Appendix A. Not for Publication: Calibration Appendix

Table 1 in the main paper summarizes the set of pre-defined parameters that are taken as given in the model. The discussion below provides more detail on the choices made for each of the parameter values.

Interest Rate and Mortgage Premium: The environment described in the model is that of a small open economy. The interest rate paid on the risk-free bond is fixed at the average of the 5-year constant-maturity Treasury rate over the period 1995 to 2005, 4.95%, minus the average CPI inflation rate, 2.53%. This is equal to an annual real rate of 2.42%.

When borrowing funds to buy a home, agents pay a mortgage premium m on top of the interest rate r. Some of that premium is to compensate the lender for granting borrowers the right to prepay the mortgage, and should thus not be considered a cost from the perspective of the borrower. Therefore the mortgage premium is set such that it captures the increase in mortgage interest rates over the risk-free rate, net of the compensation for the right to prepay. Freddie Mac's Primary Mortgage Market Survey (PMMS) collects average annual total interest rates for 15-year fixed rate mortgages. The average nominal value between 1995 and 2005 was 6.51%, giving a real value of 3.98%. About half the spread over the risk-free rate comes from the cost of the value of the prepayment option (the other half covers G-fee and servicing spread of about 25bps each, a swap-spread of between 20bps to 30bps, and an option-adjusted spread (OAS) of about 5bps) — see Stroebel and Taylor (2012) for an extensive discussion. We therefore set $m = 0.8\%$ in annual terms to cover the part of the mortgage premium not associated with the right to refinance a mortgage.

Preferences: The coefficient of relative risk aversion ρ is set to 2, which is a standard value in macroeconomics. For instance, Attanasio and Browning (1995) report estimates for the intertemporal elasticity of substitution between 0.48 and 0.67. The other important coefficient in the period utility function is $\theta = 0.141$, the share of housing in consumption, which is taken from the estimates of Jeske and Krueger (2005).

Demographics: The mortality rate of retirees is chosen using the U.S. Decennial Life Tables for 1989-1991. The parameter κ is calibrated as the conditional probability of a person aged 65 or older to survive the subsequent five years. This probability is around 73% in the data. Each period, the measure of newly born agents is equal to the measure of those who die and exit the model. As a result, the total population remains constant.

Taxes and Benefits: After mandatory retirement at age 65, agents receive a pension financed by a levy on labor income. Following Queisser and Whitehouse (2005), the replacement rate is set to 38.6% of economy-wide average earnings. In calibrating average income tax rates, we follow Díaz and Luengo-Prado (2008). In one of their specifications, they use the U.S. Federal and State Average Marginal Income Tax Rates in the NBER TAXSIM model to construct average tax rates on capital and labor income. They find an average effective tax rate on capital income for the period 1996-2006 of 29.2%. The average effective tax rate on labor income for the same period is 27.5%. Rental income in the U.S. is included in the gross income on which the income tax rate is levied. We thus set $\tau^r = \tau^y$.

Adjustment Costs in the Housing Market: Smith et al. (1988) estimate the transaction costs of changing owner-occupied housing to be approximately 8% to 10% of the value of the unit. This includes search and legal costs, costs of remodeling the unit and psychological costs from the disruption of social life. Yang (2009) assumes transaction costs from a sale to be 6% of the value of the unit sold, and transaction costs from a purchase to be 2% of the value of the unit bought (also see Piazzesi et al., 2015). Iacoviello and Pavan (2009) assume adjustment costs of 4% of the house value for both the purchasing and the selling party. To stay within these values, the cost to the seller is set to 6% of the house value, and the cost to the buyer is set to 2.5% of the house value.

Depreciation of the Housing Stock: Leigh (1980) estimates the annual depreciation rate of housing units in the U.S. to be between 0.36% and 1.36%. Cocco (2005) chooses a depreciation rate equal to 1% on an annual basis. Harding et al. (2007) use data from the American Housing Survey and a repeat sales model to estimate that housing depreciated at roughly 2.5% per year gross of maintenance between 1983 and 2001, while the net of maintenance depreciation rate was approximately 2% per year. Consistent with these estimates, the annual depreciation rate of the housing stock is set to 2%.

