Implications of Swiss Tax Policy for House Prices, Rents, and Homeownership. A Quantitative Approach

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Abstract

With only 36%, Switzerlands home ownership rate belongs to the lowest among all OECD countries. Self imputed rental value is a tax policy often said to be a driver for low home ownership rates. Applying an agent based life cycle model featuring endogenous housing prices and rents, we simulate the relationship between tax policies, house prices, rents, home ownership rates, and welfare. We found tax policies to be suitable instruments for boosting home ownership rates. Price effects are shown to be substantial and have considerable implications for welfare.

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1 Introduction

For most households in developed as well as undeveloped countries, housing is the most relevant consumption good Stiglitz et al. (2009). Housing affordability is therefore on the agenda of many political parties and organisations across all colours: "The scholars agree that housing is a 'unique' type of property with a special character in our law and policy, compared to a wide range of other forms of property.' This scholarship might seem likely to boost the affordability movement because such valuing of home might lead to laws and policies making decent and affordable homes available for all" Iglesias (2007). With only 36.2%, Switzerland has one of the lowest homeownership rates, among all OECD countries (see Bourassa and Hoesli (2010); Andrews and Sánchez (2011)).

Taxation of self imputed rental value (IRT) is one policy often said to be a driver of low homeownership rate and thus detrimental for housing affordability. By adding some imputed rental value to taxable income, the tax burden of owner-occupiers is increased. This extra cost for owner-occupiers moderates demand for housing and therefore should decrease homeownership rate. Further critique about IRT includes unfair treatment of homeowners compared with renters due to the fact that latter are not subject to this tax.

Proponents of IRT respond that the housing market[1] has inelastic supply. Thus, shifting up demand will result in price rather than quantity effects. Another issue, regional economists face, is tiebout sorting. High house prices offset low tax rates and poor provision of public goods, et vice versa (see Tiebout (1956)). This segregation of high income households from low income households can encompass negative externalities and lead to unfair endowment of social capital. Even if not intended to moderate tiebout effect[2], IRT can lift inequality in taxation by increasing taxable income for households living

[1]At least in developed countries and specially in urban areas.

[2]IRT was ad interim introduced in Switzerland in 1905, during WWI, since it was a fast and reliable source of income for the government, which was in financially dire situation. Finally, in 1945 IRT was converted into regular law.

in high valued homes and therefore in low marginal tax rate neighbourhoods. With estimated 3.8 billion CHF per year contributing to federal budget,[3] IRT is an important source of income for public finance. Closely related to IRT is mortgage interest deduction (MID) which allows homeowners to deduct interest payments araising from mortgage holdings on residential property.

This paper aims to investigate the quantitative effects, IRT and MID have on homeownership, prices, rents, and welfare. Applying an agent based life-cycle model, we simulate counterfactual policy changes to aggregated household decisions.

The structure of this paper is as follows:
Related literature to household policy and housing decisions is discussed in Section 2. The relevant features of the Swiss economy, its political system and the current political debate is laid out in Section 3. In Section 4, we describe the model, discuss the households optimisation problem and derive the stationary solution of the economy. In order to obtain realistic results, we calibrate model parameters in Section 5. Assessing the quality of the parameter choices and the model in general, we compare non-targeted simulated parameters with real world values in Section 6. Counterfactual results, obtained by elimination of MID, IRT or MID and IRT, are presented in Section 7. We sum up the results obtained and discuss implications of tax policy on ownership, housing prices, rents, and welfare in the last Section 8.

2 Related Literature

Due to the fact that imputed rental value of owner occupied housing is only subject to taxation in a few countries, literature on this topic is sparse.

Early work determining effects of removing preferential tax on owner-occupied housing includes Rosen (1985) or Hendershott and Shilling (1982). Although their results are not entirely conclusive, they only find marginal ef-

[3] According to Federal Tax administration (FTA)

fects.

Bourassa and Hoesli (2010) and Bourassa et al. (2010) found IRT as well as high house prices to be the main drivers for low ownership rate in Switzerland compared to other developed countries. Using Statistics on Income and Living Conditions (SILC) data, a tenure choice model was developed in order to simulate partial equilibrium effects. They advocate to eliminate IRT, but are concerned that if IRT and MID are eliminated simultaneously, homeownership rate would decrease.

A growing literature deals with the obstacle that imputed rental income and the resulting welfare are hard to empirically measure quantities. Balcázar et al. (2017); Arévalo and Ruiz-Castillo (2006); Ceriani et al. (2019) all stress the importance of including imputed rental income in aggregated measures such as GDP or CPI.

Some inequality considerations have to be taken into account when talking about lifting IRT. "In developed market economies, the most important private non-cash income component is, undoubtedly, imputed rent for owner-occupied accommodation" Frick et al. (2010). Due to the progressiveness of the tax code and the lumpy nature of housing investments, wealthy households are stronger exposed to tax change (see Poterba and Sinai (2008)).

MID is a more commonly used measure by policymakers than IRT. Since MID also is a demand supporting mechanism, its effects are comparable to IRT. Sommer and Sullivan (2018) were interested in the elimination of MID in the United States. They built a quantitative macroeconomic model with endogenous house prices and rents. Their results challenged the widely held view that elimination of MID would decrease homeownership rates. Price effects seem to dominate quantity effects driving up minimum down payment requirements. Similarly, Hilber and Turner (2014) used variation in the subsidy arising from changes in the MID within and across states over time. Their empirical findings also suggests a depression of homeownership rates due to MID as well as heterogenous welfare effects across households with differing socioeconomic backgrounds.

Even though MID and IRT share many similarities as both affect taxable income of households and are thus demand shifters. There is one major difference worth discussing: Where IRT affects all homeowners indifferent of their mortgage holdings, MID promotes holding mortgages and thus might increase debt ratio in the economy.

3 Institutional Setting

The tax mechanism in Switzerland is quite complex. There are federal, cantonal, and municipal authorities levying taxes. Usually income, wealth, land, and church taxes are collected, but there are huge differences in tax rates, progressiveness of tax rates, and opportunities for deductions.

Switzerland has IRT still enforced. Nevertheless, aspirations to eliminate it have started. Policymakers aiming to eliminate IRT argue to act according to the housing promotion act[4] and are convinced that eliminating IRT would increase ownership rate.

On May 5th 2021, the Economic Affairs and Taxation Committee from the Council of States EATC-S decided to recommend a parliamentary initiative to eliminate IRT. Following EATC-S, the Council of States also decided in favour of elimination on September 21th. It is now the Economic Affairs and Taxation Committee of the National Council EATC-N turn to take further steps, see Federal Assembly of Switzerland (2021).

