new economy are the same of the benchmark setup.

We employ our model for an evaluation of the taxation reforms adopted in Italy in recent years. Regarding property taxation, the fiscal legislation in Italy allows for different tax rates among owner-occupied houses and other dwellings, encouraging homeownership. Between 2008 and 2011 owner-occupied houses were completely exempted from property taxes (and before 2008 they received a preferential treatment), but in 2012 taxation was restored. At the same time the tax burden on second homes was raised further. We find that in the long run the property tax reform approved at the end of 2011 would make house prices decreasing by 1.3 percent and rents increasing by 6.0 percent in real terms.[3] Moreover, it should increase homeownership by 1.2 percentage points.

Moreover, in 2011 a reform of rental income taxation for landlords reduced their average tax burden. Through the simultaneous consideration of rental and property reforms we find that in the long run also rents go down (by 15.3 percent in real terms).[4] As there are some shortcuts in our analysis that make us believe that the results for rental income taxation could be just an upper bound, we consider this application useful to remark that additional changes in the housing taxation at large modify the assessment of the effects of property taxation.

We use our model to estimate the extent to which property taxes are capitalized on housing prices. We find that property taxes are partially capitalized, although our estimates imply a significant degree of capitalization, in line with those by Palmon and Smith (1998) for U.S. Differently from the previous literature, we are able to show that partial capitalization emerges because of the simultaneous working of the two mechanism described above. While the impact on prices of an increase of taxation on owner-occupied dwellings is significantly negative, the same percentage point increase of tax rates on

[3] We want to stress that our exercise has nothing to say about the short-run evolution of the housing market. Therefore, we cannot exclude that in short-run the effects of property taxation could have been different.

[4] Previously, rents added to other incomes determining the total taxable income of landlords and, therefore, rental income taxes were progressive. Landlords can now choose the new alternative regime: rental income taxes are proportional and they do not cumulate to other incomes, implying a lower tax burden especially for medium-high income landlords (Chiri et al., 2013).

second homes leads to a slight rise of house prices, that reduces the extent of tax capitalization.

The paper is structured as follows. The next section reviews the theoretical and empirical literature on housing market and taxation while section 2 describes the model. Section 3 describes the calibration strategy and show the results of our policy experiments. Finally, section 4 concludes.

1.1 Related literature

A large volume of empirical literature starting with Oates (1969) has analyzed if increasing property taxes affect negatively house prices and to which extent. Thi is consistent with the frictionless asset-pricing model of the owner-occupied housing market proposed by Poterba (1984): buyers should equate the price of a house with the present discounted value of its future service stream, represented by its real rental service value minus the user cost, including property taxes. As discussed by Palmon and Smith (1998) this literature fails to reach a consensus regarding the extent of such capitalization, also due to several issues involved in this exercise: firstly, there can be reverse causality (from prices to tax rates) when a fixed amount of tax revenue is targeted, as higher house values allow to impose lower tax rates; secondly, when property taxes are used to finance local public services, higher tax rate could be associated with higher prices because of the better quality of public goods. Recently, Bai et al. (2014) find totally opposite effects of property taxation on home prices in different Chinese cities, depending on taxation specifics other than tax rates.

The asset pricing approach to house price determination does not consider the interaction between tax policies and other market imperfections, such as informational frictions that hinder trade coordination in the housing market. Starting from this consideration, but also thanks to the ability to reproduce some stylized fact of the real estate market, the search and matching approach has received growing attention in recent years. The seminal contribution in this literature was provided by Wheaton (1990). In his model households buy and sell dwellings in a decentralized housing market subject to search frictions. Each family derives a flow utility from living in a house it likes. Due to an idiosyncratic preference shock a household becomes uncomfortable with its home and starts looking for a new one, incurring in a costly search effort. Once a new dwelling is found, the household move in the new location and put the previous home on sale. In this framework market prices are determined on a bilateral basis by Nash bargaining. Han and Strange (2015) provide a review of the growing literature originated from this contribution.[5] With respect to these contributions, we extend the basic framework

[5]Ngai and Sheedy (2015) analyze the case in which the decision of moving house is endogenous and show how it is sensitive to macroeconomic and policy variables such as interest rates and taxes. Moen et al. (2015) show how the transaction sequence decision of moving homeowners (buy first or sell first) is interdependent on housing market conditions and this can give rise to multiple equilibria and cycles. Lundborg and Skedinger (1999) show how transaction

of Wheaton (1990) including a fully specified rental market with endogenous rent prices and explicitly modeling the tenure choice. Also other papers in this literature feature a rental market, but differently from us it is generally modeled as a reservation state for unmatched buyers (Diaz and Jerez, 2013) or such that there is no trade-off for owners between renting or searching for buyers (Moen et al., 2015).

Sommer et al. (2013) present a dynamic general equilibrium model with markets for homeownership and rental properties to study the effects of interest rates, loan-to-values and income distribution on equilibrium house prices and rents, but assume credit frictions rather than search frictions in the housing market. The most related contributions to our work in this literature are Gervais (2002) and Sommer and Sullivan (2014). Both papers consider the effects of preferential tax treatment of homeownership in US in a stochastic life cycle economy populated by heterogeneous individuals who can either own or rent a house. In Gervais (2002) repealing the mortgage interest deduction leads to a decline in homeownership, because it increases the cost of ownership but does not reduce downpayment requirements (because house prices are kept fixed). In Sommer and Sullivan (2014), where both house prices and rents are allowed to adjust, a reduction in the tax deductions available to homeowners leads to a decline in house prices because of the higher user cost. This allows low wealth households to become homeowners because of the lower downpayment required. Moreover, as rents remain roughly constant while house prices decline, the positive effect on homeownership reinforces, because it becomes cheaper relative to renting. The main difference between our results and those of Sommer and Sullivan (2014) are related to the impact of property taxation on rental prices. Indeed, we find that rental prices should increase, in line with the empirical findings of Tsoodle and Turner (2008).

2 The model economy

Time is discrete, starts at $t = 0$, and continues forever. The economy is populated by a continuum of long-lived households with measure 1. They have linear preferences over consumption and receive each period a constant endowment w of goods, equal across all of them. The discount factor of future utility is $\beta < 1$.

Each family lives in a house, which can be owned or rented. Living in the house provides a constant flow utility, that depends on the type of tenure and preferences: if the household owns the house and she likes it, then she enjoys a utility u^m, otherwise the utility flow is $u^u < u^m$ (meaning also the case in which she lives in a rented dwelling). We define a household that likes the house where she lives as *matched*. At the same time, the owners incur in each period a cost of maintenance and they should pay a real estate property tax.

taxes reduce search effort and matching rates in the Wheaton (1990) model, because lower the private gains of a search.

Each family owns zero, one or two dwellings. Non-owners live in a rented house, while those who own two houses live in the one they prefer and put the other for sale or for rental. No household has the incentive to keep a vacant dwelling, because the ownership of a second house does not provide any utility per se.[6] Moreover, we assume perfect capital markets and, therefore, households do not own houses as a mean of saving.[7] As standard in the literature, we also impose that families cannot live in a dwelling they have put on sale.

There are two markets for dwellings. The first is a decentralized housing market subject to matching frictions as in Wheaton (1990) where both buyers and sellers search for a counterpart. In this market a buyer meets a seller with a probability strictly less than one. When there is a match, the transaction price, P, is bilaterally determined through generalized Nash bargaining. As all families need a house to live, non-owners must find a dwelling in the rental market. Since the choice of the house to buy is definitively much more difficult and challenging than the choice of the house to rent, we assume that the latter market is frictionless and centralized: renters stipulate one-period contracts with landlords in exchange for the payment of an endogenously determined market price R. This assumption allows us to keep the model more tractable.

Finally, there is no construction sector and the stock of houses is fixed, equal to $H > 1$.

2.1 Household turnover and matching

Since we want to explicitly model the equilibrium on the rental market, the number of states each family can visit during her lifetime is greater than in the standard search literature.[8] In particular, we want to consider the problem of both households that voluntarily live in a rented dwelling and those who instead are actively searching in order to buy. Moreover, households that own more than one dwelling should choose if they want to put their second house for sale or for rent. Therefore, at time t households can stay in eight different states $\mathcal{H}^{kxy}$, depending on three different dimensions: (i) the number of houses they own, $k \in \{0, 1, 2\}$; (ii) if they enjoy utility u^m or u^u, $x \in \{m, u\}$; (iii) if they participate into the sales, the rental market or neither of the two, $y \in \{h, r, o\}$. From now on we define N^{kxy} as the fraction of families in state $\mathcal{H}^{kxy}$.

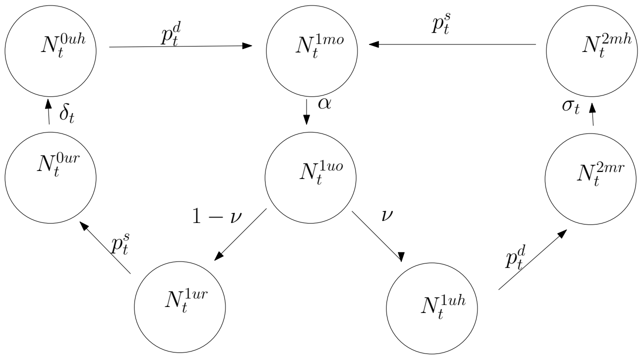
Table 1 and Figure 1 summarize household types and transitions from one state to the others. We start the description of the model from type $\mathcal{H}^{1mo}$, i.e. families who own only one house, perfectly

[6]We will show in section 3.4 an extension of the model where a vacant house gives to the owner a per period utility flow. In this case in equilibrium a positive fraction of households keep their second house vacant.

[7]Since we assume linear preferences, households are indifferent about the timing of their consumption.

[8]In standard models as in Wheaton (1990) households can visit only three states: (i) those who own one house and they are comfortable with it; (ii) those who own one house but they are searching for a new one; (iii) those who own two dwellings and are searching in the sales market as sellers.

Figure 1: Transitions among states



matched and with no participation in the rental and property markets, meaning that they receive a flow utility u^m. However, they are subject to idiosyncratic preference shocks and with probability α they have to change their house. This can reflect the fact that they have to move in a different place for work reasons or other changes in their status (i.e. in the household size) or income gains/losses that make them uncomfortable with their current dwelling.[9] Those families who receive the shock, defined as $\mathcal{H}^{1uo}$, remain in their house, but they become unmatched and receive utility u^u. In the next period we assume that a fraction ν of them choose to enter the housing market as buyers looking for a new house ($\mathcal{H}^{1uh}$) whereas the remaining fraction, $1-\nu$, enters as sellers in the housing market and move in a rented house ($\mathcal{H}^{1ur}$).[10] You can think at this type as those who have to move to a different town and have no possibility to search for a new house while they live in the old one; in this case, it would be better to move in a rented dwelling and to take time before to start searching. Moreover, as can be seen from Figure 1, if $\nu = 1$ in steady state there will be no renters and, therefore, no rental market: in this case our model collapses to Wheaton (1990).[11]

Following Figure 1, $\mathcal{H}^{1ur}$ households that at time t sell their house at $t+1$ become *voluntary renters* ($\mathcal{H}^{0ur}$). Those are families that do not own dwellings and do not search for a new house ($\mathcal{H}^{0ur}$). Each period some of them start to actively search for a new house. Families that do not own any house but are actively searching are defined as $\mathcal{H}^{0uh}$.