Income Process: Agents supply one unit of labor inelastically. However, productivity varies both across age groups and across agents. An agent's wage income thus depends on two factors, the age-specific factor γ_j, and the stochastic individual-specific factor $\eta_{i,t}$. The factor γ_j captures the hump-shape of individual earnings profiles over the life-cycle. The age-profile of labor efficiency units is taken from Table PINC-4 of the March Supplement of the 2000 CPS. To parameterize the process for $\eta_{i,t}$, we build on empirical work by Altonji and Villanueva (2007), who use PSID data to estimate the idiosyncratic component of income as an AR(1) process. Aggregating the data to five year intervals, they report an autoregressive parameter ϕ of 0.85 and a variance of innovations σ_y^2 of 0.3. The income process is discretized into an 8-state Markov chain using the procedure of Tauchen and Hussey (1991).

Downpayment Requirement: The downpayment requirement is set to 20% of the house value. This choice is consistent with the choices in most of the related literature (Díaz and Luengo-Prado, 2008; Yang, 2009).

Housing Supply Elasticity: Parameterizing the housing production function is difficult. Empirical estimates of the price elasticity of housing supply vary widely. Blackley (1999) analyzes the real value of U.S. private residential construction put in place. She finds elasticities ranging from 0.8 to 3.7, depending on the dynamic specification of her model. Mayer and Somerville (2000) estimate a flow elasticity of 6, suggesting that a 10% increase in house prices will lead to a 60% increase in housing starts. Furthermore, price elasticities of housing supply vary widely within the United States. As argued by Glaeser et al. (2005), supply-side regulation (and thus the price elasticity of housing starts) differs by region and city. Some authors, such as Ortalo-Magne and Rady (2006), have hence chosen to fix the housing stock in their model. We take a different approach: In the baseline estimates, the housing production function is parameterized to fit a price elasticity of housing starts of $\epsilon = 2.5$, which is roughly in the middle of the values estimated in the literature. As a robustness check, in Appendix D the results of the baseline estimation are compared to the model predictions obtained when setting $\epsilon = 6$ and when setting $\epsilon = 0$ (constant housing stock). This approach provides bounds on the impact of policy changes.

Finally, Figure E.1 shows that the model is able to broadly match the pattern of homeownership rates over the life cycle seen in the data.

[Locate Figure E.1 about here]

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Appendix B. Not for Publication: Analytical Appendix

This appendix describes three analytical simplifications that help solving the model.

Appendix B.1. Consumption-Renting Decision for Given House Size

A significant simplification of the agents' numerical problem can be achieved by first solving for two control variables in a static setting. For a given combination of state variables, savings choice, and housing choice, the allocation of resources between the consumption of the numeraire good and the consumption of housing services can be pinned down by a simple first-order condition.

First, consider the problem of an agent who decides not to buy a house, but instead chooses to rent. For a given set of state variables and a given savings choice, the problem of how to allocate resources between consumption and housing services is static. Let the resources available for consumption and renting be denoted by X. The problem becomes:

$$\max_{\tilde{h}} \left\{ u(c, \tilde{h}) \right\} \tag{B.1}$$

$$\text{s.t.: } c + p^r \tilde{h} \leq X \tag{B.2}$$

The optimal allocation of resources equates the marginal utility that can be derived from the two uses of funds, $p^r u_C = u_H$. Given the functional form for the utility function assumed in (1), this allows us to derive the demand for housing services (and thus the rental demand) for this particular agent as:

$$\tilde{h}^*_{\text{renter}} = \frac{\theta}{1-\theta} \frac{c}{p^r} = \theta \frac{X}{p^r} \tag{B.3}$$

Second, consider the case of an agent who chooses to buy a house of size h. For a given set of states and controls, we can again determine the resources available for consumption and housing services. For convenience, first calculate those resources for the hypothetical case where the agent decides to rent out their home completely. Again, denote those resources by X. This implies that the agent rents out the complete house and then uses the market to acquire the housing services she desires. Here, the problem is exactly analogous to the renter problem and the interior solution is then also given by (B.3).