Since the political progress is ongoing, it is not yet fully clear what scope a possible policy change will have. There are several topics around which the political debate turns. The main argument in favour of IRT elimination is a perceived unfairness because homeowners have to pay taxes for income only earned hypothetically. Especially elderly are exposed exceptionally as that remaining income is very low.

The most popular claim is to simultaneously eliminate MID as well. Further considerations raise concerns about first time homebuyers, claiming ten

[4](Wohnraumförderungsgesetz, WFG, AS 2003 3083, March 2003)

years of mortgage interest deductibility for first time buyers. In the course of reaching climate targets, many subsidies were installed in recent years, granted to homeowners renovating their homes to be more energy efficent. With elimination of IRT, some fear these subsidies to be in danger of being abolished again.

As citizens of an indirect democracy, the people of Switzerland have the opportunity to collect Swiss citizens signatures so as to enforce a referendum against any law made by the parliament. Bigger policy changes usually attract big enough opposition that a referendum will be hold. Therefore a public vote on this topic seems very likely within the next few years.

4 Model

We build a model which is highly inspired by Sommer and Sullivan (2018).

Households receive utility from nondurable consumption and shelter services. Shelter services can be obtained either through renting or through ownership. Households supply labour inelastically and face uninsurable idiosyncratic earning shocks. The economy is populated by overlapping generations households and each period is one year. At the end of each period, households make joint decision about nondurable consumption, shelter services consumption, deposits, mortgage debts, and owned housing stock. The construction of the tax code incorporates the main traits concerning housing. Despite the fact that owning is more profitable than renting, some low wealth households cannot afford to buy housing, due to the minimum down payment requirement on mortgage debt.

4.1 Preferences and Utility

Household receive utility U through consumption of nondurable consumption goods c and shelter services s. We model c and s as non-separable goods contributing to U as in a CES utility function:

$$U(c,s) = \frac{\left(c^{\alpha}s^{1-\alpha}\right)^{1-\sigma}}{1-\sigma}, \quad (1)$$

where α is the Cobb-Douglas share of nondurable consumption and the discount factor is denoted by β. Risk aversion is accounted for with the Parameter σ.

4.2 Labour Income

Labour income consists of wages w that are subject to idiosyncratic shocks. There are ten wage levels $w \in \mathcal{W} = \{w_1, ..., w_{10}\}$, with w_i being the i-th wage decile. Entering a time period, households observe their current wage w and know the probability induced to receive next period wage w'. We can write the wage transition matrix Π, linking current wage level with expected next period wage level as

$$\Pi = \begin{pmatrix} \pi(w'_1|w_1) & \dots & \pi(w'_1|w_{10}) \\ \vdots & \ddots & \vdots \\ \pi(w'_{10}|w_1) & \dots & \pi(w'_{10}|w_{10}) \end{pmatrix} \quad (2)$$

where $\pi(w'|w)$ denotes the probability of receiving next period wage w' given current wage w.

4.3 Assets and Financial Markets

Households enter each time period holding three assets: housing ($h \geq 0$), deposits ($d \geq 0$), and mortgages ($m \geq 0$). They earn a risk free interest rate r from their deposits and service their mortgages over an interest spread κ such that the mortgages interest rate amounts to $r^m = r + \kappa$. Given their within-period idiosyncratic earning shock, households optimally adjust their next-period asset position (h', d', m').

Housing is a lumpy good that is only available in discrete sizes $h \in \{0, h(1), ..., h(K)\}$. One unit of housing can be purchased at market price price q. A linear technology exists that transforms one unit of housing into one unit of shelter services. Shelter services are available on a finer grid $s \in \{\underline{s}, s(1), ..., s(L)\}$. Beside of owning, shelter services can also be rented at market rent ρ. Households can choose between owning or renting. The difference between owned housing and shelter services consumed determines the ownership status of each household. Renters do not own any housing ($h' = 0$), owner-occupiers own the same amount of housing as they consume ($h' = s$) and landlords own more units of housing as they consume ($h' > s$).

Transaction of housing is costly. Common practice is for the seller to pay for broker fees. When selling housing, owners have to pay a share τ_s of the housing value in transaction fees.

Homeowners incur maintenance expenses in order to offset physical depreciation. The maintenance costs are proportional to the housing value:

$$M(h) = \delta^h q h \tag{3}$$

Following Chambers et al. (2009), we assume that landlords face an additional fixed cost ϕ each time period that captures the burden of managing their housing property.

Housing is a big investment that might be financed through mortgage borrowing. To prevent house price bubbles and systemic default risk of unsecured mortgages in the financial market, households are bound to lending restrictions. In steady state where house prices and rents are fixed, the mortgage constraint reads as follows:

$$m' \leq (1 - \theta) q^* h' \tag{4}$$

where $0 \leq \theta \leq 1$ is the minimum down payment requirement as a proportion of steady state housing value $q^* h'$, with q^* being equilibrium housing price. Aspiring home owners or homeowners wanting to increase their housing position need to provide a fraction of at least θ deposits in order to meet the mortgage requirements.

Since prices might fluctuate, mortgage constraint binds only for households planning to increase their owned housing position, but not for households that maintain their housing stock:

$$m' I^{\{\{m'>m\} \cup \{h' \neq h\}\}} \leq (1-\theta) q h' \tag{5}$$

Thus, when house prices fluctuate over time, existing homeowners are not required to reduce their outstanding mortgage debt balance in response to a house price decline as long as they do not sell their properties. In contrast, when house prices rise, the homeowners can increase their mortgage loan borrowing by accessing their pre-approved home equity line of credit.

4.4 Government and Taxation

This Section describes the tax scheme of Switzerland. The goal is to build a parsimonious representation of the most relevant features of Switzerland tax code with regards to housing. The model incorporates progressive income as well as wealth taxes and reflects the different treatment of renters, owner-occupiers, and landlords.

A households income y consist of wages w, interest income rd, and rental income net of tax-deductible expenses TRI.

$$y = w + rd + TRI \tag{6}$$

When part of the property is owner-occupied and part is rented out, these two parts are treated as separate entities. For the fraction of owned but not occupied housing, landlords have several deductions available. Mortgage interest payments are deductible for the non-occupied owned housing. Property taxes can be deducted also for occupied as well as non-occupied housing. Maintenance costs and depreciation costs are revenue shrinking expenses that are tax deductible for owned but non-occupied housing.

$$TRI = \rho(h'-s) - \left[r^m m \left(\frac{(h'-s)}{h'} \right) + (\tau^H + \delta^H + \tau^{LL}) q (h'-s) \right] \tag{7}$$

Rental income is given by $\rho(h'-s)$. The non-occupied fraction is mortgage interest deductible $r^m m \left(\frac{(h'-s)}{h'}\right)$. Land-taxes $\tau^H q(h'-s)$, maintenance costs

$\delta^H q(h'-s)$, as well as deductions offsetting physical depreciation $\tau^{LL} q(h'-s)$ are also allowed deductions from rental income.