Households $\mathcal{H}^{1uh}$ that find a counterparty in the housing market in the next period move in the new house and rent the old one, becoming *landlords* ($\mathcal{H}^{2mr}$). Finally, in the next periods some of them can decide to put their second house for sale.[12] In the following equations we describe how the mass

[9] In doing this assumption we follow the literature. In Wheaton (1990) this is rationalized assuming that there are only two different types of dwellings, therefore only those with own one dwelling can be mismatched.

[10] By the assumption we have made at beginning, sellers cannot live in the dwelling they have put for sale, therefore if they do not own any other house they should rent.

[11] See the Appendix A.2.

[12] Differently from us, Moen et al. (2015) assume that a house put for sale can be rented, allowing the owner to get some rent while is searching for a buyer. As shown by Krainer (2001), the two opposite assumptions can lead to different

of different types evolve dynamically:

$$N_{t+1}^{0ur} - N_t^{0ur} = p_t^s N_t^{1ur} - \delta_t N_t^{0ur} \tag{1}$$

$$N_{t+1}^{0uh} - N_t^{0uh} = -p_t^d N_t^{0uh} + \delta_t N_t^{0ur} \tag{2}$$

$$N_{t+1}^{1mo} - N_t^{1mo} = p_t^d N_t^{0uh} + p_t^s N_t^{2mh} - \alpha N_t^{1mo} \tag{3}$$

$$N_{t+1}^{1uo} - N_t^{1uo} = \alpha N_t^{1mo} - \nu N_t^{1uo} - (1-\nu) N_t^{1uo} \tag{4}$$

$$N_{t+1}^{1ur} - N_t^{1ur} = (1-\nu) N_t^{1uo} - p_t^s N_t^{1ur} \tag{5}$$

$$N_{t+1}^{1uh} - N_t^{1uh} = \nu N_t^{1uo} - p_t^d N_t^{1uh} \tag{6}$$

$$N_{t+1}^{2mr} - N_t^{2mr} = p_t^d N_t^{1uh} - \sigma_t N_t^{2mr} \tag{7}$$

$$N_{t+1}^{2mh} - N_t^{2mh} = \sigma_t N_t^{2mr} - p_t^s N_t^{2mh} \tag{8}$$

The transition probabilities α and ν are exogenous and time-invariant because they reflect preference shocks. All the other transition probabilities are endogenous. Buyers and sellers find a counterparty in the housing market with probabilities p_t^d and p_t^s, determined by a matching technology described below. In each period there is a fraction δ_t of $\mathcal{H}^{0ur}$ households that start searching for a dwelling. We assume, as will be shown later, that renters should pay each period a search cost in the housing market and δ_t is pinned down by a free entry condition. Something similar happens for families that own two houses. We will assume that those households are indifferent among renting or selling their second house and we let σ_t to be pinned down by a free entry condition.

We define the mass of buyers in the housing market as $D_t^h \equiv N_t^{0uh} + N_t^{1uh}$, while the sellers are $S_t^h \equiv N_t^{1ur} + N_t^{2mh}$. The number of transactions between buyers and sellers is given by a standard matching technology $\mathcal{M}\left(D_t^h, S_t^h\right)$. We assume it is continuous, non-negative, increasing in both arguments and concave, with $\mathcal{M}\left(0, S_t^h\right) = \mathcal{M}\left(D_t^h, 0\right) = 0$ for all $\left(D_t^h, S_t^h\right)$. We also assume that $\mathcal{M}$ displays constant returns to scale. Consequently, the probability to find a counterpart for buyers and sellers are

$$p_t^d = \frac{\mathcal{M}\left(D_t^h, S_t^h\right)}{D_t^h} \qquad p_t^s = \frac{\mathcal{M}\left(D_t^h, S_t^h\right)}{S_t^h}$$

Since there is no endogenous search effort, arrival probabilities are equal for all buyers (sellers) and do not depend on their types. It is also useful to define the tightness of housing market as $\theta_t \equiv \frac{D_t^h}{S_t^h}$. Given the assumption of constant returns to scale, we can rewrite the matching function as $S_t^h \mathcal{M}\left(\theta_t, 1\right)$ and $p_t^s = \theta_t p_t^d$. In our empirical exercise we will assume that $\mathcal{M}$ is a Cobb-Douglas function

$$\mathcal{M}\left(D_t^h, S_t^h\right) = A\left(D_t^h\right)^\eta \left(S_t^h\right)^{1-\eta}$$

results about market behavior.

Table 1: Household Typologies

Household States	
$\mathcal{H}^{0ur}$	Households who do not own dwellings, live in a rented houses and are not searching in the housing market
$\mathcal{H}^{0uh}$	Households who do not own dwellings, live in a rented houses and are searching in the housing market
$\mathcal{H}^{1mo}$	Households who own the dwelling where they live and they like it
$\mathcal{H}^{1uo}$	Households who own the dwelling where they live but they dislike it
$\mathcal{H}^{1uh}$	Households who own the dwelling where they live, they dislike their house and they are searching in the housing market in order to buy a second house
$\mathcal{H}^{1ur}$	Households who own one dwelling, but they live in a rented house and they are searching in the housing market to sell their house
$\mathcal{H}^{2mr}$	Households who own two dwellings, they live in the house they like and rent the other house
$\mathcal{H}^{2mh}$	Households who own two dwellings, they live in the house they like and are searching in the housing market to sell the other house

Rental contracts for time t are signed at the beginning of the period in a centralized and frictionless market. Therefore, the market clearing condition implies that in each period the mass of *landlords* must be equal to the mass of families who need a rented dwelling:

$$N_t^{2mr} = N_t^{0ur} + N_t^{0uh} + N_t^{1ur} \tag{9}$$

In addition to the equilibrium condition on the rental market, the equation system (1)-(8) is closed by the two following conditions:

$$1 = N_t^{0ur} + N_t^{0uh} + N_t^{1mo} + N_t^{1uo} + N_t^{1ur} + N_t^{1uh} + N_t^{2mr} + N_t^{2mh} \tag{10}$$

$$H = N_t^{1mo} + N_t^{1uo} + N_t^{1ur} + N_t^{1uh} + 2N_t^{2mr} + 2N_t^{2mh} \tag{11}$$

Equations (10) and (11) imply that the measure of households and the stock of houses are fixed.

2.2 Households value functions and transaction prices

The current value for households of being in a particular state at the beginning of time t is given by the flow utility from housing and consumption and their expected discounted utility. The components of flow utility are heterogeneous among households types, apart from the endowment w, due to differences in housing utility but also because of the costs associated with the ownership of a house. Owners should pay taxes on real estate property, $\tau_1 \bar{P}_t$ or $\tau_2 \bar{P}_t$, and maintenance costs m, while renters only pay the rent R. We allow for a different property tax rates on dwellings, depending on whether they are occupied by the owner (τ_1) or not (τ_2). The tax base is the average value of housing $barP_t$, defined below.

The value functions of households who do not own any house are given by:

$$V_t^{0ur} = u^u + w - R_t + \beta \max \left[V_{t+1}^{0uh}, V_{t+1}^{0ur} \right] \tag{12}$$

$$V_t^{0uh} = u^u + w - R_t - \kappa + \beta \left\{ p_t^d \left[V_{t+1}^{1mo} - \mathbb{E}_t \left(P_t | i = 0 \right) \right] + \left(1 - p_t^d \right) V_{t+1}^{0uh} \right\} \tag{13}$$

Households $\mathcal{H}^{0ur}$ and $\mathcal{H}^{0uh}$ have the same flow utility, apart from the disutility cost to search in the housing market, κ. This cost, that can be interpreted as the opportunity cost of the time spent to find a mortgage, avoids all renters to enter the housing market. Sellers do not incur any search cost. Since renters decide endogenously to start searching, there should be a free-entry condition $V_t^{0ur} = V_t^{0uh}$ for all t.[13] Since in the housing market there are two different typologies of buyers and sellers and prices are determined by Nash bargaining, the effective price that buyers should pay is not ex ante known because it depends also on the type of seller they meet. Ex ante the price that $\mathcal{H}^{1uh}$ households expect to pay is $\mathbb{E}_t \left(P_t | i = 0 \right)$, that we define below.

Households that own only the house where they live have to pay each period a real estate property tax $\tau_1 \bar{P}_t$ and a maintenance cost m. Families perfectly matched get utility u^m while those that dislike their house enjoy u^u. The future expected utility of households $\mathcal{H}^{1mo}$ reflect the possibility that they receive an idiosyncratic preference shock and in the next period they are not comfortable anymore with their house.

$$V_t^{1mo} = u^m + w - \tau^1 \bar{P}_t - m + \beta \left[(1 - \alpha) V_{t+1}^{1mo} + \alpha V_{t+1}^{1uo} \right] \tag{14}$$

Mismatched households with only one house have different value functions, depending on the fact they want to buy a new dwelling or to put for sale the old one in order to move in a rented house.

$$V_t^{1uo} = u^u + w - \tau^1 \bar{P}_t - m + \beta \left[(1 - \nu) V_{t+1}^{1ur} + \nu V_{t+1}^{1uh} \right] \tag{15}$$

The following two equations are the value functions for types $\mathcal{H}^{1ur}$ and $\mathcal{H}^{1uh}$:

$$V_t^{1ur} = u^u + w - R_t - \tau^2 \bar{P}_t - m + \beta \left\{ p_t^s \left[V_{t+1}^{0ur} + \mathbb{E}_t \left(P_t | j = 0 \right) \right] + \left(1 - p_t^s \right) V_{t+1}^{1ur} \right\} \tag{16}$$

$$V_t^{1uh} = u^u + w - \tau^1 \bar{P}_t - m - \tilde{\kappa} + \beta \left\{ p_t^d \left[V_{t+1}^{2mr} - \mathbb{E}_t \left(P_t | i = 1 \right) \right] + \left(1 - p_t^d \right) V_{t+1}^{1uh} \right\} \tag{17}$$

[13] Let's suppose, in fact, that $V_t^{0ur} < V_t^{0uh}$: in this case more renters would start looking for a house and therefore housing demand increases lowering p^d until $V_t^{0ur} = V_t^{0uh}$ is restored.

It should be noted that $\mathcal{H}^{1ur}$ households pay a rent R_t and taxes $\tau^2\bar{P}_t$, because they do not occupy their house. In terms of expected utility they differ from $\mathcal{H}^{1uh}$ because they have the perspective to become *voluntary renters*, while the seconds will become *landlords*. Moreover, $\mathcal{H}^{1uh}$ are subject to a search cost $\tilde{\kappa} < \kappa$, meaning that for those who are already homeowners is easier to buy a house.

