Mortgage defaults and recourse*

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[Preliminary and Incomplete]

Abstract

We present minimal extensions to an equilibrium default model à la Eaton and Gersovitz (1981) in order to allow for the study of mortgages (collateralized debt) in an environment with long-term debt and both income shocks and shocks to house prices. We use our model to study whether legislation that facilitates defaulting on mortgages are likely to be welfare enhancing. We find that welfare increases monotonically with the degree of recourse in the economy and is maximized by a recourse rule that is harsh enough to eliminate mortgage defaults. Furthermore, welfare gains from increasing the degree of recourse in the economy may be sizable. Welfare gains come from the increase in home ownership, the decline in foreclosures, and the relaxation of endogenous borrowing constraints.

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1 Introduction

This paper presents a model for the quantitative study of mortgage defaults. Our model builds on the equilibrium default model à la Eaton and Gersovitz (1981) that have been used in quantitative studies of credit card debt (see, for example, Athreya (2002, 2006), Chatterjee et al. (2007), Li and Sarte (2006), and Livshits et al. (2008)).[1] We present minimal extensions to that model that allow us to study mortgage default: We study collateralized long-term debt and we incorporate shocks to the value of the collateral.

We first study a benchmark calibration of the model in which a defaulting household finishes its relationship with the lender by handing in its house. This is the case in most states in the United States because of a combination of bankruptcy laws, foreclosure laws, deficiency laws, and non-recourse laws. This legislation states that defaulting households are not responsible for the difference between the current value of the property that collateralizes the mortgage and the outstanding debt.[2] We calibrate our benchmark economy taking parameter values for the income and house-price processes from the data to match the house price to income ratio, and the home-ownership rate. We find that he benchmark also matches closely other United States data (such as the home-ownership rates over the life cycle, the down-payment to price ratio, and the payment to income ratio). Overall, the benchmark seems useful for conducting policy experiments.

We then use the model to study the effects of recourse rules with different garnishing limits. We find that as we allow the lender to garnish more of a defaulting household's income when its house value is below the value of its debt, the default probability declines, home ownership increases, and welfare increases.[3] Thus, welfare gains are maximized for recourse rules that

[1]These models share blueprints with the ones used in studies of sovereign default (see Aguiar and Gopinath (2006) and Arellano (2008)).

[2]Ghent and Kudlyak (2009) exploit law differences across US states and find that defaulter-friendly laws have a positive effect on the default probability and increase the likelihood that defaults occur through more lender-friendly methods. Feldstein (2008) argues that, without non-recourse mortgages, declines in house prices did not trigger defaults in Europe. Pence (2006) finds that the average loan size is smaller in states where foreclosure laws are more defaulter friendly.

[3]Lenders can also be allowed to garnish other assets of a defaulting household. Following previous studies of equilibrium default (see, for example, Athreya (2002, 2006), Chatterjee et al. (2007), Li and Sarte (2006), Livshits et al. (2008)), for simplicity, we do not allow households to borrow and save at the same time. Thus,

eliminate defaults and maximize home ownership. We find that these gains can be sizable.

On the one hand, one would expect that income insurance from facilitating mortgage defaults is likely to be smaller than income insurance from facilitating defaults in credit card debt. A long literature (in law, history and economics) has emphasized that the ability to repudiate debts can play an important role in helping households overcome periods of low income and, therefore, facilitating defaults can be welfare enhancing (see Athreya et al. (2009), Bolton and Jeanne (2005), Dubey et al. (2005), Zame (1993), Grochulski (forthcoming), and the references therein). This occurs when households default in periods of low income. However, as in the data, in our model mortgage defaults typically occur in periods of low house prices and not necessarily in periods of low income. Defaults by households with negative equity in their houses and relatively high income are common. Households with positive equity in their houses and low income would rather sell their house than default. Thus, facilitating mortgage defaults would be difficult to justify based on consumption smoothing. Note also that since households consume housing services, they often do not suffer from changes in their wealth implied by changes in the value of their house (see Benito et al. (2006)). In the wake of recent sharp declines in house prices, policymakers have argued that we must provide relief to homeowners who may default on their mortgages. Such views have led to several large programs aimed at facilitating renegotiation, and debt reduction (see, Adelino et al. (2009)). Our analysis illustrates how these programs are likely to benefit homeowners who are not affected by negative income shocks and do not suffer because of the negative shocks to the price of their house.