However, an agent with significant financial wealth who owns a small house might run into the constraint given by equation (2). In that case, the homeowner is trying to rent additional housing units which is not allowed by assumption. Hence, the owners choice of housing services can be expressed as:

$$\tilde{h}^*_{\text{owner}} = \min\left\{h, \theta\frac{X}{p^r}\right\}. \tag{B.4}$$

Appendix B.2. Policy Alternatives in the Budget Constraint

For notational convenience, start with the case of no deductions. This is equivalent to setting $\Psi_1 = \Psi_2 = 0$ in equation (14). That is, mortgage interest payments cannot be deducted from the tax bill and the tax on rental income is levied both on real rental income as well as on imputed rental income from owner-occupied housing. It is important to note that the current U.S. policy is given by $\Psi_1 = \Psi_2 = 1$. For both potential deductions considered in this paper, we illustrate the effect on the agent's budget constraint, both in the homeowner case and in the renter case. The overall tax payments of each individual are also restricted so that they do not result in a net subsidy.

To simplify notation, define the amount of resources to be spent on c and $\tilde{h}$ as

X. This is analogous to Appendix B.1. The intra-temporal problem is then again given by the maximization of period utility $u(c, \tilde{h})$ given the constraint $c + p^r\tilde{h} \leq X$.

Homeowner Case: In the absence of any deductions, the owner's budget constraint can be written as follows, where T denotes the owner's tax burden:

$$\begin{aligned} &c + s' + ph + AC + T = \\ &p^r(h - \tilde{h}) + (1 + r + mI_{\{s<0\}})s + (1 - \tau^{ss})y + p(1 - \delta)h_{-1} + F \end{aligned} \tag{B.5}$$

For the homeowner, the amount of resources available for consumption and housing services is thus given by:

$$X = p^r h + (1 + r + mI_{\{s<0\}})s + (1 - \tau^{ss})y + p((1 - \delta)h_{-1} - h) - T + F - s' - AC \tag{B.6}$$

In terms of the model's solution, the only effect of the policy alternatives is to alter equation (B.2). The constraint becomes:

$$c + p^r\tilde{h} - \Psi_1 \cdot (p^r - \delta p)\tilde{h}\tau^r \leq X - \Psi_2 \cdot rI_{\{s<0\}}s \tag{B.7}$$

$$c + p^r\tilde{h}\,(1 - \Psi_1 \cdot \hat{\tau}^r) \leq X - \Psi_2 \cdot rI_{\{s<0\}}s \tag{B.8}$$

The effective tax rate $\hat{\tau}^r$ is given by $\tau^r \cdot (1 - \delta\frac{p}{p^r})$. By defining the amount of *effective* resources as $\hat{X}$ and the *effective* price of housing services for the owner as $\hat{p}$, we can use the exact same program to solve the intra-temporal problem for any combination of policy alternatives.

$$\hat{X} \equiv X - \Psi_2 \cdot r I_{\{s<0\}} s \tag{B.9}$$

$$\hat{p} \equiv p^r \left(1 - \Psi_1 \cdot \hat{\tau^r}\right) \tag{B.10}$$

$$c + \hat{p}\tilde{h} \leq \hat{X} \tag{B.11}$$

Renter Case: The renter case can be derived analogously. For the renter, the amount of available resources is given by:

$$X^r = (1+r)s + (1-\tau^{ss})y + p\left((1-\delta)h_{-1}\right) - T + F - s' - AC \tag{B.12}$$

Note that the mortgage interest rate deduction can apply to a renter, as the renter can be a former homeowner who just sold her home and is paying off the mortgage in the current period. Following the same steps as above and noting that deduction Ψ_1 does not apply, it can be shown that:

$$\hat{X^r} \equiv X^r - \Psi_2 \cdot r I_{\{s<0\}} s \tag{B.13}$$

$$\hat{p^r} \equiv p^r \tag{B.14}$$

$$c + \hat{p^r}\tilde{h} \leq \hat{X} \tag{B.15}$$

Appendix B.3. Voluntary Savings

In the numerical solution, we follow Yao and Zhang (2005) who define voluntary savings instead of actual savings. In equation (8), the lower bound on savings, which is equivalent to the maximum mortgage the agent can hold, depends on the value of the house and is thus time-varying. Instead, define voluntary savings as:

$$b' = s' + (1 - d)hp, \tag{B.16}$$

so that whenever b' is set equal to zero, the agent holds the maximum mortgage allowed, $(1 - d)hp$. This formulation has the advantage of creating a rectangular constraint set with c, b', and h bounded below by zero. This makes the computational solution on a grid significantly easier. It comes at the cost of having to carry the previous period's price as an additional state. A further downside of this formulation is that it implies that mortgages involve margin calls and that negative home-equity is not allowed.

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Appendix C. Not for Publication: Computational Appendix

This appendix outlines the steps taken to solve the model numerically.