Finally, the value functions of agents that own two houses are the following:

$$V_t^{2mr} = u^m + w + R_t(1-\tau^i) - \tau^1\bar{P}_t - (1-d)\tau^2\bar{P}_t - 2m + \beta \max\left[V_{t+1}^{2mh}, V_{t+1}^{2mr}\right] \tag{18}$$

$$V_t^{2mh} = u^m + w - \tau^1\bar{P}_t - \tau^2\bar{P}_t - 2m + \beta\left\{p_t^s\left[V_{t+1}^{1mo} + \mathbb{E}_t\left(P_t|j=1\right)\right] + \left(1-p_t^s\right)V_{t+1}^{2mh}\right\} \tag{19}$$

Both types of households enjoy housing utility u^m, pay maintenance costs on both houses and the same taxes on the first house. However, *landlords* pay rental income taxes $R_t\tau^i$, but receive a discount on property taxes for the second house they rent. Since σ_t is endogenously determined, we impose the free entry condition on the housing market $V_t^{2mr} = V_t^{2mh}$ for all t. This means that households are indifferent between renting their house or trying to sell it.

Since in the sales market there are two types of buyers and two of sellers, each with a different value function, transaction prices will be heterogeneous, independently of the fact that there are no quality differences among dwellings. This is because prices are determined by Nash bargaining and the different households have also different reservation utilities. We define the effective transaction price as $P^{i,j}$, where $i,j = 0,1$. The index i identifies the typology of buyers, while j the sellers:

$$i = \begin{cases} 0 & \text{if buyers } = N^{0uh} \\ 1 & \text{if buyers } = N^{1uh} \end{cases} \qquad j = \begin{cases} 0 & \text{if sellers } = N^{1ur} \\ 1 & \text{if sellers } = N^{2mh} \end{cases}$$

Assuming buyers have bargaining power $\chi \in (0,1)$, transaction prices are defined as follows:

$$P_t^{00} = \beta\left[(1-\chi)\left(V_{t+1}^{1mo} - V_{t+1}^{0uh}\right) + \chi\left(V_{t+1}^{1ur} - V_{t+1}^{0ur}\right)\right] \tag{20}$$

$$P_t^{01} = \beta\left[(1-\chi)\left(V_{t+1}^{1mo} - V_{t+1}^{0uh}\right) + \chi\left(V_{t+1}^{2mh} - V_{t+1}^{1mo}\right)\right] \tag{21}$$

$$P_t^{10} = \beta\left[(1-\chi)\left(V_{t+1}^{2mr} - V_{t+1}^{1uh}\right) + \chi\left(V_{t+1}^{1ur} - V_{t+1}^{0ur}\right)\right] \tag{22}$$

$$P_t^{11} = \beta\left[(1-\chi)\left(V_{t+1}^{2mr} - V_{t+1}^{1uh}\right) + \chi\left(V_{t+1}^{2mh} - V_{t+1}^{1mo}\right)\right] \tag{23}$$

and, therefore, the expected prices in value functions (13), (16), (17) and (19) are equal to:

$$\mathbb{E}_t\left(P_t|i=0\right) = \frac{N_t^{1ur}}{S_t^h}P_t^{00} + \frac{N_t^{2mh}}{S_t^h}P_t^{01} \tag{24}$$

$$\mathbb{E}_t\left(P_t|i=1\right) = \frac{N_t^{1ur}}{S_t^h}P_t^{10} + \frac{N_t^{2mh}}{S_t^h}P_t^{11} \tag{25}$$

$$\mathbb{E}_t\left(P_t|j=0\right) = \frac{N_t^{0uh}}{D_t^h}P_t^{00} + \frac{N_t^{1uh}}{D_t^h}P_t^{10} \tag{26}$$

$$\mathbb{E}_t\left(P_t|j=1\right) = \frac{N_t^{0uh}}{D_t^h}P_t^{01} + \frac{N_t^{1uh}}{D_t^h}P_t^{11} \tag{27}$$

Finally, the average house value, used as tax base for propety taxes, is a weighted average of prices determined in the various transactions:

$$\bar{P}_t = \left(\frac{N_t^{0uh}}{D_t^h} p^d \frac{N_t^{1ur}}{S_t^h} p^s\right) P_t^{00} + \left(\frac{N_t^{0uh}}{D_t^h} p^d \frac{N_t^{2mh}}{S_t^h} p^s\right) P_t^{01} + \left(\frac{N_t^{1uh}}{D_t^h} p^d \frac{N_t^{1ur}}{S_t^h} p^s\right) P_t^{10} + \left(\frac{N_t^{1uh}}{D_t^h} p^d \frac{N_t^{2mh}}{S_t^h} P_t^{11} p^s\right) P_t^{11} \tag{28}$$

The equilibrium of the model is defined below:

Definition 1 (Equilibrium) *A search equilibrium is a list of value functions, (V_t^{0ur}, V_t^{0uh}, V_t^{1mo}, V_t^{1uo}, V_t^{1uh}, V_t^{1ur}, V_t^{2mr}, V_t^{2mh}), measures of households, (N_t^{0ur}, N_t^{0uh}, N_t^{1mo}, N_t^{1uo}, N_t^{1uh}, N_t^{1ur}, N_t^{2mr}, N_t^{2mh}), prices, (R_t, P_t^{00}, P_t^{01}, P_t^{10}, P_t^{11}) and probabilities, (δ_t, σ_t, p_t^d, p_t^s), such that, given all the parameters, $V_t^{0ur} = V_t^{0uh}$, $V_t^{2mr} = V_t^{2mh}$ and equations* (1)-(27) *are satisfied* $\forall t$.

3 Simulation results

3.1 Calibration

The steady state of the model is a function of 16 parameters. Among them 9 are directly calibrated, while the remaining seven are estimated in order to match a same number of targets of the Italian housing market during the period 2007-2012 at quarterly frequencies. The choice of this period is related to the availability of data on the microstructure of the housing market: the Italian housing market was affected by a severe recession. When looking to the results of our simulations this should be kept in mind. Our benchmark parametrization is summarized in Table 2.

The household income is normalized to 1. We set the discount factor $\beta = (1+r)^{-0.25}$ such as the real interest rate r is equal to 3.5 percent. The maintenance cost m is calibrated equal to 0.0086, as the average ratio of maintenance expenditure over household disposable income in the period 2007-2012 (based of National Accounts).

Sanchez and Andrews (2011) show that in Italy the percentage of households that changed residence within the two-years period 2005-2006 was equal 9.2 percent (based on EU-Silc 2007 data). According to this evidence we set the quarterly probability for homeowners to become mismatched, α, equal to 1.15 percent.[14] Using Istat data about population movements across municipalities over the same two-years period, we assume that only those households that move across different regions are unmatched homeowners that start searching to sell their home and become tenants. Then, we implicitly assume that agents $\mathcal{H}^{1ur}$ have a greater information problems about the housing market of the new region:

[14] Indeed, we are also implicitly assuming that no household moved more than once in the two-year period and that the distribution of movements was uniform across different quarters.

they prefer rent a new home in the new location and put on sale the dwelling of the old region. As in the average of 2005-2006 the annual share of households who moved across different regions can be estimated to be equal to 0.56 percent, while according to Eu-Silc those who changed residence were about 4.6 percent, we set the probability $1-\nu$ to $0.56/4.6 = 0.12$ (therefore $\nu = 0.88$). The estimated elasticity of the house sales with respect to flow of buyers, η, is equal to 0.48.[15] We computed the number of transactions per households using data on sales provided by OMI-Agenzia delle Entrate whereas the number of households is provided by Istat. The flow of buyers is measured as the percentage of households who declare the intention to purchase a home in the next 12 months in the consumers' survey by Istat.[16]

The taxation setup is set in order to replicate the Italian tax system in 2011. As will be explained later, in Italy the tax base for property taxes is not the market value of dwellings, but the imputed value recorded in the cadastral registry. In this paper we always set the property tax rates in effective terms, as they were computed on market values of dwellings. The property tax rate on the owner-occupied dwellings, τ^1, was set to zero, as between 2008 and 2011 owners were exempted from property taxes. Instead, the property tax rate on the second houses, τ^2, was equal to 0.19 percent.[17] We allow for a discount in favor of *landlords* related to the taxation on the second house, $d = 4.4$ percent,[18] and we take into account the income taxation by setting $\tau^i = 30.5$ percent.[19]

The remaining parameter are set in order to match several empirical targets related to the Italian housing market. Actually, we compute them and the main steady state values through a Newton-Raphson algorithm. Using the average time on the market (TOM) from the Italian Housing Market Survey (equal to 2.3 quarters) we derive that the probability to sell in a quarter is $p^s = 0.43$. Our target for housing market tightness is $\theta = 1.40$, computed by using the ratio between housing demand (D^h) and housing supply (S^h). The demand is approximated by the flow of buyers used in the computation of η. On the other hand, the supply S^h is estimated as the ratio of normalized transactions over the probability to sell, p^s, derived above. We will consider as a target also the shares of households that owns only one house ($N^{1mo}+N^{1uo}+N^{1uh} = 57.3$ percent) and the one of tenants ($N^{0ur}+N^{1ur}+N^{0uh} = 20.8$ percent) obtained by the SHIW (Survey on Household Income and Wealth conducted by Bank

[15] Given the structural nature of η we estimate it over a period as long as possible (2004Q1-2012Q4).

[16] We consider as potential buyers those who declare that will buy a home for sure and those who answer they will probably buy.

[17] According to Banca d'Italia (2013a), in 2011 the average tax rate was equal to 0.65 percent of the cadastral value (increased by 5 percent). As we estimate that market values were about 3.4 times greater than the tax base (see section 3.3), the effective tax rate as a percentage of market values was equal to 0.19 percent.

[18] Tax discount is computed on the basis of the tax rates set by the Italian region capitals in 2011 and in 2012. We found that after the reform this parameter remained unchanged.

[19] The estimate for τ^i was computed on the basis of data collected by Lungarella (2011).

of Italy). Hereafter, we refer to homeowners as those who own only one house, keeping apart those who own also a second home.[20] We derive from the same datasource the price-to-income (number of quarters of average household income that would be required to purchase the households' dwelling) and the rent-to-income ratios (equal to 26 and 0.23 respectively). The scaling parameter of the matching function (A) is set to get the number of house sales per family which is equal to 0.0054 per quarter.

3.2 Effects of property taxation

In order to highlight the channels by which our model works, we now consider separately an increase of taxation on owner-occupied dwellings and on second homes. We show they have qualitatively opposite effects. Then, keeping these experiments in mind we study the issue of property tax capitalization on house prices. Figure 2 describes the effects on house prices and rent of property taxes for different combination of tax rates $\left(\tau^1, \tau^2\right)$.