On the other hand, there are additional costs of facilitating mortgage defaults compared to the costs of facilitating defaults in credit card debt. First, making mortgage defaults more difficult and, thus, relaxing the borrowing constraint faced by households may be welfare enhancing because it increases home ownership. In our model, gains from the increase in home ownership are sizable. Second, reducing mortgage defaults is beneficial because it mitigates the losses from the loss in value of foreclosed houses. Our stylized model does not capture other gains from

households cannot hold other assets while they own a house. Allowing households to hold different assets would increase the computation time significantly. Hatchondo et al. (forthcoming) discuss the difficulties in obtaining accurate solutions in equilibrium default models. The recourse rule we study allows us to illustrate the benefits from decreasing the default probability.

eliminating mortgage defaults and foreclosures.

Mortgage defaults and foreclosures are widely seem as very costly, which has lead to both academic and policy discussions about how to facilitate contract renegotiations to discourage mortgage defaults (see, Adelino et al. (2009), Piskorski et al. (2008), and the references therein). Our model contributes to the discussion by quantifying the net benefits of facilitating mortgage defaults.

1.1 Related literature

There are six characteristics of the exercise we present that are important in accounting for our results and in differentiating our work from previous studies. First, we calibrate the process for house prices using micro data estimations. In particular, we allow for correlation between income and house prices, which is important for evaluating the insurance properties of mortgage defaults. This contrasts with previous studies that calibrate the process for house prices to match targets in the data (e.g., the default rate) and do not allow for correlation between income and house prices.

Second, as is standard in models of unsecured debt (e.g., Chatterjee et al. (2007)), we do not impose restrictions on the borrowers' ability to choose their debt level. In particular, in our setup, borrowers can choose the downpayment level freely. This contrasts with the approach in other studies where the borrowers' choice is restricted to a small predetermined set of downpayment levels. We find that even though we allow borrowers to choose their downpayment freely and we do not target downpayment levels, our model produces downpayment levels close to the ones observed in the data. The clear advantage of our approach is that it allows downpayments to change endogenously when the model is used to perform policy exercises.

Third, we assume long-term debt. This contrasts with previous studies that assume one-period bonds. We show that assuming long-term debt is essential for generating mortgage defaults (if one takes the process for house prices from the data).

Fourth, each period, we allow borrowers to modify their debt level. This contrasts with other studies with long-term mortgage contracts in which refinancing is not possible or is expensive.

As most studies of mortgage debt, we do not allow mortgage debtors to hold multiple mortgages (or home-equity lines of credit) or to accumulate assets different from home equity. This is done for computation simplicity. However, even in a one-asset model borrowers can easily adjust how leveraged they are since we allow them to modify their debt level in each period. In addition, in spite of assuming a unique type of mortgage contract with constant payment and a given duration, since we allow borrowers to modify their debt level, they can choose a decreasing or increasing pattern of payments and the effective duration of their debt. We find that the payment to income ratio chosen by borrowers in our model matches the data well. Also for computation simplicity, we do not allow debtors to hold financial assets (this is also standard in models of bankruptcy; e.g., Chatterjee et al. (2007)). However, since we allow borrowers to modify the equity they have in their house, they can choose an optimal level of savings.

Fifth, we allow the interest rate on mortgage contracts to be a function of the borrower's characteristics. This eliminates profitable deviations for lenders. Corbae and Quintin (2010) study a mortgage-default model in which pooling borrowers with different characteristics into the same mortgage contract affects results significantly.

Sixth, we present a standard life-cycle model.[4] This helps us discipline the model by making it more comparable with data. For instance, we can take the income process directly from the data and compare home ownership over the life cycle in the model and data. Additionally, this allows us to illustrate how non-recourse legislation hurts intertemporal consumption smoothing by forcing young household to save for a down-payment.

Chambers et al. (2009a) account for the boom in home ownership from 1994 to 2005 by examining the roles of demographic changes and mortgage innovations. We do not consider this trend and calibrate a model without demographic changes and mortgage innovations to match home ownership in 2004. Their model of the home ownership decision is richer than ours: we simply calibrate a disutility from renting parameter to match our home ownership rate target. Their study also differs from ours in that (i) they assume homeowners only observe their house price after they decide to sell it (and cannot refrain from selling the house after observing its price); (ii)

[4] In fact, our model collapses to a standard life-cycle model without housing if we set house prices equal to zero.