The Swiss tax code favours landlords (L) and owner-occupiers (O) over renters (R) since there are no housing related deductions available for renters. On the other hand, there are no imputed values added to taxable income for renters, contrary to homeowners. Taxable income $\tilde{y}$ is equal to income minus net allowable deductions ψ, i.e deductions minus imputations,

$$\tilde{y} = y - \psi(k) \tag{8}$$

where $k \in \{R, O, L\}$. As described above, renters have no options for deductions. Therefore,

$$\psi(R) = 0. \tag{9}$$

For homeowners, MID and property taxes are deductible whereas IRT is imputed on occupied housing,

$$\psi(O, L) = \tau^m r^m m \left(\frac{s}{h'}\right) - \tau^v h\rho \left(\frac{s}{h'}\right) + \tau^h qs. \tag{10}$$

$\tau^m r^m m \left(\frac{s}{h'}\right)$ are the MID payments which a household has to make. The IRT payments imputed on rental income are $\tau^v h\rho \left(\frac{s}{h'}\right)$. Property taxes amount to $\tau^h qs$ for each homeowner.

Finally, total taxes paid T amount to income plus net wealth taxes both of which follow some progressive structure:

$$T(\tilde{y}, e) = \zeta(\tilde{y}) + \eta(e), \tag{11}$$

where $e = d - m$ is net equity and ζ, η are progressive tax functions for taxable income and net wealth, respectively.

$$\zeta(\tilde{y}) = \begin{cases} 0 & \text{for} \quad \tilde{y} \leq 0 \\ \zeta_1 & \text{for} \quad 0 < \tilde{y} \leq a_1 \\ \zeta_2 & \text{for} \quad a_1 < \tilde{y} \leq a_2 \\ \vdots & \qquad \vdots \\ \zeta_K & \text{for} \quad a_{K-1} < \tilde{y} \leq a_K \end{cases} \tag{12}$$

For $i = 1, 2, ..., K$, ζ_i is the marginal tax rate for taxable income between a_{i-1} and a_i.

$$\eta(e) = \begin{cases} 0 & \text{for} \quad e \leq 0 \\ \eta_1 & \text{for} \quad 0 < e \leq b_1 \\ \eta_2 & \text{for} \quad b_1 < e \leq b_2 \\ \vdots & \qquad \vdots \\ \eta_L & \text{for} \quad b_{L-1} < e \leq b_L \end{cases} \tag{13}$$

For $j = 1, 2, ..., L$, η_j is the marginal tax rate for net equity between b_{j-1} and b_j.

Finally, we normalised all units measured in Swiss francs by division with mean wage $\bar{w}$. All proceeds from taxation are used to finance government expenditures that do not affect individual households.

4.5 Household Problem

Households enter each time period with owned housing stock ($h \geq 0$), accumulated deposits ($d \geq 0$), and outstanding mortgage debt ($m \geq 0$). After observing idiosyncratic wage shocks w and given current prices (q, ρ), they choose optimal levels of nondurable consumption ($c > 0$), shelter services ($s > 0$), as well as next-period owned housing ($h' > 0$), deposits ($d' > 0$), and mortgage debt ($m' > 0$).

$$v(w, d, m, h) = \max_{c,s,d',m',h'} U(c, s) + \sum_{w' \in \mathcal{W}} \pi(w'|w) v(w', d', m', h') \tag{14}$$

s.t.

$$c + \rho(h' - s) + d' - m' + q(h' - h) + I^S \tau^S qh$$
$$\leq w + (1+r)d - (1+r^m)m - T(\tilde{y}, e) - \tau^H qh' - M(h') - \phi I^{h'>s} \tag{15}$$

$$m' I^{\{m'>m, h' \neq h\}} \geq (1-\theta)qh \tag{16}$$

$$d' \geq 0 \tag{17}$$

$$m' \geq 0 \tag{18}$$

$$h' \geq s \text{ if } h' > 0 \tag{19}$$

The budget constraint (BC) is given in equation (15). The term $\rho(h' - s)$ is either rents paid in case the household is a renter (i.e, $h' = 0$) or rental income if she is a landlady (i.e, $h' > s$). Next-period net equity is captured by the term $d' - m'$. The value difference of owned housing stock at the start of the time period (h') and entering the time period (h) is accounted for by the term $q(h' - h)$. In case of housing been sold, households have to pay broker fees of $I^S \tau^S qh$ where $I^S = 1$ if $h' < h$ is the indicator function for selling housing. Households receive earnings from deposits of $(1 + r)d$ and must pay $(1+r^m)m$ in mortgage interests. Total income and wealth taxes paid $T(\tilde{y}, e)$ enter the budget constraint as described in Section 4.4 and property taxes amount to $\tau^H qh'$. In order to offset depreciation of physical structures, maintenance cost $M(h')$ have to be paid and $\phi I^{h'>s}$ captures landlords fixed costs for administrative expenses.

Finally, equation (16) introduces the mortgages constraint MC, imposing collateral requirements as described in Section 4.3.

4.6 Housing Supply

After solving the household problem determining housing demand, we build the housing supply of the economy. Since our main focus lays on housing decision of heterogenous households and evolution of endogenous prices and rents in response to tax reforms[5], we keep supply side as simple as possible.

Two main assumptions are made so as to construct the supply:

(i) We assume that aggregated residential investment I is mainly driven by population growth.

(ii) The evolution of aggregated housing stock H is governed by the responsiveness of residential investment to changes in housing prices.

Population N grows at constant rate n, and evolves over time.

$$N' = (1 + n)N \tag{20}$$

Residential investment is proportional to the current housing stock.

$$I' = f(q, \epsilon)H \tag{21}$$

where f is a isoelastic supply function. The parameter ϵ is the elasticity of residential investment with respect to house price q. Assumption 1 implies that f has a stationary solution at $f(q^*, \epsilon) = n$, i.e. per capita housing stock stays constant in steady state.

A linear technology translates residential investment into housing stock, so the law of motion for aggregated housing stock is a standard capital accumulation equation,

$$H' = H + I. \tag{22}$$

We must consider that equation (22) does not account for physical depreciation of housing. We modelled homeowners' BC in equation (15) to finance maintenance in order to offset depreciation. We thus do not need to account for it in the law of motion for aggregated housing stock anymore.