Taxation on owner-occupied dwellings: an increase of the property tax on owner-occupied houses (Policy B) induces a decrease of the continuation utility for homeowners, because the user cost of housing rises. Landlords are initially less affected, because the tax rate on the rented dwelling remains unchanged. As there is more convenience for tenants to mantain their current tenure, housing demand goes down. The property market tightness drops, as the the probability to sell and the number of house sales (Figure 3); at the opposite, p^d increases. Since houses become more illiquid their prices decrease and, since in equilibrium N^{2mr} and N^{2mh} households have the same continuation utility, also rents must decrease, making renters better off. Indeed, in the new steady state the fraction of tenants on total households increases and homeownership correspondingly reduces (Figure 4). This results is at the opposite of Sommer and Sullivan (2014), where homeownership goes up. In their heterogenous agents model an increase of property taxes on owner-occupied dwellings leads to a decrease of house prices while rents are almost unaffected. Therefore, the fraction of low income households that can afford to buy a dwelling rises and the share of homeowners goes up.

Taxation on second homes: a change to τ^2 affects only the owners of two houses (Policy C). In this case, landlords shift part of the greater tax burden on renters through an increase of rental prices. Therefore, as τ^1 was left unchanged, tenants find more convenient to become homeowners, driving up housing demand in the property market. Consistent with the congestion effect due to the rise of the housing demand, sellers have a greater probability to sell their house whereas buyers have a lower probability to buy a home. Market tightness increase and also the number of transactions goes up

[20] This separation is done only to make simpler the calibration exercise, while it should be clear that also those who own a second home are usually included among the homeowners.

Table 2: Calibrated Parameters at quarterly frequency of the Benchmark Economy: (a) Assumption and normalization, (b) Calibrated to match the Italian housing market target, (c) Italian housing market targets.

Description	**Parameter**	**Value**	**Type**
Discount factor	β	0.9915	a
Household income	w	1.0000	a
Maintenance costs	m	0.0086	a
Probability to become mismatched	α	0.0115	a
Probability to start searching for a second home	ν	0.88	a
Tax rate on owner-occupied dwellings	τ^1	0.0000	a
Tax rate on second homes	τ^2	0.0019	a
Landlords property tax discount rate	d	0.0440	a
Rental income tax rate	τ^i	0.3050	a
Elasticity of the matching function	η	0.4800	b
Scalar parameter of matching function	A	0.3399	b
Entry cost for owners	κ^h	12.7224	b
Entry cost for renters	κ^r	0.00005	b
Owners' utility	u^m	13.6712	b
Renters' utility	u^u	13.2051	b
Buyers' bargaining power	χ	0.9038	b
Sales per family	M	0.0054	c
Housing market tightness	θ	1.4000	c
Price-to-income ratio	$\frac{P}{w}$	26.000	c
Rent-to-income ratio	$\frac{R}{w}$	0.2300	c
Share of owners living in or searching for a comfortable house	$N^{1mo} + N^{1uo} + N^{1uh}$	57.300	c
Share of renters	$N^{0ur} + N^{1ur} + N^{0uh}$	20.770	c
Time on the Market	TOM	2.3000	c

Table 3: Results of policy experiments.

Variables	Baseline	Policy A	Policy B	Policy C
θ	1.40	1.40	1.36	1.44
p^d	0.31	0.31	0.32	0.31
p^s	0.44	0.44	0.43	0.44
Homeowners %	57.3	57.3	56.5	58.2
Renters %	20.7	20.7	21.1	20.3
Owners of two houses %	22.0	22.0	22.4	21.5
$\Delta\%R$	-	1.2	-2.4	3.7
$\Delta\%P$	-	-1.8	-2.1	0.4
$\Delta\%$ House sales	-	0.1	-1.4	1.5
Rent-to-price ratio %	3.6	3.6	3.5	3.7

Policy A: additional 0.1% property taxes on all dwellings. Policy B: additional 0.1% property taxes on owner-occupied dwellings. Policy C: additional 0.1% property taxes on second homes.

(Figure 5). This induces an increase in house prices, but much lower than the one in rents, because landlords have to restore the profitability (net of property taxes) of their second home. Indeed, the fraction of renters goes down and the share of homeowners goes up.

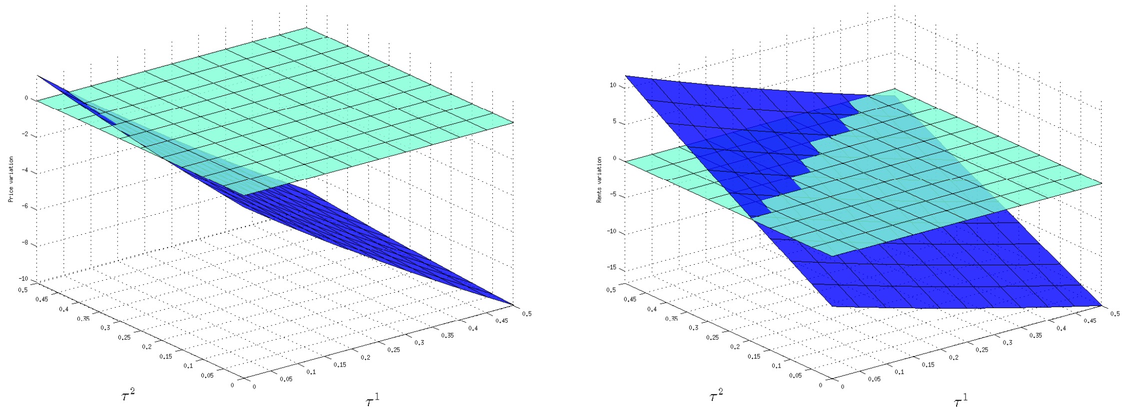
This mechanism is a novelty in the literature because we explicitly model the rental market. In order to be more clear on this regard, we present in Fig. A.1 the results of these policy experiments in the basic model of housing search proposed by Wheaton (1990). In his model there is no rental market and each household owns its home. This implies that taxation on owner-occupied dwellings amounts to a change in the numeraire, lefting unchanged the relative price of housing. An increase of τ^2, instead, drives house prices down, because there is no way to shift the tax burden and the increase in taxation is borne by households who own two dwellings; as their continuation utility decreases, households that are going to buy a second dwelling discount the lower future utility and house prices goes down.

House price capitalization: according to a standard asset pricing equation as in Poterba (1984) and abstracting from all the components of the user cost other than property taxes, housing values can be written as follows

$$P_t = \sum_{t=1}^{T} \frac{1}{(1+r)^{t-1}} \left(S_t - \pi \mathcal{T}_t\right)$$

where S_t is the rental stream of housing services and $\mathcal{T}_t$ are property tax payments. If there is only partial capitalization we should observe $\pi < 1$. The debate in the literature have been focusing on the

Figure 2: Effects of housing property taxes on house prices and rents



(a) House prices

(b) Rents

value taken by π.

Assuming infinite house life and holding fixed household characteristics, the effect on prices can be rewritten as a function of effective tax rate τ:

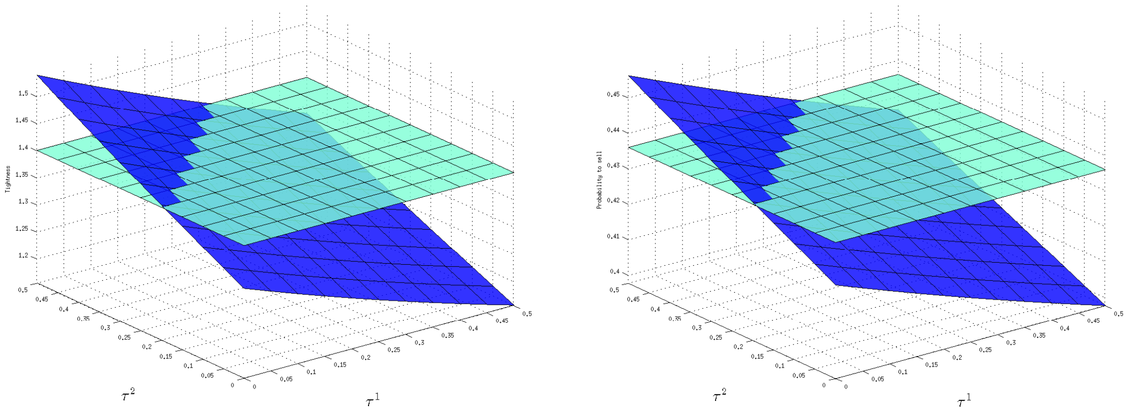
$$\Delta \log(P_t) = -\frac{\pi \Delta \tau}{r} \tag{29}$$

Using this simple formula and assuming $\pi = 1$ we provide a benchmark for house price variation against which we will compare the results coming from our model. According to (29) and assuming a real interest equal to 3.5 percent, if there is full capitalization an increase of the effective tax rate by 0.1 percent would lead to a price reduction of 2.9 percent.

Then, we use the model presented in the previous section to evaluate the extent of tax capitalization in Italy. Since we allow for different effective tax rates among owner-occupied dwellings (τ^1) and other houses (τ^2), we increase both rates permanently by 0.1 percent. As can be seen in the second column of Table 3 (Policy A), increasing the effective tax rate by 0.1 percent leads to a reduction of house price by 1.8 percent. Therefore, our model support the view that property taxes are only partially capitalized in house prices. In particular, we find that π is equal to 0.6, in line with the estimates of Palmon and Smith (1998). In addition to the effects on house prices, we also consider the impacts on other important variables. First of all, the effect on market rents is positive (1.2 percent). This is in line with the results of Tsoodle and Turner (2008), according to which in US an increase in the property tax rate has a significant positive effect on residential rents. More interestingly, in our experiment the shares of homeowners and renters remain unchanged, challenging the common view that an increase of property taxes should discourage homeownership.[21]

[21] Our setup results obviously depend on the implemented calibration. Hence, e.g., if we modify our parameterization

Figure 3: Effects of housing property taxes on housing market tightness and probability to sell



(a) Housing market tightness (b) Probability to sell a house

3.3 Effects of 2011 housing taxation reform in Italy

In this section we will quantify the effects of the Italian housing tax reforms achieved in 2010-2011. Firstly, we will consider the effects of the property tax reform taken alone; secondly, those coming from the change of rental income taxation for landlords. Finally, we will show the results coming from the simultaneous introduction of both reforms.