they assume mortgage contracts of predetermined length and downpayment; (iii) they assume that households cannot modify their mortgage contract and can only terminate this contract if they choose to sell the house, but they allow households to save while they are mortgage debtors; and (iv) they assume that all borrowers who choose the same mortgage contract (downpayment and length) pay the same interest rate, independently from their household characteristics. Chambers et al. (2009c) use the model in Chambers et al. (2009a) but with a unique mortgage contract to study how housing impact the effects of income tax reforms, and different policies to foster owner-occupied housing. Chambers et al. (2009b) study how the structure of mortgage loans affects both the borrower's selection of a mortgage contract and the aggregate economy. Chambers et al. (2009b) study a model close to the one studied in Chambers et al. (2009a) but allow borrowers to choose from pairs of mortgage contracts that differ in their structure and assume that, each period, borrowers can prepay their existing mortgage contract and ask for a new mortgage.

Jeske et al. (2010) study the macroeconomic effects of a mortgage interest rate subsidy. They study a general equilibrium model in which the risk-free interest rate and the housing price are endogenous, households face a depreciation shock to their housing capital. In contrast, we study a partial equilibrium model with an exogenous risk-free rate and house prices. Their study also differs from ours in that (i) they calibrate the housing depreciation shock to match a default rate target; (ii) the assume one period mortgage contracts; (iii) they assume that households can save while they are mortgage debtors; and (iv) they do not study a life-cycle model.

Chatterjee and Eyigungor (2009) study the effect on mortgage defaults of an unanticipated increase in the supply of housing and the possible effects of a governments foreclosure prevention policy. Following Chambers et al. (2009a) and Gervais (2002), Chatterjee and Eyigungor (2009) model the housing market as a market for homogeneous housing space. In their model, defaulting households are forced to rent and renters demand less housing space. Consequently, an increase in the number of defaults implies an increase in house prices. Since we assume exogenous house prices, this effect is not present in our model. Their study also differs from ours in that (i) they assume a constant house price for their steady state; (ii) they assume that households cannot modify their mortgage contract and can only terminate this contract if they choose to sell the house, but households can save while they are mortgage debtors; and (iii) Chatterjee and Eyigungor (2009) do not study a life-cycle model.

Corbae and Quintin (2010) discuss how much of the recent rise in foreclosures can be explained by the introduction of low downpayment, delayed amortization mortgage contracts in a model without mortgage defaults. We do not study changes in the set of contracts available to borrowers. Their study also differs from ours in that (i) they assume three possible house prices, which they calibrate targeting a default rate; (ii) they force borrowers to choose from two possible mortgage contracts that differ in the downpayment level and in whether the profile of payments is increasing; (iii) they assume that households cannot modify their mortgage contract and can only terminate this contract if they choose to sell the house, but they allow households to save while they are mortgage debtors; and (iv) they model agents of three possible ages who age stochastically.

Guler (2008) study the effects of improvements in the lenders' ability to assess mortgage credit risk in a model with asymmetric information about the borrower's type. In contrast, we do not allow for asymmetric information. His study also differs from ours in that (i) he assumes a constant house price; (ii) he assumes that households cannot modify their mortgage contract and can only terminate this contract if they choose to sell the house, but he allows households to save while they are mortgage debtors.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 discuss our calibration. Section 4 presents the results. Section 5 concludes.

2 The model

The basic structure of the model studied in the paper follows previous quantitative studies of equilibrium default for uncollateralized household debt. We extend the framework used in those studies to incorporate housing, long-term collateralized debt, and shocks to the value of the collateral (the house).

2.1 The environment

We consider a partial equilibrium life-cycle model. A measure of households is born in every period with initial assets b_0 and lives for T periods. For notational simplicity, we do not use subscripts to identify households. Each period, each household receives an endowment of income y_t. Households must live in a house and it may choose to buy or rent its house. There is a disutility from renting denoted by θ. Households can only buy one house and if they buy a house they must live in the house they buy. Each household lives in a different neighborhood with many identical houses with the same price, which is denoted by p_t. We assume households cannot change neighborhood. A household lives for T periods and maximizes

$$E_a\left[\sum_{s=0}^{T-a}\beta^s\left(\frac{c_{a+s}^{1-\gamma}}{1-\gamma}-I\theta\right)\right].$$

where β denotes the subjective discount factor, c_a denotes consumption at age a, γ denotes the constant coefficient of relative risk aversion, and $I = 1$ ($I = 0$) if the household is renting (owns a house).