[5]And also because the dimensionality of our grid is already remarkably high.

4.7 Stationary Equilibrium

We constructed the demand side of our economy in Sections 4.1 - 4.5 and the supply side in Section 4.6. Now, it is time to put everything together to find the stationary equilibrium.

The individual state vector $x = (d, m, h, w)$ describes the asset position as well as the stochastically driven household wage entering a time period. All state vectors lie in the span of the state space $\mathcal{S} = \mathcal{D} \times \mathcal{M} \times \mathcal{H} \times \mathcal{W}$ with $\mathcal{D} = \mathbb{R}_+^0$, $\mathcal{M} = \mathbb{R}_+^0$, $\mathcal{H} = \{0, h(1), ..., h(K)\}$ and $\mathcal{W} = \{w_1, ..., w_{10}\}$. Let λ be a probability measure on $(\mathcal{S}, \mathcal{B}_s)$ where $\mathcal{B}_s$ is the Borel σ - Algebra. For every Borel set $B \in \mathcal{B}_s$, let $\lambda(B)$ indicate the mass of of agents whose individual state vectors lie in B. Finally, define a probability function $P : \mathcal{S} \times \mathcal{B}_s \to [0, 1]$, s.t. $P(x, B)$ is the probability that a household with state vector x will enter next period with a state vector x' lying in B.

A stationary squilibrium is a collection of value functions $v(x)$, a set of household policy functions $\{c(x), s(x), d'(x), m'(x), h'(x)\}$, a probability measure λ, and equilibrium prices (q^*, ρ^*), s.t:

(i) $c(x)$, $s(x)$, $d'(x)$, $m'(x)$ and $h'(x)$ are optimal decision rules to the households' problem from Section 4.5 given prices q^* and ρ^*.

(ii) Housing and rental markets clear:

- $\int_{\mathcal{S}} h'(x) d\lambda = H$
- $\int_{\mathcal{S}} h'(x) - s(x) d\lambda = 0$

(iii) λ is a stationary probability measure: $\lambda(B) = P(x, \mathcal{B}_s)$ for any Borel set $B \in \mathcal{B}_s$.

5 Calibration

After describing the model, we take a look at the parameter values used in our model. We use two steps for calibrating our parameters. In a first step, we looked at general economic parameters describing the Swiss economy and

Parameter	**Value**
Consumption share (α)	0.685
Discount factor (β)	0.985
Risk aversion (σ)	2.5
Down payment (θ)	0.25
House price supply elasticity (ϵ)	0.5
Landlord fixed costs (ϕ)	0.056
Risk-free interest rate (r)	0.01
Mortgage interest rate spread (κ)	0.021
Maintenance cost rate (δ^H)	0.015
Property taxes (τ^H)	0.01
Mortgage deductibility rate (τ^M)	1
Imputed rental rate (τ^V)	0.8
Deductibility rate for depreciation of rental property (τ^{LL})	0.02
Population growth rate (n)	0.008

Table 1: Parameter Values

some tax related parameters used in our model. For other harder to measure parameters, we rely on work already performed by fellow scientists which are found in literature. *Table 1* summarises all values of the model parameters we used.

5.1 Demography and Tax Parameters

The main source for heterogeneity in households decision is idiosyncratic wage shocks mechanism. This mechanism is driven by the wage transition matrix described in Section 4.2. We applied the wage transition matrix estimated by Coulon and Zürcher (2004). *Table 2* displays the wage transition matrix used in our model. For ten wage deciles, we have the corresponding transition probabilities π_{ij} in percentages.

		next period									
	wage decile	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
current period	1st	56.3	19.7	8.4	3.9	2.3	1.7	2.3	1.2	1.6	2.6
	2nd	19.1	40.9	18	8.8	4.2	2.7	1.4	1.2	1.2	2.5
	3rd	7.5	17.1	32.7	18.3	11.8	5.6	2.8	1.1	1.3	1.8
	4th	4.4	8.5	19.1	27.6	20.8	10.2	4.8	2	0.6	1.9
	5th	2.7	4.6	8.9	21.6	25.8	18.8	10.3	4.5	1.9	0.9
	6th	2.8	2.1	4.7	9.5	19.4	29.8	18.7	8	2.6	2.4
	7th	1.5	2.1	2.7	4.4	8.4	19.7	29.6	22.5	6.8	2.3
	8th	1.8	1.3	1.2	2.1	3.7	7.2	21	35	20.7	5.9
	9th	1.7	1.3	1.1	2.1	1.3	1.5	6.4	21.2	45.5	17.8
	10th	2.7	1.9	3.1	1.7	2.2	2.8	2.7	3.3	17.7	61.9

Source: Coulon and Zürcher (2004)

Table 2: Wage Transition Matrix Π

The corresponding wage deciles were drawn from the Swiss Earnings Structure Survey 2022 (ESS-22).

According to World Bank data, the annual population growth rate n in Switzerland was around 0.8% between the years 1988 and 2021. The average interest rate for a government bond with 20 years maturity, set by the Swiss National Bank (SNB) between the years 1988 and 2022, was around 1%[6] whereas, according to SNB data, average mortgages rate r^M was 3.1%, yielding an average mortgage interest rate spread κ of 2.1%.

Broker expenses usually vary between $2\% - 3\%$ of housing value at the date of transaction and we thus set selling costs τ^S to 2.5%.[7]

[6] Appendix A.1 shows sensitivity analysis along the risk free interest rate parameter r.

[7] Usually, broker fees as percentage of selling price tend to decrease, the higher the selling price for an object was. However, finding reliable data describing this mechanism was hard and we thus made an educated guess between the regulatory boundaries and self proclaimed numbers of several brokerage firms.

	Cantonal	Municipal	Church
Income taxes	154 %	118 %	13 %
Capital taxes	157 %	104 %	4 %

Source: FTA - Federal Tax Administration, 2021

Note: The base rate is 100% and corresponds to total federal tax liabilities.

Table 3: Mean Base Tax Rates

Studying households reaction to tax reform bears many tax parameters. The Swiss tax code is special insofar that income and capital taxes are levied on federal level, cantonal level, municipal level, and a small percentage even for church levels. Usually, cantonal, municipal, and church taxes are collected as a share of federal taxes. *Table 3* displays the mean tax rates in percentage of the federal tax rate for income and capital taxes. If a household has to pay 1'000 CHF in federal income taxes and 1'000 CHF in federal capital taxes, they have an expected total tax expenditure of 3'850 CHF plus 3'650 CHF, respectively. At this point, we need to remember that income and capital taxes follow a progressive curve.