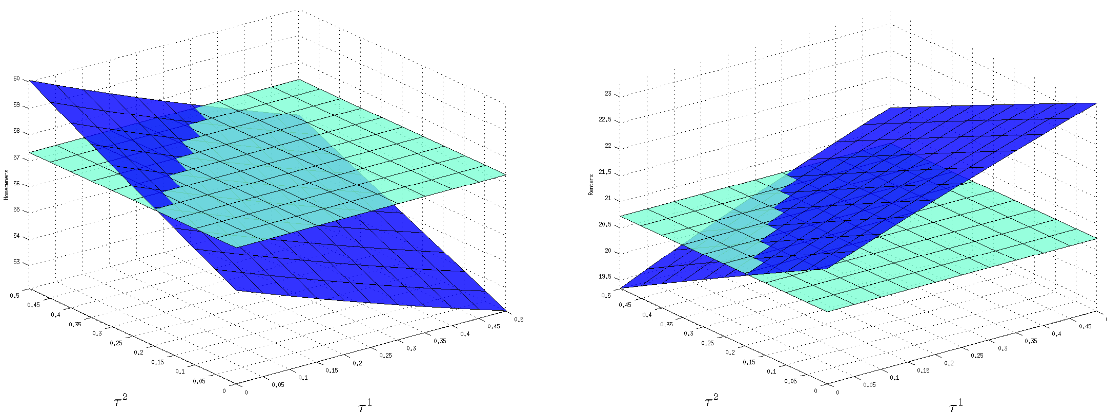
Property taxes in Italy are not computed on housing market values. The tax base is derived by the values recorded in the cadastral registry, that are not consistent with market prices because they are not periodically updated. Moreover, the tax regime is characterized by a preferential treatment for owner-occupied dwellings that consists especially in lower tax rates for homeowners: between 2008 and 2011 owner-occupied dwellings were even exempted.

At the end of 2011 a broad reform of real estate property taxation took place. There are two main features of the reform that we will consider in our analysis.[22] Firstly, the tax base is still represented by the cadastral values, but for fiscal purposes they are augmented by 60 percent. This increase of the tax base by sixty percent was aimed to reduce the huge gap between market values and those recorded in the land registry record. Nevertheless, according to Agenzia delle Entrate (2012), the tax base remains in average about 2.3 times lower than the market value. Secondly, all property tax rates were substantially increased. Property taxes were imposed also on owner-occupied dwellings, that were

to match a share of renters equal to 33.3 per cent (similar to the U.K. rental market) the partial tax capitalization is confirmed but it is slightly more complete ($\pi = 0.65$).

[22] A comprehensive description of the recent housing taxations reforms goes beyond the scope of this paper and can be found in Messina and Savegnago (2014).

Figure 4: Effects of housing property taxes on homeowners and renters' shares



(a) Share of homeowners (b) Share of renters

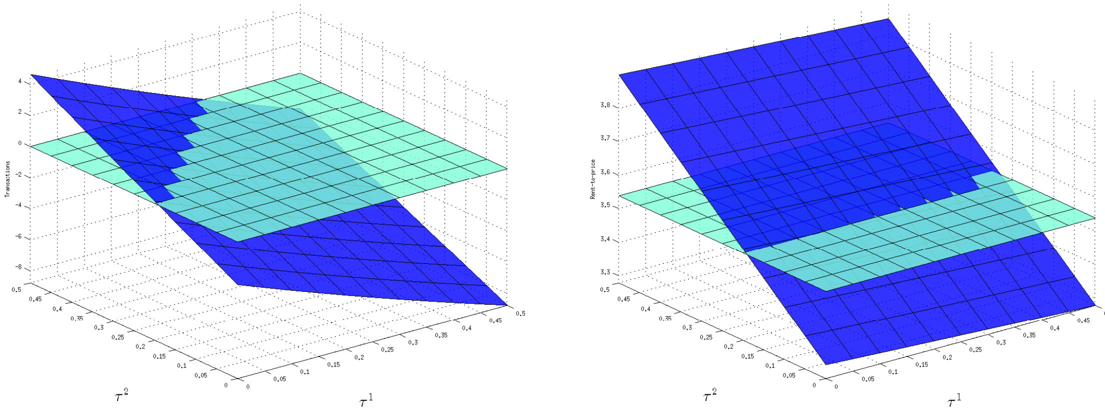
exempted since 2008. For those class of dwellings an average effective tax rate of 0.098 percent of house market values was set. The average tax rate on second homes was increased from 0.19 to 0.42 percent of market values.[23]

In order to be coherent with the Italian housing taxation system when we set different tax rates we will maintain the same tax base i.e, the steady state average house price used to compute the new amount of taxes. As can be expected from the previous section, the whole effect of the 2011 reform is the net result of the compensation among the opposite effects implied by an increase in τ^1 ans τ^2. According to our model in the long-run equilibrium house prices should decrease by only 1.3 percent (see policy D in Table 4), because the negative effect of an increase of user cost for homeowners dominates the indirect effect coming from the increase of τ^2. Equilibrium rental prices should instead increase by 6.0 percent, because landlords shift part of the increased tax burden to renters in order to offset the initial negative effect on renting profitability. This is more clear looking to the rent-to-price ratio, that in the new steady state increases to 3.8 percent. Moreover, as homeownership becomes relative more convenient than rental, housing demand rises and so also market tightness. As a result the fraction of homeowners increase by more than one percentage point, to 58.5 percent. In equilibrium also house sales increase (by 2 percent).[24]

[23]As with the reform the tax base was increased by sixty percent, in order to compare the effective tax rates after the reform with those prevailing before, we compute all of them in terms of percentage of market values. Moreover, considering the effective tax rates we include the lump sum deduction for owner-occupied dwellings, but we abstract from its distributional effects (see Messina and Savegnago, 2014). The average tax rates were computed in Banca d'Italia (2013b).

[24]Despite our model encompasses many realistic features of the housing markets, there are of course some simplifications made in order to keep the model tractable. In section 3.4 we will discuss the bias deriving from the assumption of perfect

Figure 5: Effects of housing property taxes on transactions and rent-to-price ratio



(a) Transactions (b) Rent-to-price ratio

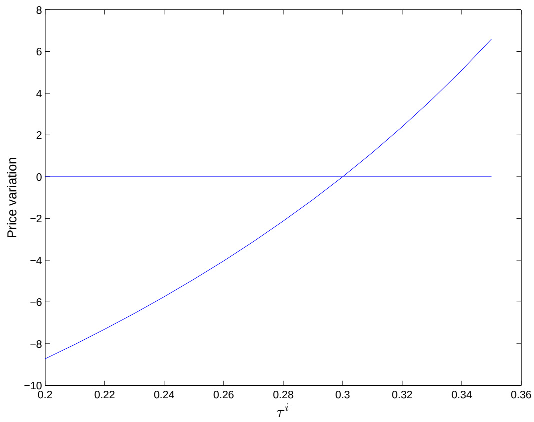
Indeed, a key message of our experiment is that the overall effect of the property taxation reform on the housing market is quite limited in the long run . However, we believe it is really challenging to test this result using standard econometric analysis, because of the almost contemporaneous change of rental income taxation for landlords as well as the inertia of house prices. Before 2011 rents on leased houses were subject to progressive rental income taxation, as they were added to other incomes determining the total income of landlords. According to the new taxation regime introduced in 2011 (named "cedolare secca"), landlords had the opportunity to choose between the previous progressive framework and the new proportional tax rate. In 2012, this rate was set to 21 percent for market contracts and the tax base was the nominal value of the rental contract.[25] This guarantees a lower tax burden for almost all the landlords.

We simulate the rental income taxation reform as a permanent reduction of τ^i from the baseline value of 30.5 percent to 21 percent (Policy E). Furthermore, it should be considered we are assuming that the reduction of the rental tax rate is related to all contracts while in the reality the new tax regime is an alternative with respect to the old one. According to Chiri et al. (2013), before the reform the effective marginal tax rate was equal to 28.05 percent for landlords with a total income in the range 15-28 thousands euro, while it was equal to 38.25 percent over 28 thousands euro. Indeed, this

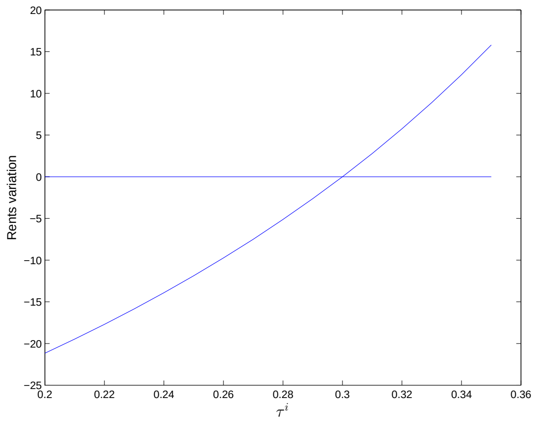
capital markets and the absence of a construction sector. We will consider also the case in which second homes are not rented or put for sale. The latter is particularly relevant for Italy, where about 16 percent of the housing stock is kept as vacant or for holidays (Chiri et al., 2013).

[25] In this work we concentrate on market rental contracts (those where rents are freely determined by landlords and renters). According to Chiri et al. (2013), in Italy about 20 percent of rental contracts are not individually negotiated ("canone concordato"): rents are predetermined and generally lower than those prevailing on the market.

Figure 6: Effects of rental income taxes on house prices and rents



(a) House prices



(b) Rents

supports our assumption.

As for property taxes on second homes the transmission channel is the shifting of tax burden from landlords to tenants. Since for the initial level of R a fall of rental income taxes increase the net return of landlords, perfect competition and free-entry on the rental market push rents down, making homeownership relatively less convenient. Housing demand decreases, prices go down and the fraction of renters increases. We find that the 9.5 percentage points decrease of rental income taxation leads to a reduction of house prices by 8.3 percent in the steady state equilibrium. The decline is stronger for rental prices (-19.9 percent), while the share of tenants increases by slightly less than 2 percentage points.[26] The reduction of prices and rents are explained by the fact that the effective return of rental investment for landlords keeps in account also rental income taxation; consequently adjustments of the rent-to-price ratio are needed to restore the net return of landlords. The results shown in Table 3 must be considered as a lower bound, because of our modeling assumptions: in particular, we do not control for tax evasion.[27]

According to the model, as a result of the joint consideration of the tax property on all owners and

[26]See also the Appendix B.1.

[27]With respect to the new regime we should keep in mind two issues: (i) companies have no possibility to choose it; (ii) the effects can be less important as the rental market is seriously affected by tax evasion. The latter is particular relevant, as one of the main goal for the reform was to reduce tax evasion and to induce landlords to pay taxes. Our model is not able to provide control for this issue, as there is no endogeonus choice for landlords to pay taxes or not. However, we believe that this will reduce drastically the negative variation on rents, because for landlords that before did not pay any taxes the new regime would imply an increase of taxation (if they decide to leave the underground economy). Indeed, we simulated an increase of rental income taxation for all landlords from 0 to 21 percent and we got as a result that house prices would increase by about 10 percent and rents by 24 percent.

the reduction of τ^i (Policy F) house prices and rents go down by 10.3 and 15.3 percent respectively. The fraction of tenants increases to 21.8 percent, while house sales drops by 3.6 percent.

Table 4: Results of policy experiments.