We allow for correlation between income and house prices. As it is standard in the housing literature, we explicitly allow for predictability in house prices (see Corradin, Fillat and Vergara-Alert (2010), Nagaraja et al (2009), and the references therein). In particular, as in Nagaraja et al (2009), prices are assumed to followed an AR(1) process:

$$p_{t+1} = (1-\rho_p)\bar{p} + \rho_p p_t + \nu_t,$$

where $\bar{p}$ is the mean price. Income has a persistent component, a life-cycle component, and an i.i.d component:

$$y_t = \exp(z_t + f(a) + \varepsilon_t),$$

where

$$z_t = \rho_z z_{t-1} + e_t,$$

ε is normally distributed with variance σ_ε^2, and e and ν are jointly normally distributed with correlation $\rho_{e,\nu}$ and variances σ_e^2 and σ_ν^2.

A homeowner can choose to ask for a loan collateralized by its house. We assume long-term loan contracts. A mortgage for household of age a is a promise to make constant payments for next $n = T - a$ years or to cancel its debt in any future period. If a household chooses to cancel its debt, it must pay the value of the remaining payment obligations in its mortgage contract discounted at the risk free rate.[5] Households can only have one mortgage. In the period in which they cancel a mortgage, households can ask for a new mortgage. Mortgage loans are the only loans available to households. Households with mortgages can only save by accumulating home equity. Households without mortgages can save using one-period bonds that pay the interest rate $\overline{r}$. Mortgages are priced by risk-neutral lenders who make zero profits in expectation and have an opportunity cost of lending given by the interest rate $\overline{r}$.

Households can default on their mortgage. If a household chooses to default it hands in its house to its lender who sells it at $p_t(1-\eta)$, with $0 \leq \eta \leq 1$. The lender also garnishes

$$\pi(b, y, \varepsilon, p, n) = \min\left\{\max\left\{y - \phi, 0\right\}, q^*(n)b - p\right\},$$

where $y = \exp(z + f(T-n) + \varepsilon$ and

$$q^*(n) = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{1}{1+\overline{r}}\right)^i.$$

denotes the value of an obligation of paying one unit of consumption discounted at the risk-free interest rate $\bar{r}$, and b the per-period mortgage payment promised by the household. The household must rent in the period in which it defaults (it starts next period as a renter). Note that a household whose income is garnished will have $\phi - r$ available for ex-housing consumption.

The timing of events is as follows. At the beginning of the period, a household (that can be a homeowner or a renter) observes the realization of its income and house price shocks. If the household enters the period as a renter, it has the option becoming a homeowner. There is a cost of buying a house given by $\xi_B p$. For simplicity, we assume a constant renting cost, r, that a household must pay each period in which it chooses to rent. Assuming a constant renting cost facilitates assuring that households can always afford housing. If the household enters the period

[5]We could also compute the payment amount needed for canceling a mortgage using the rate originally agreed in the contract, but this would imply introducing an additional state variable.

as a homeowner, it has four choices: (i) it can pay its current loan obligations, (ii) it can sell the house and rent during the period , (iii) it can refinance the mortgage loan, and (iv) it can default on its mortgage loan. There is a cost of selling a house given by $\xi_S p$.

2.1.1 Recursive formulation

Abusing notation, in this section, we write the household's expected utility as a function of its total income y instead of a function of the vector of income shocks. The life-time utility of a household that enters the period as a renter is denoted by the function R and is determined by

$$R(b, z, \varepsilon, p, n) = \max\{G(\cdot), B(\cdot)\}, \tag{1}$$

where $b \leq 0$ denotes the renter's saving level at the beginning od the period, G denotes the life-time utility of a household that decides to stay as a renter during the period and B denotes the life-time utility of a household that buys a house in the period.

The value of $G(b, z, \varepsilon, p, n)$ is determined as follows:

$$G(b, z, \varepsilon, p, n) = \max_{b' \leq 0} \left\{ u\left(y - b + \frac{b'}{1+\overline{r}} - r\right) - \theta + \beta\mathbb{E}\{R(b', y', p', n-1)|z, p\} \right\}, \tag{2}$$

where

$$y = \exp(z + f(T-n) + \varepsilon)$$

The expected utility of a household that decides to buy a house in the period satisfies

$$B(b, z, \varepsilon, p, n) = \max_{b'} \left\{ u(y - b - p + q(b', z, p, n)b' - \xi_B p - \epsilon) + \beta\mathbb{E}\{H(b', y', p', n-1)|z, p\} \right\}, \tag{3}$$