Besides income and capital taxes, our model features some taxes and deductions directly related to housing. First, we have property taxes τ^H, also known as land or real estate taxes. We set them to 1%.[8] Mortgage interests can be fully deducted thus, mortgage deductibility rate τ^M is set to one, whereas self imputed rental value has only to be added to taxable income up to 70% of estimated housing value. Following recommendations of Federal Tax Administration (FTA), we allow depreciation of owned housing value to be deducted from taxable income up to 2% of housing value (τ^{LL}). The minimum share in down payment required for buying a house θ is set to 25%.[9] A summary of all databases used for calibration is displayed in *Table 4*.

[8]Property taxes are levied on cantonal level and range from 1% up to 16 %, but some cantons do not collect property taxes at all.

[9]As this is the current regulatory value imposed by financial market supervision FINMA.

Parameter	Source
Wage deciles $\{w_1, ..., w_{10}\}$	FSO - Swiss Earnings Structure Survey, 2022
Age distribution	FSO - Section Demography and Migration, 2020
Population growth rate (n)	World Bank, 1988 - 2021
Risk free interest rate (r)	SNB - Swiss National Bank, 1988 - 2022
Mortgage interest spread(κ)	SNB - Swiss National Bank, 1988 - 2022
Property taxes (τ^H)	FTA - Federal Tax Administration, 2021
Imputed rental rate (τ^V)	FTA - Federal Tax Administration, 2021
Deductibility rate for depreciation of rental property (τ^{LL})	FTA - Federal Tax Administration, 2021
Minimum down payment requirement (θ)	FINMA - Financial Market Supervision, 2019

Table 4: Parameters Drawn from Databases and Regulators' Data

5.2 Parameter Calibration According to Literature Values

Since our model relies heavily on the work of Sommer and Sullivan (2018), we drew the parameters in the households utility function[10] as well as landlord fixed rate from their work. Schöni et al. (2018) estimated housing supply elasticity for Switzerland and found 0.5 as the average value.[11] Finally, Díaz and Luengo-Prado (2008) estimated depreciation rate of housing δ^H to equal 1.5% p.a. All parameters drawn from literature and their respective source are displayed in *Table 5*.

[10] Appendix A.2 discusses sensitivity analysis along the risk aversion parameter σ.

[11] In fact, they calculated housing supply elasticity for each municipality and found considerable heterogeneity. Thus, some caution when interpreting the results from the average value might be wise.

Parameter	**Source**
Consumption share (α)	Sommer and Sullivan (2018)
Discount factor (β)	Sommer and Sullivan (2018)
Risk aversion σ	Sommer and Sullivan (2018)
House price supply elasticity (ϵ)	Schöni et al. (2018)
Landlord fixed costs ϕ	Sommer and Sullivan (2018)
Depreciation rate δ^H	Díaz and Luengo-Prado (2008)

Table 5: Parameters Drawn from Literature

6 Validation

As a source for external validation, we compare moments produced by the baseline model with Statistics reported by Federal Statistics Office (FSO) and SNB, respectively. The term baseline model refers to our model where imputed rents are subject to taxable income and mortgage interests can be deducted as described in Section 4.4. *Table 6* displays the comparison and gives measurements to assess the strengths and weakness of our model.

The match in home ownership rate is excellent. The found 0.5% deviation from reported level gives confidence for applicability of our model in order to explain home ownership decisions. Median value to rent (VTR) as well as loan

	Target	**Baseline Model**
Home ownership rate	36.2% [1)]	36.7 %
Median value to rent ratio	32.65 [2)]	20.17
Median loan to value ratio	0.2858 [2)]	0.1913

1) FSO - Construction and housing, 2020

2) SNB - 2022-Q1

Table 6: Validation

to value (LTV) ratio both are significantly underestimated by our model. A reason for this undervaluation might be that we did not incorporate inheritance of housing in our model. If we would incorporate households featuring characteristics from dynasties, we might increase VTR, driving up housing prices. Higher housing prices enact borrowing constraint more often, driving households on the edge of owning out of ownership.

7 Counterfactuals

In order to investigate potential effects from policy change on the economy, we perform counterfactual experiments. We illustrate the mechanism between legislation and housing along three different scenaria. The first scenario partially models effects from MID by singlehandedly eliminating MID while keeping IRT enacted. In contrast, we partially model effects from IRT in scenario two by elimination of IRT while keeping MID enacted. Scenario three looks at the most likely policy change where MID and IRT both get eliminated.

First, we will look at stationary results where we compare steady state solutions from each scenario with steady state solutions in the baseline model. In a second step, we discuss transitional dynamics by describing the flow from steady state baseline equilibrium to the counterfactual equilibria.

7.1 Stationary Results

Legislations should be constructed with a focus on durability. Looking at differences in the stationary solutions of the economy along each counterfactual compared to the baseline model yields a framework to asses the long run implications of a policy change. The effects might differ regarding ownership status of the household. The main results comparing stationary results according to ownership status are listed in *Table 7*.

Table 7: Stationary Results

	Baseline	MID eliminated	IRT eliminated	MID & IRT eliminated
All Agents:				
House price	8.088	7.782	10.023	9.453
Rents	0.401	0.391	0.502	0.483
Ownership rate	0.367	0.350	0.506	0.471
Landlord rate	0.121	0.117	0.158	0.135
Average mortgage	1.428	1.302	1.619	1.350
Average deposits	1.792	1.999	1.004	1.294
Average net deposits	0.364	0.697	-0.614	-0.057
Average consumption	0.462	0.466	0.440	0.446
Average per period utility	-2.826	-2.796	-3.133	-3.073
Average imputed rent	0.093	0.086	0	0
Average mortgage interests	0.011	0	0.029	0
Average income and capital taxes	0.224	0.227	0.186	0.197
Homeowners:				
Average mortgage	3.885	3.723	3.200	2.868
Average deposits	0.501	0.775	0.315	0.550
Average net deposits	-3.383	-2.949	-2.885	-2.318
Average consumption	0.544	0.554	0.507	0.515
Average per period utility	-1.378	-1.353	-1.524	-1.484
Average imputed rent	0.252	0.245	0	0
Average mortgage interests	0.030	0	0.057	0
Median VTR	20.172	19.880	19.978	19.585
Median LTV	0.191	0.163	0.291	0.223
owner-occupiers:				
Average mortgage	0.603	0.273	2.046	1.252