Appendix C.1. State Space and Choice Variables:

Before describing our solution algorithm in more detail, it will be useful to define the state space and control variables. An agent's current state depends on four individual variables: the housing stock h_{-1} and savings s at the beginning of the period, the current realization of the persistent, idiosyncratic income shock η, and the agent's age j. An agent chooses whether to rent or buy, and in the latter case how many housing units h to purchase. Other choice variables are savings s' and the amount of housing services consumed in the current period $\tilde{h}$.

The housing variable h can take a value of zero if the agent decides to rent, and a value in the set $\left\{h^{\min}, h^{\min}(1-\delta)^{-1}, h^{\min}(1-\delta)^{-2}, \ldots\right\}$ if the agent decides to be a homeowner. Restricting the housing choice to a *delta-spaced* housing grid is a convenient assumption in the presence of fixed transaction costs. Appendix B.3 introduced the concept of voluntary savings: $b' = s' + (1-d)hp$. This reformulation of the model allows us to work with a rectangular constraint set, as the lower bound on choices of b' is always zero and thus independent of the housing choice. The state variable b is approximated with a grid. Using the parameters of the estimated autoregressive income process described in Section 5.1, we use a procedure introduced by Tauchen and Hussey (1991) to discretize the income process with an eight-state Markov process. As outlined in the discussion of the calibration in Section 5, the model contains nine working cohorts and a group of retirees. Retired agents who die are replaced with an equal measure of newborn agents, and the total measure of agents is normalized to one. The relative size of the cohorts can thus be derived from the retirees' survival probability.

Appendix C.2. Calculation of Stationary Equilibria:

Stationary equilibria are calculated for a given policy regime and constant prices and rents. We start with a reasonable guess of the level of lump-sum transfers. Given those transfers and prices, we calculate optimal policies by solving an infinite horizon problem for retirees using value function iteration. The resulting value function can be used to solve the working cohorts' problem backwards. Using the optimal policy correspondence, we simulate the economy forward until a stationary distribution of agents over the state space is achieved. We then check market clearing in the housing and rental markets. The equilibrium prices are found using the nonlinear optimization routine *fminsearchcon* for Matlab. In a last step, we adjust the level of transfers and iterate until the government budget constraint clears as well.

To simplify the problem, we first calculate the resources available for consumption of the nondurable numeraire good and housing services for all combinations of states and remaining controls. That allows us to solve a simple static optimization problem as outlined in Appendix B.1. Here, it is important to carefully consider corner solutions. Using the optimal allocation of resources to those two uses, we calculate the momentary utility flow for all possible choices and store those in a large multidimensional object. The actual iteration on the value function is then simple and fast. To further improve computational speed, we vectorize the problem such that there is only a single maximization per iteration.

In the simulation, we store the exact distribution on the state-space grid. This allows for a fast simulation routine given the Markov properties of both the exogenous processes and the policy correspondences.

Appendix C.3. Solution Algorithm for Transitions:

For a given set of parameters and policy variables, we define the vector of market clearing-equilibrium prices and government transfers as q_t. This vector has three elements: p_t, p_t^r, and F_t. Recall that Ω_t captures the distribution of agents over age, income, owned housing, and savings.

The algorithm for calculating the transition paths proceeds as follows. First, guess the approximate length of the transition phase, T. Choosing a larger number is computationally intensive, but ensures that transition can be achieved within the number of periods considered. If transition can be achieved in a smaller number of periods, the last transition periods will look very similar to the new steady state. In our simulations, we choose a conservative $T = 25$, but find that the transition path is not affected significantly for values of T greater than 15. After solving for the stationary equilibria before and after the policy change that is considered, we know the starting points q_0 and Ω_0 as well as the end points q_T and Ω_T. The algorithm then iterates over the following steps:

1. Guess a sequence of $\widetilde{q}_t$ for $t = 1, ..., T-1$.
2. Solve backwards for the value functions given the guessed values $\widetilde{q}_t$. For example, for period $T-1$, it is easy to calculate $V_{T-1} = \max u_{T-1} + \beta V_T$ given $\widetilde{q}_{T-1}$ as V_T is known in the new stationary equilibrium. Ignore distributions, since we are not yet interested in market clearing.
3. Now solve forward: For period 1, find the market clearing $\overline{q}_1$, given V_2 calculated in step 2 and Ω_0. Also calculate $\overline{\Omega}_1$. This gives the sequence of $\overline{q}_t$ and $\overline{\Omega}_t$ for $t = 1, ..., T-1$.
4. Compare $\widetilde{q}_t$ and $\overline{q}_t$. If not the same, replace $\widetilde{q}_t$ by a weighted average of $\widetilde{q}_t$ and $\overline{q}_t$ and return to step 2.