where H denotes life-time utility of a household that enters the period as a homeowner and, for $b' < 0$,

$$q(b', z, p, n) = \frac{1}{1+\overline{r}},$$

and for $b' > 0$, $q(b', z, p, n)$ denotes the secondary market price of a mortgage for which the household promises constant payments of b'. The price of mortgage contracts satisfies

$$q(b', z, p, n) = \frac{(q_{\text{pay}} + q_{\text{sell}} + q_{\text{refinance}} + q_{\text{default}})}{(1+\overline{r})b'},$$

where

$$\begin{aligned}
q_{\text{pay}} &= \mathbb{E}_{p,y}\left[I_{\text{pay}}(b', z', \varepsilon', p', n-1)\left[\frac{b'}{n}\right.\right. \\
&\quad \left.\left. + \; q\left(b' - \frac{b'}{n}, y', p', n-1\right)\left(b' - \frac{b'}{n}\right)\right]\right], \\
q_{\text{sell}} &= \mathbb{E}_{p,y}\left[I_{\text{sell}}(b', z', \varepsilon', p', n-1)q^*(n-1)b'\right], \\
q_{\text{refinance}} &= \mathbb{E}_{p,y}\left[I_{\text{refinance}}(b', z', \varepsilon', p', n-1)q^*(n-1)b'\right], \\
q_{\text{default}} &= \mathbb{E}_{p,y}\left[I_{\text{default}}(b', z', \varepsilon', p', n-1)(p'(1-\overline{\xi}_S)\right. \\
&\quad \left. +\pi(b', z', \varepsilon', p', n-1))\right]
\end{aligned}$$

The value function H satisfies

$$H(b, z, \varepsilon, p, n) = \max\{P(\cdot), S(\cdot), F(\cdot), D(\cdot)\}. \tag{4}$$

where

$$P(b, z, \varepsilon, p, n) = u(y - b/n) + \beta\mathbb{E}\{H(b - b/n, y', p', n-1)|z, p\} \tag{5}$$

denotes the life-time utility of staying current on the mortgage contract,

$$S(b, z, \varepsilon, p, n) = \max_{b' \leq 0}\{u(y + p - q^*(n)b - \xi_S p + \frac{b'}{1+\overline{r}} - r) + \beta\mathbb{E}\{R(b', y', p', n-1)|z, p\}\} \tag{6}$$

denotes the life-time utility of selling the current house, and

$$F(b, z, \varepsilon, p, n) = \max_{b'}\{u(y - q^*(n)b + q(b', z, p, n)b' - \epsilon) + \beta\mathbb{E}\{H(b', y', p', n-1)|z, p\}\}. \tag{7}$$

denotes the life-time utility of refinancing the current mortgage loan (i.e., the utility of canceling the initial mortgage and asking for a new mortgage).

The life-time utility of defaulting on the mortgage loan satisfies

$$D(b, z, \varepsilon, p, n) = u(y - \pi(b, z, \varepsilon, p, n) - r) + \beta\mathbb{E}\{R(0, z', \varepsilon', p', n-1)|z, p\}. \tag{8}$$

3 Calibration

For our benchmark, we assume that there is no recourse. That is, we assume that ϕ is higher than the maximum possible income level. Our policy experiment is to solve the model for different values of ϕ while keeping the values of other parameters constant.

Our strategy is to feed into the benchmark standard income and individual house-price processes obtained using micro data from the Unite States. We use estimations presented in previous studies to set the parameter values with the exception of the rent cost, the disutility from renting, the discount factor, and the mean house price. Those four parameter values are set to match the home ownership rate, the mean house price to income ratio, and mean house equity and net-worth.

The mean house price is the key parameter that allows us to match the mean house price to income ratio in the United States. The rent cost and the rent disutility are key parameter to determine home ownership in our simulations. We set $r = 0.2$ to assure that households without savings and with the lowest possible income are able to afford renting. Calibrating the rent disutility parameter allows us to match the home ownership in the data.

A period in the model refers to a year, households enter to the model with age 22, they retire at 62, and then die at 82 years old. We set $\sigma = 2$, which is within the range of accepted values in studies of real business cycles. Following Kocherlakota and Pistaferri (2009), we set $\overline{r} = 2\%$.