Variables	**Baseline**	**Policy D**	**Policy E**	**Policy F**
θ	1.40	1.46	1.25	1.30
p^d	0.31	0.30	0.33	0.32
p^s	0.44	0.44	0.41	0.42
Homeowners %	57.3	58.5	54.2	55.2
Renters %	20.7	20.1	22.3	21.8
Owners of two houses %	22.0	21.4	23.5	23.0
$\Delta\%R$	-	6.0	-19.9	-15.3
$\Delta\%P$	-	-1.3	-8.3	-10.3
Δ% House sales	-	2.0	-5.3	-3.6
Rent-to-price ratio %	3.6	3.8	3.1	3.3

Policy D: 0.098% (from zero) property tax rate on owner-occupied dwellings, 0.42% (from 0.19%) on second homes. Policy E: 21% (from 30.5%) rental income tax rate. Policy F: policy D plus policy E.

3.4 Discussion

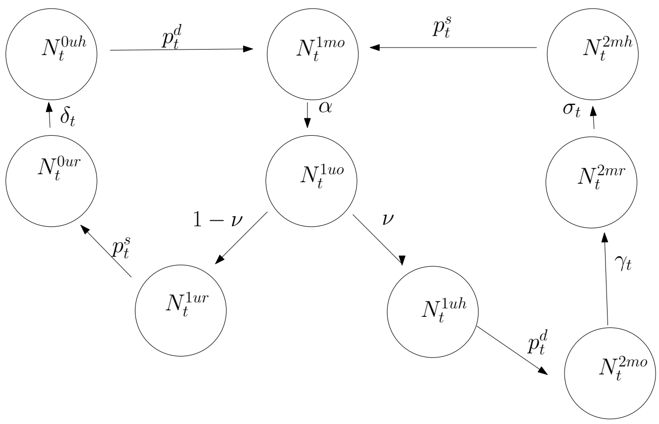
Despite our model encompasses many realistic features of the housing markets, there are of course some simplifications made in order to keep the model tractable. In this section we will discuss some caveat that we consider particularly relevant.

The role of credit markets: as standard in the housing search literature we assume perfect capital markets. However, there is an important strand of theoretical literature that explicitly stress the importance of credit frictions in the mortgage market. The key friction in this literature is observable when households buy a dwelling and they need to have a sufficient wealth to be used as downpayment. Indeed, credit frictions prevent households from borrowing the full value of the house (loan-to-value lower than 100 percent). In a heterogeneous agents framework á la Aiyagari, only a fraction of the households can afford housing property, in particular those who have been able to accumulate enough wealth in the past. Considering this additional channel in our framework is hardly feasible because of the computation difficulties involved. However, there is a recent paper that made a similar analysis for the U.S. housing market. Sommer and Sullivan (2014) consider the effects of a disposal of the property tax deductions on owner-occupied dwellings, taking into account explicitly the individuals tenure choice. An increase in the tax property to homeowners leads to a decline in house prices because the user cost rises, but reduced house prices allow low wealth households to become homeowners because the downpayment falls. This counterbalances the initial decline. In equilibrium rents remain roughly constant even as house prices decline, so this relative price shift encourages a shift from renting to owning.

The role construction sector: The second issue is related to the housing stock, that we assume fixed. In the long run it is plausible that it will eventually adjust in response to house prices changes. A higher level of house prices would lead to an increase of the housing stock, because of the increased return of housing investment for construction firms. The opposite eventually is not true when house prices lower, because as Glaeser and Gyourko (2005) show, positive and negative demand shocks have asymmetric effects. Houses are durable goods that do not disappear quickly when demand falls. Ignoring housing supply does not affect qualitatively our results related to property taxation, due to the low sensitivity of the housing supply with respect to a reduction of home prices.

The role of vacant houses: The third caveat is that in our model all second houses are either rented or put for sale; none of them are kept vacant or for holidays by their owners. It could be argued that after an increase of property taxes on second houses the owners can decide to rent the house or put it for sale, therefore increasing supply and adding downward pressure on prices and rents. This issue is

Figure 7: Transitions among states



particularly important in Italy, where about 16 percent of the housing stock is kept as vacant or for holidays (Chiri et al., 2013). The absence of houses kept as vacant is not an assumption but a result of the model, because owners derive no utility from a vacant second house. What we will do here, instead, is to assume that a vacant house gives the owners a flow utility $\tilde{u}$.[28] For the sake of tractability and

[28]You can think at this utility in different ways: it can be the utility from having a house for the holidays or a place were to host friends or relatives, but it could also represent the opportunity cost to argue with your parents because the house was their gift.

to have some heterogeneity among households, we assume that $\tilde{u}$ is equal for everyone, but at each period t households have to pay an idiosyncratic disutility cost c to keep the house vacant. This cost is independently and randomly distributed among households according to a cumulative distribution $F(c)$ on the continuous support $[0, \bar{c}]$.[29] Households discover at time t the cost c they should pay at $t+1$ to keep the house vacant, apart from the first period in which they start owning the house. We will assume that $\mathcal{H}^{1uh}$ agents that successfully buy a second house in the first period keep them vacant; we will call this type of households $\mathcal{H}^{2mo}$. Once these households discover their disutility cost c, they decide to keep the household as vacant or to rent it (Figure 7).[30]

Since we have the new state $\mathcal{H}^{2mo}$ a new transition equation has to be introduced and (7) must be accordingly modified:

$$N_{t+1}^{2mo} - N_t^{2mo} = p_t^d N_t^{1uh} - \gamma_t N_t^{2mo} \tag{30}$$

$$N_{t+1}^{2mr} - N_t^{2mr} = \gamma_t N_t^{2mo} - \sigma_t N_t^{2mr} \tag{31}$$

where γ_t is the endogenous fraction of households that become *landlords* in the next period.[31] Free entry in the rental market implies that there exists some threshold level $c^* = V^{2mo} - V^{2mr}$ such that families with $c \leq c^*$ will keep the house vacant, while the others will rent it. The continuation utility of $\mathcal{H}^{2mo}$ households in steady state is

$$V^{2mo} = u^m + \tilde{u} + w - \tau^1 \bar{P} - \tau^2 \bar{P} - 2m + \beta \left\{ (1-\gamma) \left[V^{2mo} - \int_0^{c^*} \frac{c}{F(c^*)}\, dF(c) \right] + \gamma V^{2mr} \right\} \tag{32}$$

where the fraction $\mathcal{H}^{2mo}$ entering the rental market is given by

$$\gamma = 1 - F(c^*) \tag{33}$$

Household with a disutility cost greater than c^* will be better off entering the rental market. Using (32), (18) and the free entry condition $c^* = V^{2mo} - V^{2mr}$ we derive the threshold at the steady state as the solution to:

$$(1-\beta\gamma)c^* + \beta \int_0^{c^*} c\, dF(c) = \tilde{u}^h - R(1-\tau^i) - \tau^2 d\bar{P} \tag{34}$$

[29] An equivalent way to formalize households heterogeneity is to assume that each of them has an i.i.d. idiosyncratic utility $\tilde{u}^i$, that is extracted in each period from some random distribution. However, this formalization is less tractable from a computational point of view.

[30] This assumption is innocuous, since we know that in equilibrium the continuation utility of a *landlord* is the same of a seller. Moreover, if we would let type $\mathcal{H}^{1ur}$ households to keep vacant they have left, the results would almost similar.

[31] An additional difference with the baseline model is about the relation among the total stock of housing and the housing supply. While in the baseline model can be shown that in the steady state $S^h = H - 1$, now the relation becomes $S^h + N^{2mo} = H - 1$.

For a given R, there exists only one value of c^* for which (34) holds.[32] Since both $\mathcal{H}^{2mo}$ and *landlords* are subject to the same maintenance costs and taxes, the threshold disutility cost for keeping a house vacant is a function of the utility $\tilde{u}$, the opportunity cost of renting $R(1-\tau^i)$ and the tax discount $\tau^2 d\bar{P}$. It is clear from (33) and (34) that the direct effect of an increase of property taxes on second houses is related to the presence of tax discounts on rented houses. When $d = 0$ the fraction of $\mathcal{H}^{2mo}$ households that want to become *landlords* increase only if R increases (because c^* decreases).[33]

As a consequence, the introduction of $\mathcal{H}^{2mo}$ households should at most lessen the magnitude of our previous simulations, but should not change the qualitative effects. Then, we perform two exercises in order to give some insights on the quantitative effects compared with those of the previous section.[34] We modified the baseline model assuming that before the policy intervention the fraction of $\mathcal{H}^{2mo}$ households on total population was about 2 and 5 percent and we calibrated again the model, following the procedure described in 3.1.[35] As expected, we find that the net effect of the property tax increase is similar to the main experiments in both our exercises.[36] Figures B.2 and B.3 provides a broad picture of what happens and how results depends on the initial level of N^{2mo}.

4 Conclusions

We propose a framework for evaluating the long-run effects of housing taxation on house prices, rents and household tenure choice. Our main contribution is the introduction of an active rental market in a standard search model of the housing market. In this way we can deepen the analysis of housing

[32]For a given R the right hand side of (34) is a constant. The left hand side is instead an increasing function of c^*:

$$\frac{dLHS}{dc^*} = 1 - \beta\gamma\left(c^*\right) > 0$$

For $c^* = 0$ the LHS is null, while for $c^* = \bar{c}$ it is equal to $\bar{c} - \mathbb{E}\left(c\right)$. Therefore, if $\tilde{u}^h - R(1-\tau^i) - \tau^2 d\bar{P}$ is in the interval between 0 and $\bar{c} - \mathbb{E}\left(c\right)$ there exists a single solution for (34).

[33]Indeed, looking to the tax rates set by the italian capital regions we found that following the property taxation reform of 2011 tax discounts on rented houses remained almost unchanged. For this reason we believe that this channel did not work in that case.

[34]A sound calibration proves to be difficult. A first issue is related to the restriction that each household can at most own two dwellings, that hampers the ability to match the empirical distribution of the stock of dwellings across households. A second issue is that no information can be retrieved on the shape of the distribution $F(c)$.

[35]For simplicity we assume that the disutility cost is distributed according to a uniform distribution. In this case we have two new parameters, $\tilde{u}$ and $\bar{c}$, that we pin down using as target the assumed value for N^{2mo} and the share of renters in the population. When $N^{2mo} = 0.02$ we have $\tilde{u} = 0.72$ and $\bar{c} = 1.43$, while for $N^{2mo} = 0.05$ we get $\tilde{u} = 0.76$ and $\bar{c} = 1.37$.

[36]However, it is interesting to note that the effects on the share of homeowners are generally stronger when we take into account vacant homes. If property taxation makes homeownership more attractive than renting, in equilibrium the stock of vacant homes goes down and it is absorbed by demand for homeownership.

property taxation, in which the household tenure choice has a crucial role. In particular, the joint consideration of both housing and rental markets highlights a new channel: landlords shift part of the tax burden on renters, affecting the economy's evolution of prices and quantities.