5. Compare $\overline{\Omega}_T$ with Ω_T and increase T if the two distributions differ.

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Appendix D. Not for Publication: Robustness Appendix

The results in the main body of the paper are obtained using a price elasticity of housing starts of $\epsilon = 2.5$. As a robustness check, we also computed the results for the model when the elasticity is $\epsilon = 6$, and when the elasticity is $\epsilon = 0$ (fixed housing stock). These results are presented below.

Appendix D.1. Tax Credits

Table E.1 shows the welfare effects for the period immediately following the tax credit for both the First-Time Homebuyer and the Repeat Homebuyer Tax Credits under the various elasticities. The results in this table are calculated using the steady state as the baseline for comparison. This differs from the approach taken in the main body of the paper, where the welfare implications were computed relative to a baseline in which a downpayment shock generated a boom-bust cycle in house prices. We do this because the response of the economy to the downpayment shock, and hence our baseline for computing the welfare, would be different for each value of price elasticity. Computing the welfare effects relative to the steady state means that all welfare effects are measured relative to a common baseline.

[Locate Table E.1 about here]

The results for the different housing supply elasticities show that independently of the assumptions about ϵ, compensating all agents such that each is indifferent towards the tax credit (lump-sum taxing winners and subsidizing losers) would involve a net cost to the government. The tax credits therefore appear to have negative aggregate welfare effects for the range of reasonable price elasticities of housing supply.

It is interesting to observe that for the First-Time Homebuyer Tax Credit, the aggregate welfare effects are not monotone in the elasticity of housing supply. As the elasticity increases, more initial homeowners and landlords suffer, since transfer payments decline by a larger amount. In addition, for higher values of ϵ, the housing stock rises more, reducing the value of existing housing assets by more and for a longer period of time following the removal of the tax credit. Rents also decline by more for higher values of ϵ, which hurts landlords. On the other hand, the larger fall in rents explains why fewer initial renters lose as ϵ increases. In addition, since in the high-elasticity economy house prices rise by the smallest amount, more renters take advantage of the tax credit offered to them and become homeowners. This is reflected in a larger increase in transaction volume in the high-elasticity economy compared to the low-elasticity economy.

Appendix D.2. Tax on Imputed Rents

Table E.2 shows the price and quantity effects under various assumptions for the housing supply elasticity on steady states when imputed rents are taxed. As expected, the results show that with a more elastic housing supply the housing stock declines by more. Consequently, house prices need to fall less to re-establish equilibrium in the housing market. The smaller the price decrease, the larger the fall in the homeownership rate resulting from the taxation of imputed rents.

[Locate Table E.2 about here]

Table E.3 shows the effect that taxing imputed rents has on welfare for the various elasticity values, both between steady states and immediately following the introduction. Interestingly, the number of agents losing in the new steady state is increasing in the housing supply elasticity. The higher rents in high-ϵ economies increase the tax burden due to the taxation of imputed rents for all agents. This more than outweighs the lower capital losses for homeowners due to smaller price declines in high-ϵ economies. On the other hand, relative to all homeowners, fewer landlords lose in the high-ϵ state relative to the medium-ϵ state. While higher rents increase the cost of owner-occupying due to the newly introduced tax, they also increase the benefits of being a landlord. The low rents in the $\epsilon = 0$ economy also explain why the resources required to compensate losers are higher than in the $\epsilon = 2.5$ economy, despite the fact that fewer agents lose. In particular, the comparatively rich landlords are significantly worse off in the zero-elasticity economy since both the value of their housing stock and their rental income falls. Consequently, they require a large consumption compensation to make them indifferent between staying in the old steady state and switching with a similar agent in the new steady state.

[Locate Table E.3 about here]

In the low-ϵ economy, it is particularly the landlords that suffer more in the immediate aftermath of the policy change than in a comparison of steady states. This is due to the initial decline in rents.