We seek to replicate in our distributions of prices and incomes two features of observed data described in Campbell and Cocco (2003) searching on the variance of house price innovations σ_{ν}^{2} and the correlation of base income and house price innovations ($\rho_{e,\nu}$). In particular, we match $\sigma_{\Delta_p} = 0.115$ and $\rho_{\Delta_p,\Delta_y} = 0.027$, where

$$\begin{aligned} \Delta_p &= \log(p_{t+1}) - \log(p_t) \\ \Delta_y &= \log(y_{t+1}) - \log(y_t) \end{aligned}$$

and σ_{Δ_p} and ρ_{Δ_p,Δ_y} are respectively the standard deviation of Δ_p and the correlation coefficient of Δ_p and Δy. The persistence of prices, ρ_p is obtained from Nagaraja et al (2009).

The life-cycle component of the income process is calibrated in the lines of Kaplan and

Table 1: Parameter values.

Parameter	Value	Definition	Basis
ϕ	$\infty, 0.45, 0.21$	Income not subject to garnishing	policy experiment
ξ_B	0.025	Cost of buying, hhds	Gruber and Martin (2003)
ξ_S	0.070	Cost of selling, hhds	Gruber and Martin (2003)
γ	0.220	Cost of selling, bank	Pennington-Cross (2006)
$\rho_{e,\nu}$	0.098	Correlation e and ν	Campbell and Cocco (2003)*
σ_ν^2	0.302	Variance of ν	Campbell and Cocco (2003)*
ρ_p	0.970	Persistence in p	Nagaraja et al (2009)**
$f(a)$	–	Life-cycle component	Kaplan and Violante (2009)
ρ_z	0.977	Persistence in z	Storesletten et al (2000)
σ_ε^2	0.0630	Variance of ε	Storesletten et al (2000)
σ_e^2	0.0166	Variance of e	Storesletten et al (2000)
$\overline{r}$	0.020	Risk-free rate	Kocherlakota and Pistaferri (2009)
b_0	0.250	Initial wealth	SCF
σ	2.000	Risk aversion	Standard
r	0.200	Rent	Positive consumption
θ	0.008	Renting disutility	Calibrated to fit targets
$\overline{p}$	5.699	Mean price	Calibrated to fit targets
β	0.940	Discount factor	Calibrated to fit targets

Violante (2009).[6] The parameters $\sigma_e, \sigma_\varepsilon, \rho_z$ are set following Storesletten et al (2000). The correlation between income and house price shocks $\rho_{e,\nu}$ is calibrated to match obtained from Campbell and Cocco (2003). Table 1 presents the parameter values we use.

4 Results

We first study the performance of a benchmark without recourse and later study the effect of introducing recourse in the economy. We solve the model using discrete state space with 20 grid points for p, 20 grid points for z, 15 grid points for ε, and 225 grid points for b. We simulate the behavior of 5,000 households during their life time. Statistics are computed using agents younger than 62 years old and using Census data to assign population weights to each cohort.

4.1 Benchmark

We first solve the model for a value of ϕ higher than the maximum possible income (which implies that there is no recourse). Table 2 reports moments in the data and in our simulations. The data for down payment and defaults is from mortgages in LPS (Lender Processing Services) in 2004. The rest of the data is from the 2004 SCF (Survey of Consumer Finance).[7]

Table 2 shows that the values of the home ownership rate and mean price-to-income ratio in our simulations are close to those observed in the data. The table also illustrates a tension between approximating the mean home equity and net-worth in the data. This is not surprising since households can hold only hold one financial asset in our model and, therefore, borrowers can only save by increasing their home equity. In spite of generating a relatively high mean home equity, our model can generate poor households with negative equity that are willing to default. In fact, Table 2 shows that the default rate in our benchmark is higher than the one we

[6] The estimated profile peaks after 21 years of labor market experience at twice the initial value, and then it slowly declines to 80 percent of the peak value. At retirement, earnings are flat at 60% of the last value of the persistent component of earnings.

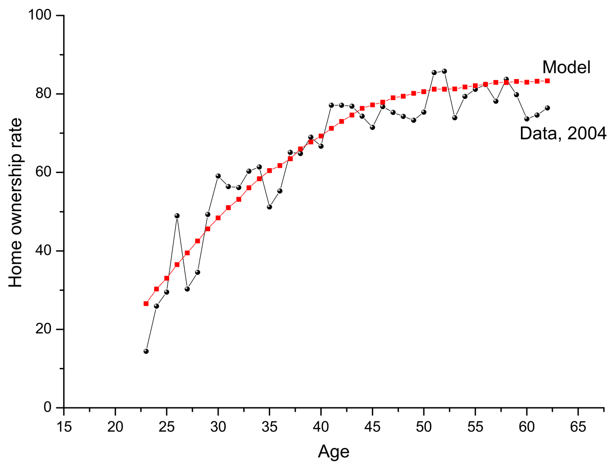
[7] We consider households with age between 22 and 62 that are not in the top 5 percentile of wealth for comparability with the data generated using the model.