. . . continued

	Baseline	**MID eliminated**	**IRT eliminated**	**MID & IRT eliminated**
Average deposits	0.743	1.157	0.447	0.761
Average net deposits	0.140	0.884	-1.599	-0.491
Average consumption	0.490	0.498	0.478	0.478
Average per period utility	-1.424	-1.397	-1.462	-1.472
Average imputed rent	0.281	0.274	0	0
Average mortgage interests	0.018	0	0.060	0
Median VTR	20.172	19.880	19.978	19.585
Median LTV	0.157	0.091	0.291	0.222
Landlords:				
Average mortgage	10.572	10.570	5.747	6.868
Average deposits	0.008	0.017	0.024	0.027
Average net deposits	-10.564	-10.554	-5.723	-6.841
Average consumption	0.652	0.663	0.572	0.607
Average per period utility	-1.283	-1.266	-1.663	-1.515
Average imputed rent	0.193	0.187	0	0
Average mortgage interests	0.053	0	0.050	0
Median VTR	20.172	19.880	19.978	19.585
Median LTV	0.260	0.306	0.291	0.251
Renters:				
Average deposits	2.542	2.657	1.709	1.955
Average consumption	0.415	0.419	0.370	0.385
Average per period utility	-3.667	-3.572	-4.778	-4.487
Average rental costs	0.203	0.203	0.210	0.206

Note: Simulation of N = 500'000 Agents. Price.Tol = Rent.Tol = 0.001. Converge.Tol = 0.0001

The first main learning from our exercise is that effects stemming from MID are usually much smaller in size than those from IRT. Thus, many statistics in the second column (MID eliminated) are very similar to the first column (baseline model). Elimination of IRT, on the other hand, usually deviates stronger from baseline levels. The second main learning is that partial effects due to MID compared to IRT often differ in their direction relative to baseline model. The combined effect from elimination of both policies in column four (MID & IRT eliminated) broadly incorporates the first two main lessons, i.e. the direction relative to baseline levels of the effects points towards IRT elimination, but the size of the effect is shortened accounting for opposing force of MID pulling back.

As expected, we see significant price effects in both house prices and rents. Elimination of IRT will itemize into housing prices and rents and increase them from 8.088/0.401 to around 10.023/0.502, whereas elimination of MID would decrease house prices a little to 7.782/0.391. Following the general trend described above, we find housing prices of 9.453/0.483 in case of elimination of both laws. We observe that VTR stays very constant across all four scenaria as an indication that renters are as well effected by policy change.

We found that elimination of IRT would increase ownership rate and similarly, elimination of MID [12] would decrease ownership rates. Unsurprisingly, indebtedness would decrease by elimination of MID such that net deposits become even more positive compared to the baseline model. Elimination of IRT however, promotes indebtedness, leading to negative average net deposits and an increase in LTV.

Higher prices and rents depress households income. Having less money in the pocket affects households consumption decisions and drives down utility. Thus, we see a trade off between higher homeownership rates and welfare.

Turning to agents household status, we observe that owner-occupiers usually have higher mortgage, consumption, and utility levels than renters.

[12] We highly recommend to take a look at A.1 where we found an interesting relationship between MID effect, home ownership rate and risk free interest rate

7.2 Transitional Dynamics

Stationary solutions give a sound description of what is happening in long run equilibria. When investigating the evolution of the economy as it transforms from baseline equilibrium to a counterfactual equilibrium, we use impulse response functions of several key statistics in order to describe the transition path.

Figure 1 displays IRF of the house price, the rents, the price to rent ratio, the fraction homeowners, as well as the fraction homeowners in debt and average net deposits.

Looking at the IRF plots shows that about 60 time periods are required until the economy fully converges to its new equilibrium. With the lumpy nature of housing and long time horizons until savings reach minimum down payment requirements, we understand that in housing economics, transitioning might take a long time.

For both scenaria, when IRT is eliminated, we see an immediate massive price and rent jump in the very first period after the unexpected policy change occurs. The initial jump in prices must be bigger than in rents as price to rent ratio also spikes right after the policy change. Despite the fact that housing-prices as well as rents being higher than steady state levels of the counterfactuals, must the economy be in excess demand as the fraction of homeowners lies still below steady state counterfactual levels and is steadily increasing. As housing becomes more popular, the fraction of households in debt increases and average net deposits decrease and even become negative, indicating a big demand for mortgages. At the moment that the IRF for fraction homeowners crosses its equilibrium level, house prices (and with some lag also rents) start decreasing again until they converge to their new equilibrium level.

The scale of IRF for MID elimination usually is smaller but the mechanism at work seems to be an inverted mechanism describing IRT elimination.