Appendix D.3. No Mortgage Interest Deductions

Table E.4 shows the price and quantity effects in the steady state under the various elasticity values when no mortgage interest deductions are allowed. Again, with a higher elasticity, the price of housing declines by less due to the larger adjustments in the quantity of the housing stock. The other prices and quantities in the model are relatively unaffected by the elasticity choice.

[Locate Table E.4 about here]

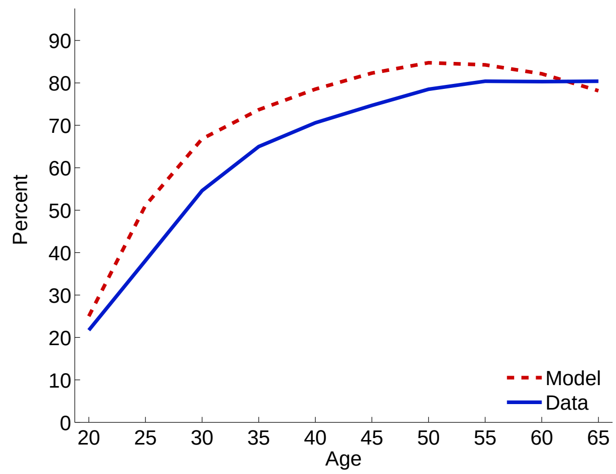
Table E.5 shows the effect that removing mortgage interest deductions has on welfare for the various elasticity values, both between steady states and immediately following the change in policy. Unlike in the previous experiment, the percentage of agents who lose in the new steady state is decreasing in ϵ. The number of owner-occupiers and landlords who lose declines because prices fall by less in the higher-ϵ economy, reducing the capital loss faced by homeowners.[16] In addition to the price effect, as the elasticity increases, rents increase by more following the reform, reducing the number of landlords who are worse off as a result of this policy change.

[Locate Table E.5 about here]

[16] In the previous experiment, this effect was outweighed by the increasing cost of the tax on imputed rents.

Appendix E. Figures and Tables for Appendices

Figure E.1: Homeownership Rate for Different Age Groups



Note: Data for the homeownership rate by age (solid blue line) comes from the U.S. Statistical Abstract for 2005, Table 957. We take the average homeownership rate for the year 2000. The model line (dashed red line) shows the homeownership rate when the model is in the baseline steady state.

Table E.1: Welfare Effects Immediately Following Tax Credit

Characteristic	First-Time Homebuyers			Repeat Homebuyers		
	$\epsilon = 0$	$\epsilon = 2.5$	$\epsilon = 6$	$\epsilon = 0$	$\epsilon = 2.5$	$\epsilon = 6$
Agents losing in new steady state (in %)	76.9	77.2	76.0	76.5	76.4	70.1
Initial owners losing (in %)	81.4	81.8	81.3	78.1	78.2	72.2
Initial renters losing (in %)	65.3	65.3	62.3	71.9	71.3	64.0
Initial landlords losing (in %)	92.9	95.0	97.8	91.8	93.3	93.1
Consumption needed to compensate losers (% of $\overline{y}$)	0.72	0.75	0.76	0.55	0.55	0.51
Netgain after compensating all households (% of $\overline{y}$)	-0.65	-0.68	-0.67	-0.41	-0.41	-0.34

Note: The first three columns show the immediate welfare implications, under various assumptions for the elasticity of housing supply (ϵ), if the government was to introduce a First-Time Homebuyer Tax Credit. The last three columns show the immediate welfare implications under the same elasticities of housing supply for the introduction of a tax credit for all homebuyers (Repeat Homebuyers). The welfare implications in all six columns are computed relative to the baseline steady state. Hence the values for $\epsilon = 2.5$ differ from those in table 3, which are computed relative to the scenario with a shock to downpayment requirements. $\overline{y}$ denotes total labor income in the economy.

Table E.2: Quantity and Price Effects in Steady State — Tax on Imputed Rents

Moment of Interest	Baseline	$\epsilon = 0$	$\epsilon = 2.5$	$\epsilon = 6$
House Price (normalized)	1.00	0.85	0.96	0.98
Rental Price (normalized)	1.00	0.90	1.00	1.02
Price-Rent Ratio	21.66	20.63	20.68	20.68
Housing Stock (normalized)	1.000	1.000	0.896	0.875
Rental Market (normalized)	1.000	2.697	2.604	2.566
Homeownership Rate (in %)	72.3	43.2	39.9	39.3
Share of Landlords (in %)	18.6	17.8	21.5	22.1
Average LTV (in %)	29.5	7.9	7.6	8.1
Transfers (% of $\bar{y}$)	38.57	41.61	41.45	41.43
Tax Loss: mortgage interest deduction	0.48	0.13	0.13	0.14
Tax Loss: non-taxed imputed rents	1.77	0.00	0.00	0.00

Note: The table shows moments of interest in the baseline steady state as well as the steady state for the model with taxes on imputed rents ($\Psi_1 = 0$) under various assumptions for the elasticity of housing supply (ϵ). $\bar{y}$ denotes total labor income in the economy.