A permanent increase of tax rates on owner-occupied dwellings causes a decrease of the share of homeowners and of the housing and rental prices, as expected. The opposite effects derive from an increase of tax rates on second homes; landlords shift part of the tax burden on tenants. As the latter have to pay a higher rent, it is more convenient to become homeowner. Consequently, demand for owner-occupied housing rises, putting an upward pressure on prices. In the long run the system adjusts to the permanent tax variation and in the new steady state the fraction of homeowners increases, as well as house prices and rents.

We can provide answers to old questions, such as the extent of property taxes capitalization on house prices. We find that the pass through of tax rates on house prices is only partial, but the magnitude is substantial (sixty percent), confirming the results found in previous contributions.

We also evaluate housing taxation reforms occurred in Italy. In 2012 property taxation increased substantially for both owner-occupied dwellings and second homes; according to our model, as a net result house prices should decrease in real terms by 1.3 percent, while rents should increase by 6.0 percent. Based on our model' simulation, the share of homeowners rises (by 1.2 percentage points). Moreover, in 2011 a reform of rental income taxation for landlords reduced their average tax burden. In our theoretical framework, through the simultaneous consideration of rental and property reforms we find that in the long run also rents go down (by 15.3 percent in real terms). Of course, given that we solve for the steady-state of the model, it is not possible to run plausible policy implications, as we are silent about the short-run dynamics of the system associated to policy changes.

Another insight of the model is that the same policy target (i.e. promoting homeownership) can be achieved through different instruments or combinations of them. Indeed, while it is obvious that a reduction of taxation on owner-occupied dwellings has the direct effect to promote homeownership, it is not equally obvious that the same result is reachable by increasing taxes on second homes. Moreover, the same qualitative effects of property taxation on second homes can be reached by varying the rental income tax rate for landlords.

Of course, such modelling comes with potential caveats and semplifications in order to keep the model more tractable. Nevertheless, we believe that including some of them does not qualitatively change our results. Firstly, we abstract from credit frictions (downpayment). However, Sommer and Sullivan (2014) did an analysis similar to ours for the U.S. housing market and they found that an increase in the tax property to homeowners leads to a decline in house prices because the user cost rises, but reduced house prices allow low wealth households to become homeowners because the downpayment falls. This counterbalances the initial decline. In equilibrium rents remain roughly constant even as house prices decline, so this relative price shift encourages a shift from renting to owning, as in our model.

The second issue is related to the housing stock, that we assume fixed. In the long run it is plausible that it will eventually adjust in response to house prices changes and the quantitative effect depends on the elasticity of housing supply with respect to the home prices. However, according to Nobili and Zollino (2016) and Loberto and Zollino (2016) this elasticity in Italy is relatively low. Moreover, it is plausible that a lower level of house prices has no effect on the housing stock, because as argued by Glaeser and Gyourko (2005) houses are durable goods that do not disappear quickly when demand falls. Therefore, we believe that ignoring housing supply does not affect qualitatively our results related to property taxation.

The third caveat is that in our model all second houses are either rented or put for sale; none of them are kept vacant or for holidays by their owners. It could be argued that after an increase of property taxes on secondary dwellings the owners can decide to rent the house or put it for sale, therefore increasing supply and adding downward pressure on prices and rents. In section 3.4 we allow vacant dwellings to provide a fixed flow utility, but we show that this extension does not qualitatively change our results.[37]

Our analysis can be extended in two directions. As so far we have considered only the effects on the steady state equilibrium of the housing market, a natural evolution is to analyze the full evolution path toward the new equilibrium. This extension is tricky, as the evaluation of the short run dynamics cannot avoid the modeling of staggered rental contracts and the consideration that different effects can emerge depending on the macroeconomic conditions (boom/recession). A second extension will be to analyze the effects of variations on stamp and duties taxes, as search models are the natural environment of this policy.

[37]The intuition goes as follows. The marginal households is indifferent beetwen renting out its secondary dwelling or keeping it as vacant. As an increase of property taxation on secondary houses affects all dwellings, the previous marginal household decides to rent out only if rental prices increases. Then, the qualitative effect is the same.

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A Appendix A

A.1 Steady state equations

Transition equations:

$$\begin{aligned}
p^s N^{1ur} &= \delta N^{0ur} \\
p^d N^{0uh} &= \delta N^{0ur} \\
p^d N^{0uh} &= p^s N^{2mh} - \alpha N^{1mo} \\
\alpha N^{1mo} &= \nu N^{1uo} - (1-\nu) N^{1uo} \\
p^s N^{1ur} &= (1-\nu) N^{1uo} \\
\nu N^{1uo} &= p^d N^{1uh} \\
p^d N^{1uh} &= \sigma N^{2mr} \\
\sigma N^{2mr} &= p^s N^{2mh}
\end{aligned}$$

Value functions:

$$\begin{aligned}
V^{0ur} &= \frac{u^u + w - R}{1-\beta} \\
V^{0uh} &= \frac{u^u + w - R - \kappa + \beta p^d \left[V^{1mo} - \mathbb{E}\left(P|i=0\right)\right]}{1-\beta\left(1-p^d\right)} \\
V^{1mo} &= \frac{u^m + w - \tau^1 - m + \beta\alpha V^{1uo}}{1-\beta(1-\alpha)} \\
V^{1uo} &= u^u + w - \tau^1 - m - \tilde{k} + \beta\left[(1-\nu)V^{1ur} + \nu V^{1uh}\right] \\
V^{1ur} &= \frac{u^u + w - R - \tau^2 - m + \beta p^s \left[V^{0ur} + \mathbb{E}\left(P|j=0\right)\right]}{1-\beta\left(1-p^s\right)} \\
V^{1uh} &= \frac{u^u + w - \tau^1 + \beta p^d \left[V^{2mr} - \mathbb{E}\left(P|i=1\right)\right]}{1-\beta\left(1-p^d\right)} \\
V^{2mr} &= \frac{u^m + w + R(1-\tau^i) - \tau^1 - \tau^2(1-d) - 2m}{1-\beta} \\
V^{2mh} &= \frac{u^m + w - \tau^1 - \tau^2 - 2m + \beta p^s \left[V^{1mo} + \mathbb{E}\left(P|j=1\right)\right]}{1-\beta\left(1-p^s\right)}
\end{aligned}$$

Prices:

$$
\begin{aligned}
P^{00} &= \beta\left[(1-\chi)\left(V^{1mo}-V^{0uh}\right)+\chi\left(V^{1ur}-V^{0ur}\right)\right]\\
P^{01} &= \beta\left[(1-\chi)\left(V^{1mo}-V^{0uh}\right)+\chi\left(V^{2mh}-V^{1mo}\right)\right]\\
P^{10} &= \beta\left[(1-\chi)\left(V^{2mr}-V^{1uh}\right)+\chi\left(V^{1ur}-V^{0ur}\right)\right]\\
P^{11} &= \beta\left[(1-\chi)\left(V^{2mr}-V^{1uh}\right)+\chi\left(V^{2mh}-V^{1mo}\right)\right]\\
\mathbb{E}\left(P|i=0\right) &= \frac{N^{1ur}}{S^h}P^{00}+\frac{N^{2mh}}{S^h}P^{01}\\
\mathbb{E}\left(P|i=1\right) &= \frac{N^{1ur}}{S^h}P^{10}+\frac{N^{2mh}}{S^h}P^{11}\\
\mathbb{E}\left(P|j=0\right) &= \frac{N^{0uh}}{D^h}P^{00}+\frac{N^{1uh}}{D^h}P^{10}\\
\mathbb{E}\left(P|j=1\right) &= \frac{N^{0uh}}{D^h}P^{01}+\frac{N^{1uh}}{D^h}P^{11}
\end{aligned}
$$

A.2 Wheaton's model

In Wheaton (1990) there is no rental market. All households are homeowners and they can be in one of three occupancy states. There is a measure N^{1mo} of households living in a house they like; N^{2mh} are the matched households that own also a second dwelling; N^{1uh} are mismatched households (living in a house they do not like). N^{1mo} households become mismatched with probability α. There is a decentralized housing market where N^{1uh} households find a counterparty N^{2mh} and house prices are determined by Nash bargaining with equal bargaining power among buyers and sellers; N^{1uh} households that successfully trade become N^{2mh}, while the N^{2mh} households become N^{1mo}. The total number of households is 1 and the stock of houses is fixed and equal to H. The number of vacancies is $V=H-1$.

The Wheaton's model is defined on continuous time and the transitions among states are described by the following differential equations:

$$\dot{N^{1uh}} = -N^{1uh}(2\alpha+m)+\alpha\left(1-N^{2mh}\right) \tag{A.1}$$

$$\dot{N^{2mh}} = mN^{1uh}\left(1-\frac{N^{2mh}}{V}\right) \tag{A.2}$$

$$\dot{N^{1mo}} = -\dot{N^{1uh}}-\dot{N^{2mh}} \tag{A.3}$$

where m is the arrival rate for N^{1uh} households of a counterparty in the housing market. Wheaton (1990) assumes that m is a function of costly search effort and the fraction of vacant units:

$$m\left(E,\frac{V}{H}\right);\quad m\left(0,\frac{V}{H}\right)=0,\ \frac{\partial m}{\partial E}>0,\ \frac{\partial^2 m}{\partial E^2}<0,\ \frac{\partial m}{\partial V/H}\geq 0 \tag{A.4}$$

and the cost of effort is defined as

$$c(E); \quad c(0) = 0, \ \frac{\partial c}{\partial E} > 0, \ \frac{\partial^2 c}{\partial E^2} > 0 \tag{A.5}$$

The present discounted value of being in each of the three occupancy states, modified in order to consider property taxes, is defined by the following equations:

$$rV^{1mo} = u^m - \tau^1 - \alpha(V^{1mo} - V^{1uh}) \tag{A.6}$$

$$rV^{2mh} = u^m - \tau^1 - \tau^2 + q(V^{1mo} - V^{2mh} + P) \tag{A.7}$$

$$rV^{1uh} = u^u - \tau^1 - c(E) + \alpha(V^{1mo} - V^{1uh}) + m(E)(V^{2mh} - V^{1uh} - P) \tag{A.8}$$

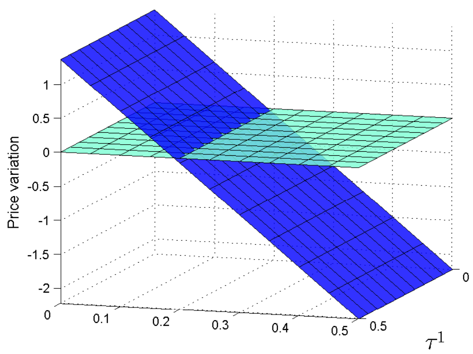
where r is the discount rate and $q = m(E)\frac{N^{1uh}}{V}$ is the arrival rate of a counterparty in the housing market for N^{2mh} households. Housing prices are determined by Nash barganining:

$$P = \frac{V^{2mh} - V^{1uh} + V^{2mh} - V^{1mo}}{2} \tag{A.9}$$

Since households select the level of search effort E so as to maximize the value of being mismatched, in equilibrium search must be conducted until the marginal gain from the last unit of search effort equals the cost of that effort. Therefore, the final equation that close the model is