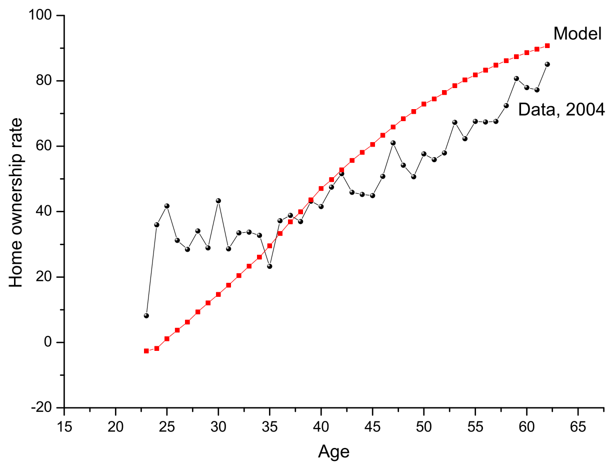
Table 2: Benchmark simulations

Statistics	Data 2004	Model
Home ownership rate	0.645	0.675
Mean Price-to-Income ratio	2.640	2.756
Mean Equity-to-Price ratio	0.500	0.583
Mean Net-worth over mean income	2.946	1.660
Default rate	0.5	0.9
Mean Down payment-to-Price ratio	0.204	0.229
Mean Payment-to-Income ratio	0.113	0.096

report using LPS.[8] In addition, Table 2 shows that the model matches well other measures of indebtedness such as the levels of down payment and mortgage payments. Additionally, Figure 1 shows that the benchmark also matches well the life-cycle profile of home ownership and equity even though we only target the average home ownership and average equity.

Figure 1: Home ownership and equity over the life cycle



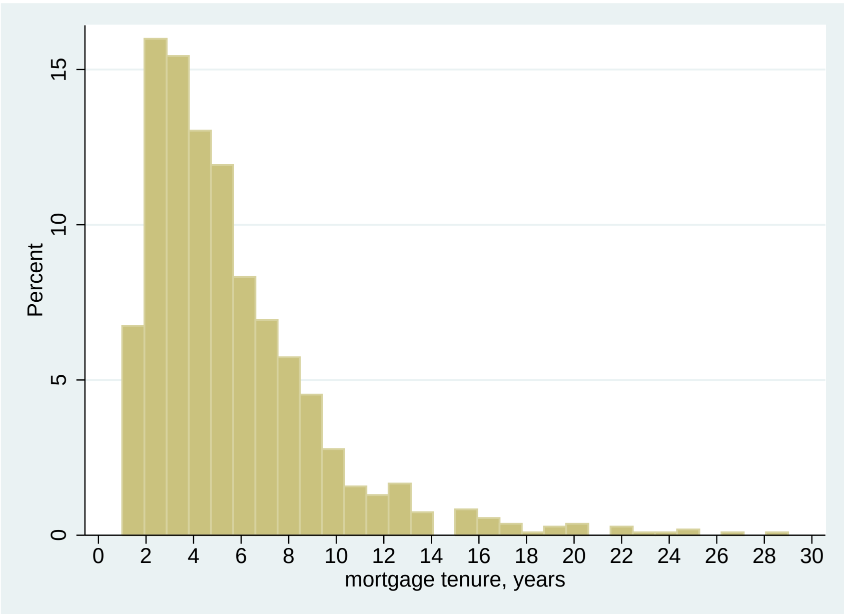


Finally, in order to illustrate the importance of the long-term debt for our results, Figure 2

[8]Also, notice that default rates are higher if data from Mortgage Bankers Association is instead considered.

presents the share of mortgages in default by tenure. Since households that just bought a house have positive equity—they paid a positive down payment, with one-period mortgage contracts defaults would only occur after very infrequent large declines in house prices over one period. Following our approach of calibrating changes in house prices using micro data, this would make defaults very unlikely. In contrast, with long-term mortgage contracts, foreclosures can result from the accumulation of house price declines over several periods. Figure 2 shows that in our simulations, only 6% of the mortgages in default are mortgages acquired in the previous period.

Figure 2: Mortgages in default by tenure.