Table E.3: Welfare Comparison — Tax on Imputed Rents

Characteristic	Between Steady States			Along Transition		
	$\epsilon = 0$	$\epsilon = 2.5$	$\epsilon = 6$	$\epsilon = 0$	$\epsilon = 2.5$	$\epsilon = 6$
Agents losing in new steady state (in %)	38.7	52.4	53.8	56.0	53.4	54.8
Initial owners losing (in %)	53.1	63.7	65.7	76.5	73.1	75.0
Initial renters losing (in %)	1.4	23.0	23.0	2.4	1.9	1.8
Initial landlords losing (in %)	75.2	74.7	73.1	97.4	80.6	81.3
Consumption needed to compensate losers (% of $\overline{y}$)	2.86	2.68	2.65	4.03	3.29	3.12
Netgain after compensating all households (% of $\overline{y}$)	4.29	0.83	0.41	0.23	-0.37	-0.50

Note: The first three columns show the aggregate welfare implications of comparing the steady state with a tax on imputed rents to the baseline steady state under various assumptions for the elasticity of housing supply (ϵ). The last three columns show the welfare implications (under the same elasticities) immediately following the introduction of the tax on imputed rents. $\overline{y}$ denotes total labor income in the economy.

Table E.4: Quantity and Price Effects in Steady State — No Mortgage Interest Deductions

Moment of Interest	Baseline	$\epsilon = 0$	$\epsilon = 2.5$	$\epsilon = 6$
House Price (normalized)	1.00	0.97	0.99	1.00
Rental Price (normalized)	1.00	1.00	1.02	1.03
Price-Rent Ratio	21.66	21.06	21.02	21.02
Housing Stock (normalized)	1.000	1.000	0.982	0.977
Rental Market (normalized)	1.000	1.788	1.756	1.732
Homeownership Rate (in %)	72.3	57.7	57.5	57.4
Share of Landlords (in %)	18.6	19.7	19.9	20.1
Average LTV (in %)	29.5	15.0	15.3	15.3
Transfers (% of $\bar{y}$)	38.57	39.86	39.83	39.84
Tax Loss: mortgage interest deduction	0.48	0.00	0.00	0.00
Tax Loss: non-taxed imputed rents	1.77	1.57	1.57	1.58

Note: The table shows moments of interest in the baseline steady state as well as the steady state for the model with no mortgage interest deductions ($\Psi_2 = 0$) under various assumptions for the elasticity of housing supply (ϵ). $\bar{y}$ denotes total labor income in the economy.

Table E.5: Welfare Comparison — No Mortgage Interest Deductions

Characteristic	Between Steady States			Along Transition		
	$\epsilon = 0$	$\epsilon = 2.5$	$\epsilon = 6$	$\epsilon = 0$	$\epsilon = 2.5$	$\epsilon = 6$
Agents losing in new steady state (in %)	27.7	17.8	17.4	31.9	33.6	32.7
Initial owners losing (in %)	29.5	15.8	15.2	43.2	37.4	36.0
Initial renters losing (in %)	23.0	23.0	23.0	2.4	23.9	23.9
Initial landlords losing (in %)	73.2	25.0	23.9	86.0	77.6	75.6
Consumption needed to compensate losers (% of $\overline{y}$)	0.11	0.10	0.11	0.51	0.36	0.31
Netgain after compensating all households (% of $\overline{y}$)	2.70	2.20	2.15	1.23	1.21	1.19

Note: The first three columns show the aggregate welfare implications of comparing the steady state with a tax on no mortgage interest deductions to the baseline steady state under various assumptions for the elasticity of housing supply (ϵ). The last three columns show the welfare implications (under the same elasticities) immediately following the removal of mortgage interest deductions. $\overline{y}$ denotes total labor income in the economy.