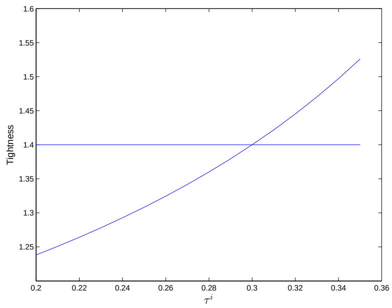
$$\frac{\partial C(E)}{\partial E} = \frac{\partial m(E)}{\partial E}\left(V^{2mh} - V^{1uh} - P\right) \tag{A.10}$$

Figure A.1: Effects of housing property taxes on house prices in Wheaton's model

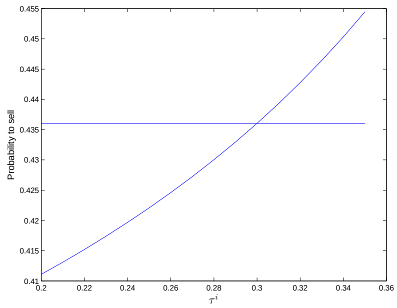


B Appendix B

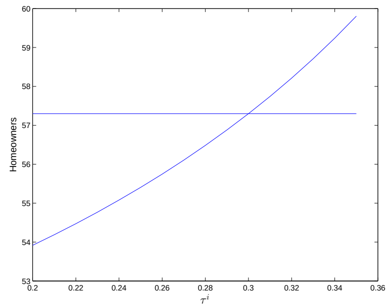
Figure B.1: Effects of rental income taxes.



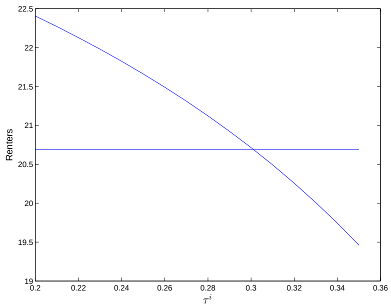
(a) Tightness



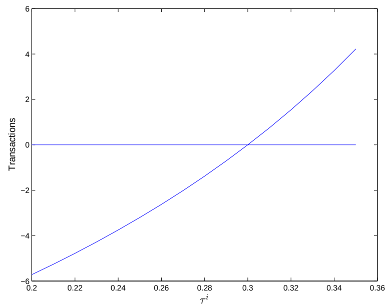
(b) Probability to sell a house



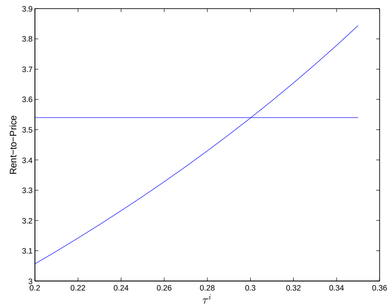
(c) Share of homeowners



(d) Share of renters

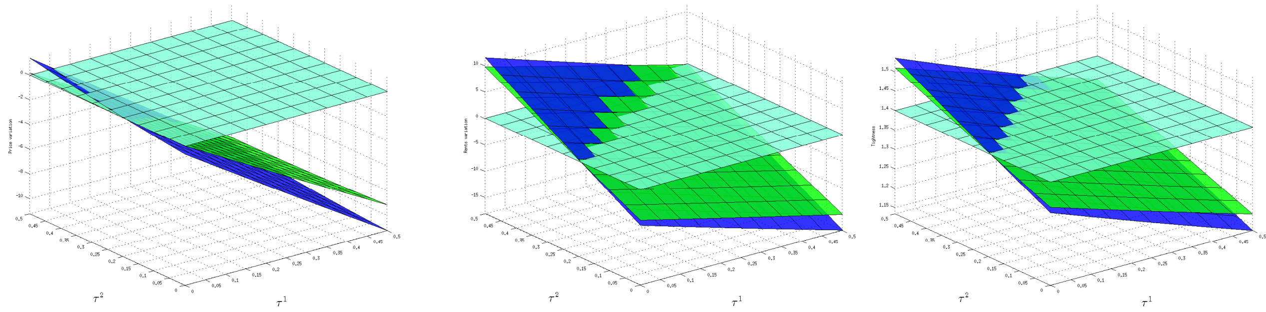


(e) Transactions

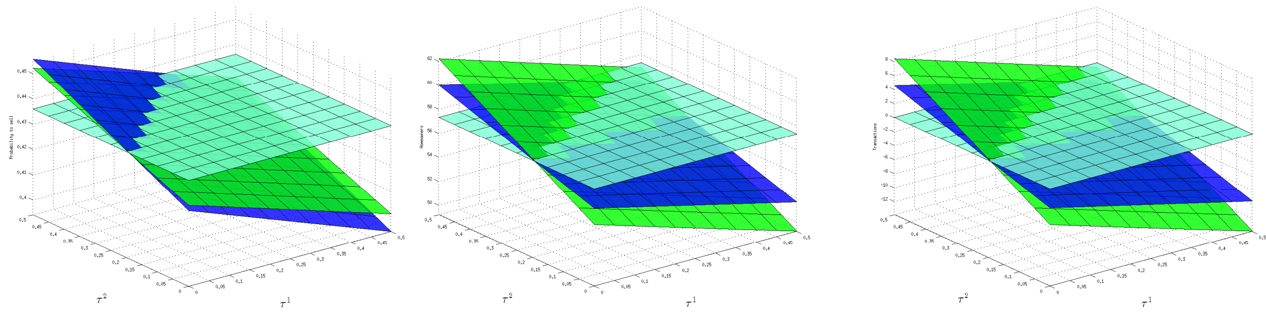


(f) Rent-to-price ratio

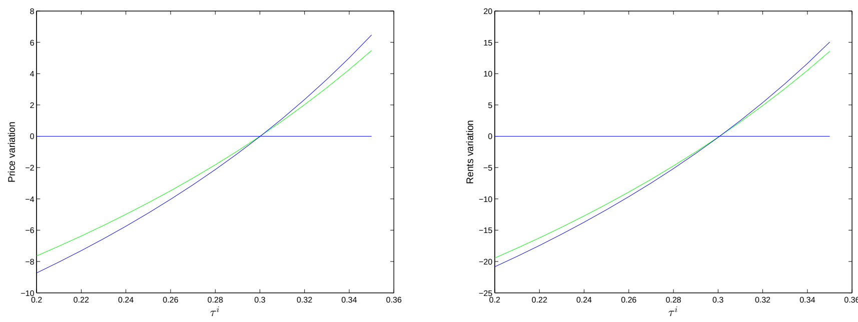
Figure B.2: Effects of housing property taxes. $N^{2mo} = 2\%$



(a) House prices (b) Rents (c) Tightness



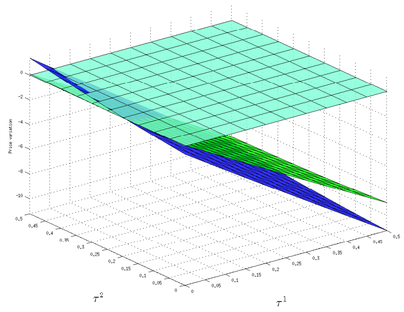
(d) Probability to sell a house (e) Share of homeowners (f) Transactions



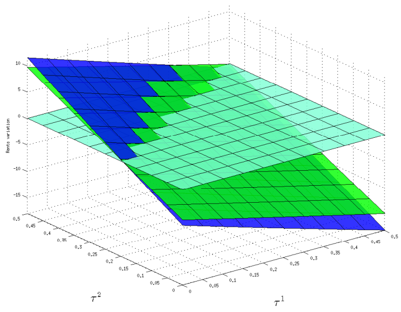
(g) House prices (h) Rents

Figures a, b, c, d, e, refer to changes in property taxation. Figures g and h refer to rental income taxation. Baseline model (blue) and Model with vacant houses (green).

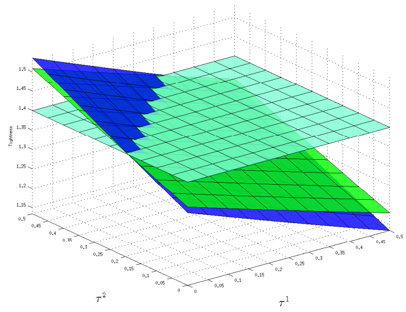
Figure B.3: Effects of housing property taxes. $N^{2mo} = 5\%$



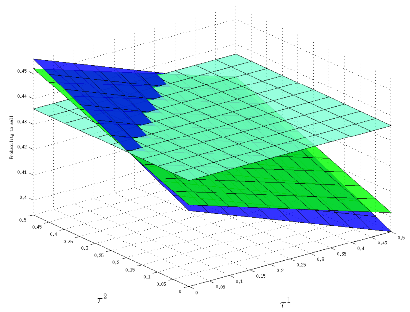
(a) House prices



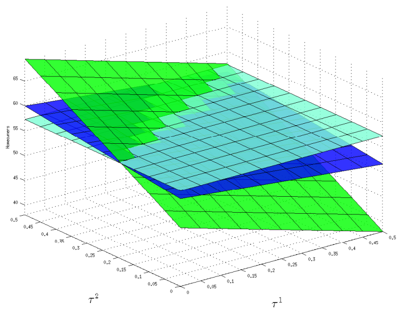
(b) Rents



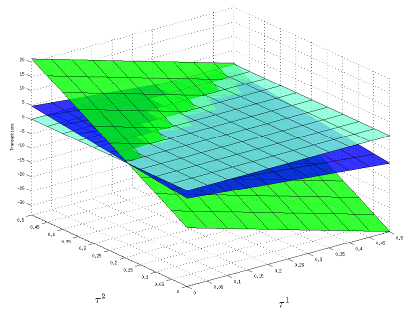
(c) Tightness



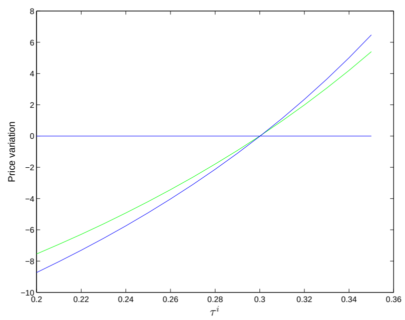
(d) Probability to sell a house



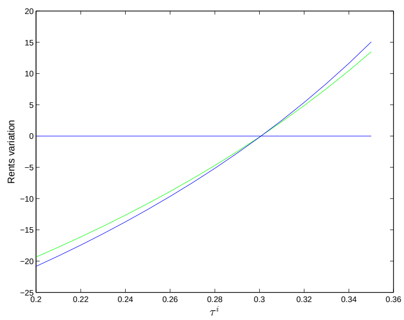
(e) Share of homeowners



(f) Transactions



(g) House prices



(h) Rents

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