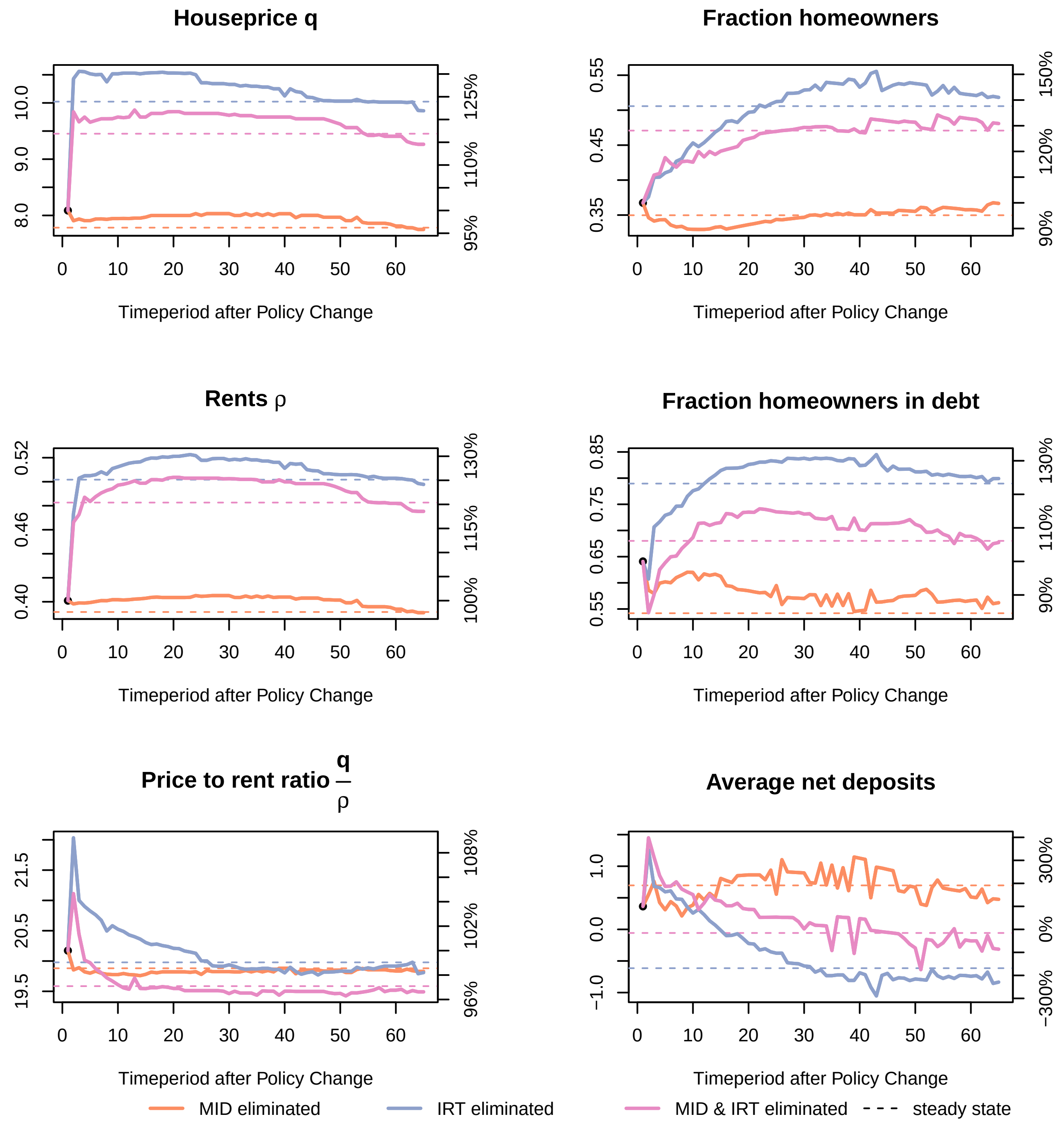

Figure 1: Transition Path of the Economy after an unexpected Policy Change at the End of Time Period t = 1.

8 Conclusion

Building an agent based life-cycle model in order to investigate implications from tax policies on home ownership, prices, rents, and welfare worked in order to describe ownership in the baseline model. With a rather simple supply side in our model, there could be room for improvements when including a more sophisticated mechanism explaining evolution of housing stock and residential investment. Especially regional differences in residential investments, with varying house price supply elasticities seems a promising exercise. With these limitations in mind we are confident that we can derive some well reasoned conclusions.

First, price effects are important. House prices as well as rents react very quickly and strong to policy changes. Price effects are faster than an increase in ownership rate, raising a transition period with overvalued prices. Keeping in mind that the majority of Swiss residents are renters, raises concerns of welfare losses due to raising renting costs when IRT is eliminated. However, elimination of IRT can increase ownership rates aligning with the goal of housing promotion act.

Second, higher prices leave households with less budget to spend on non-durable consumption moderating utility. On the aggregate level, elimination of IRT leads to sinking utility levels.

Finally, we derive that IRT is a much more powerful policy compared to MID. Thus, bargains involving elimination of both policies should be treated with critical caution.

The Swiss housing market faces supply shortage rather than a lack in demand. Policies aiming at promoting demand seem to be an unsuitable instrument in order to fight low home ownership rates and would rather lead to price effects.

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A Sensitivity Analysis

For some key economic parameters employed in our model, we used long term mean or standard values from literature. Those parameter reflect vague concepts and one can not fully rule out the possibility that they might differ. We thus investigate the reaction of our model with respect to these parameters. In the first part of this Section, we will look at the risk free interest rate that is linked closely to business cycle and fluctuates in the long run quite considerably. In the second part of this Section, we look at risk aversion parameter, a very hard to empirically measure parameter where we expect variability to be likely.

A.1 Risk Free Interest Rate Parameter r

This Section examines how sensitive our results are w.r.t. changes in risk free interest rate r. We are mainly interested in raising interests r as mortgage rates are connected to treasury bonds and households' willingness to finance housing with mortgages will decrease as r increases.

Table 8 displays the effect when the economic environment evolves into an high interest rate territory. We thus raise r from 1% to 3%.

A general interesting finding is that for, all scenaria, we observe that a decrease in housing prices whereas rents increase compared to a low risk rate scenario. The change in deposits and mortgage is also considerable as saving becomes much more attractive while holding mortgages is less popular.

A very interesting mechanism is that with, elimination of MID home ownership rate would increase rather than decrease. This might explain why our effects from MID elimination do not align with the results from US studies (Sommer and Sullivan (2018) & Hilber and Turner (2014)) where they found the same effect. Notably, Sommer and Sullivan (2018) used risk free interest raten of 4%. IRT, however, is not subject to this phenomenon likely because imputed rental value does not directly depend on r whereas mortgage interests consist of r plus κ.

	Baseline eliminated		**MID eliminated**		**IRT eliminated**		**MID & IRT eliminated**	
	$r = 1\%$	$r = 3\%$	$r = 1\%$	$r = 3\%$	$r = 1\%$	$r = 3\%$	$r = 1\%$	$r = 3\%$
All Agents:								
House price	8.088	6.686	7.782	6.657	8.470	10.023	8.183	9.453
Rents	0.401	0.412	0.391	0.413	0.530	0.502	0.517	0.483
Ownership rate	0.367	0.365	0.350	0.378	0.460	0.506	0.458	0.471
Landlord rate	0.121	0.109	0.117	0.131	0.128	0.158	0.130	0.135
Average mortgage	1.428	0.594	1.302	0.393	0.536	1.619	0.402	1.350
Average deposits	1.792	3.244	1.999	3.076	2.121	1.004	2.350	1.294
Average net deposits	0.364	2.650	0.697	2.683	-0.614	1.584	1.949	-0.057
Average consumption	0.462	0.491	0.466	0.493	0.471	0.440	0.477	0.446
Average per period utility	-2.826	-2.721	-2.796	-2.724	-3.133	-3.057	-3.013	-3.073
Average imputed rent	0.093	0.098	0.086	0.099	0	0	0	0
Average mortgage interests	0.011	0.004	0	0	0.010	0.029	0	0
Average income and capital taxes	0.224	0.263	0.227	0.266	0.186	0.217	0.224	0.197

Note: Simulation of N = 500'000 Agents. Price.Tol = Rent.Tol = 0.001. Converge.Tol = 0.0001

Table 8: Sensitivity w.r.t Risk Free Interest Rate r

A.2 Risk Aversion Parameter σ

This Section examines how sensitive our results are w.r.t changes in risk aversion parameter σ. We decrease σ in order to investigate the reaction of our model to households becoming more risk averse.

Table 9 displays the comparison of risk aversion level used in the original model and a lower risk aversion level. We observe that most mechanism work, as we are used to, from the higher risk aversion environment. Only decisions to policy chances involving net deposits' holdings become amplified, i.e. if a certain policy would increase deposits' holdings, it would now increase it even more, et vice versa for mortgage positions.

B Endogenous Prices and Rents - Algorithm

To find equilibrium prices, we need to solve for housing and shelter services' markets clearing prices and rents (q^*, ρ^*) as described in Section 4.7. For N simulated agents, the following two conditions have to hold:

$$\sum_{i=1}^{N} h_i'(q^*, \rho^*|x) = H \tag{1}$$

$$\sum_{i=1}^{N} s_i'(q^*, \rho^*|x) = H. \tag{2}$$

Solving for equilibrium prices and rents is very time consuming because it demands resolving the model and then simulating the economy until the conditions 1 and 2 are simultaneously met. The following algorithm explains how we can accelerate the process for solving this problem compared to other search methods. The main idea is to exploit the downward sloping nature of the demand function and the fact that ceteris paribus if house prices increase, rents also increase, et vice versa.

Let q_k be the k-th guess of housing prices, $\rho(q_k)$ denotes the rent which clears the housing market, given the price guess q_k. Notice that the range of rents is boundet. The lower bound of rents is given by nonnegativity condition.

	Baseline eliminated		**MID eliminated**		**IRT eliminated**		**MID & IRT eliminated**	
	$\sigma = 2.5$	$\sigma = 1.5$	$\sigma = 2.5$	$\sigma = 1.5$	$\sigma = 2.5$	$\sigma = 1.5$	$\sigma = 2.5$	$\sigma = 1.5$
All Agents:								
House price	8.088	8.069	7.782	7.767	8.470	10.062	8.183	9.376
Rents	0.401	0.396	0.391	.386	0.530	0.496	0.517	0.467
Ownership rate	0.367	0.347	0.350	0.329	0.460	0.470	0.458	0.452
Landlord rate	0.121	0.113	0.117	0.112	0.128	0.126	0.130	0.118
Average mortgage	1.428	1.487	1.302	1.227	0.536	1.670	0.402	1.266
Average deposits	1.792	1.548	1.999	1.765	2.121	0.981	2.350	1.296
Average net deposits	0.364	0.061	0.697	0.538	-0.614	−0.689	1.949	0.030
Average consumption	0.462	0.465	0.466	0.469	0.471	0.439	0.477	0.446
Average per period utility	-2.972	-2.721	-2.796	-2.960	-3.133	-3.065	-3.013	-3.040
Average imputed rent	0.093	0.085	0.086	0.078	0	0	0	0
Average mortgage interests	0.011	0.011	0	0	0.010	0.030	0	0
Average income and capital taxes	0.224	0.221	0.227	0.225	0.186	0.186	0.224	0.197

Note: Simulation of N = 500'000 Agents. Price.Tol = Rent.Tol = 0.001. Converge.Tol = 0.0001

Table 9: Sensitivity w.r.t Risk Aversion Parameter σ

The upper bound must be chosen in such a way that households with minimum wage w_1 can afford the smallest shelter unit $\underline{s}$ on the shelter grid. Thus $\rho(q_k) \in (\rho^-, \rho^+]$, with $\rho^- = 0$ and $\rho^+ = w_1/\underline{s}$.

We further define the following excess demand functions:

$$ED_h^k(q_k, \rho_k) = \sum_{i=1}^{N} h_i'(q_k, \rho_k|x) - H \tag{3}$$

$$ED_s^k(q_k, \rho_k) = \sum_{i=1}^{N} s_i(q_k, \rho_k|x) - H \tag{4}$$

where $ED_h^k(q_k, \rho_k)$ and $ED_s^k(q_k, \rho_k)$ are excess demand in housing and shelter services market, respectively, given prices guess (q_k, ρ_k). In equilibrium, excess demand needs to be zero in all markets. Thus for (q^*, ρ^*), we have

$$ED_h^k(q^*, \rho^*) = 0 \tag{5}$$

$$ED_s^k(q^*, \rho^*) = 0. \tag{6}$$

In order to efficiently find q^*, we want to start with big q-steps. Once we are getting close to the solution, we make our q-steps smaller. Thus, our step function ϵ_k determining the new price guess q_k is akin to a lasso. First, it is loose. Once we found the region within which q^* lies, we decrease the step size gradually:

$$\epsilon_k(\epsilon_{k-1}|q_1, ..., q_{k-1}) = \begin{cases} \epsilon_{k-1} & ,(q_k + \epsilon_{k-1}) \notin \{q_1, ...q_{k-1}\} \\ \epsilon_{k-1}/2 & ,(q_k + \epsilon_{k-1}) \in \{q_1, ...q_{k-1}\} \end{cases}$$

The algorithm works as follows:

1. Set some initial guess for housing prices q_k.

2. Given the housing price guess q_k, we want to find the root of excess demand in the housing market, i.e. find the root $\rho(q_k)$ s.t. $ED_h^k(q_k, \rho(q_k)) = 0$. This root can be calculated efficiently using biSection on the interval $(\rho^-, \rho^+]$.

3. (a) If $ED_s^k(q_k, \rho(q_k)) > 0$, the initial house price guess q_k is too small because $ED_s^k(q_k, \rho(q_k))$ is decreasing in q_k. Set $k = k+1$, $q_{k+1} = q_k + \epsilon_k(\epsilon_{k-1}|q_1, ..., q_{k-1})$ and $\rho^- = \rho(q_k)$ because $\rho(q)$ is increasing in q. Go to step 2.

   (b) If $ED_s^k(q_k, \rho(q_k)) < 0$, the initial house price guess q_k is too big. Set $k = k+1$, $q_{k+1} = q_k - \epsilon_k(\epsilon_{k-1}|q_1, ..., q_{k-1})$ and $\rho^+ = \rho(q_k)$. Go to step 2.

   (c) If $ED_s^k(q_k, \rho(q_k)) = 0$, the equilibrium house prices are $q^* = q_k$ and rents $\rho^* = \rho(q_k)$, so stop.

C Code

The code to solve the model was written in Matlab and is publicly available, for replication purposes or as basis for related work. You will also find the simulated datasets for the four policy scenarios as well as the transition path of the experiments. Comments and requests to improve the code are very welcome. (`https://github.com/camest-sci/IRT_ELIM-SUI`)

Statement of authorship

I hereby declare that I have written this thesis without any help from others and without the use of documents and aids other than those stated above. I have mentioned all used sources and cited them correctly according to established academic citation rules. I am aware that otherwise the Senate is entitled to revoke the degree awarded on the basis of this thesis, according to article 36 paragraph 1 letter o of the University Act from 5 September 1996.

Bern, 31.08.2022

(Signature)