4.2 Policy experiment

Table 3 presents simulation results for different values of ϕ. Recall that $\phi - r$ is the minimum ex-housing consumption that a household is granted after defaulting (and $r = 0.2$). The table shows that the more income lenders can garnish from defaulting households, the easier it is for households to obtain credit and, thus, ownership increases. As garnishing income becomes easier, defaulting becomes less likely even though the average downpayment and home equity are lower,

Table 3: Summary statistics under different recourse rules

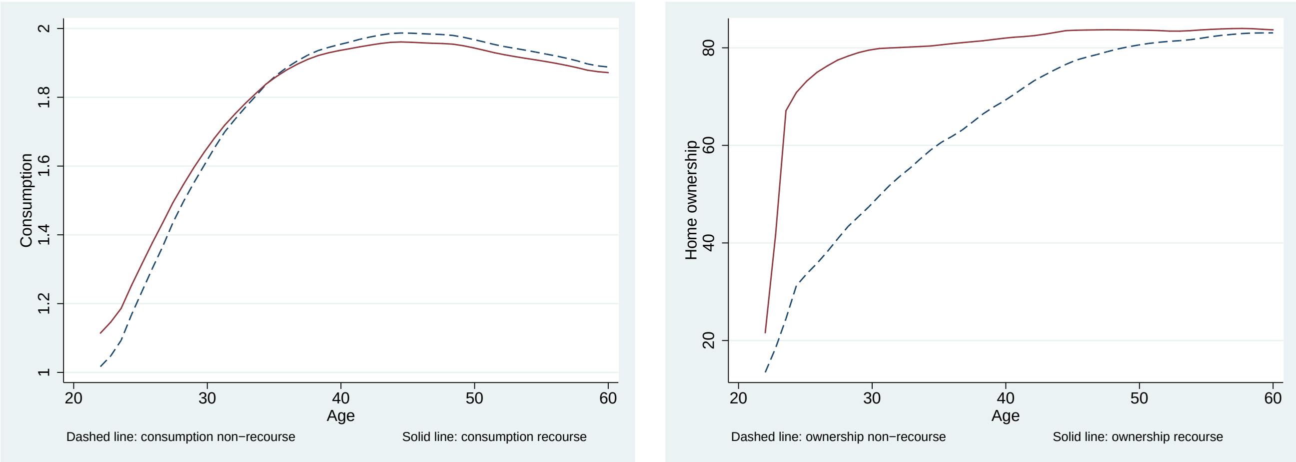
Statistics	Data 2004	Benchmark	$\phi = \text{rent} + 0.01$	$\phi = \text{rent} + 0.25$
Home ownership rate	0.645	0.675	0.803	0.789
Mean Price-to-Income ratio	2.640	2.756	2.755	2.755
Mean Equity-to-Price ratio	0.500	0.583	0.401	0.417
Mean Net-worth over mean income	2.946	1.660	1.391	1.426
Default rate	0.5	0.9	0.0	0.001
Mean Down payment-to-Price ratio	0.204	0.229	0.138	0.137
Mean Payment-to-Income ratio	0.113	0.096	0.121	0.116

and the payment to income ratio is higher.

In order to evaluate the welfare impact of each policy, we consider the ex-ante expected utility of a 22 year old (the lowest age in our model) before the household has observed his initial price and income shocks. We find that a recourse rule with a minimum ex-housing consumption of 0.01 is equivalent to a proportional consumption increase of 3.97 percent during the household's life time. A recourse rule with a minimum ex-housing consumption of 0.25 implies a welfare gain of 3.21 percent during the household's life time.

Individuals enter the economy without houses and typically want to reallocate their income stream toward the earliest ages, when income is low and the present value of buying a house is the largest (renting is a costly alternative in our model). A mortgage is an instrument that help individuals achieve that type of income reallocation: it implies a transfer from future states in which the household pays off the mortgage to the period in which the mortgage is signed. This helps in understanding why harsher recourse rules that enable individuals to borrow more early in life tend to be welfare enhancing. In Figure 3 (left panel), the dashed line is the mean consumption in the economy with no recourse while the solid line represent the mean consumption in the economy with harsh recourse. Clearly, the profile is flatter when recourse is allowed. In Figure 3 (right panel), the dashed and solid lines represents the home ownership in the economies with and without recourse, respectively. This illustrates how households are able to become homeowners earlier with a harsher recourse rule.

Figure 3: Changes in consumption and home ownership over the life cycle

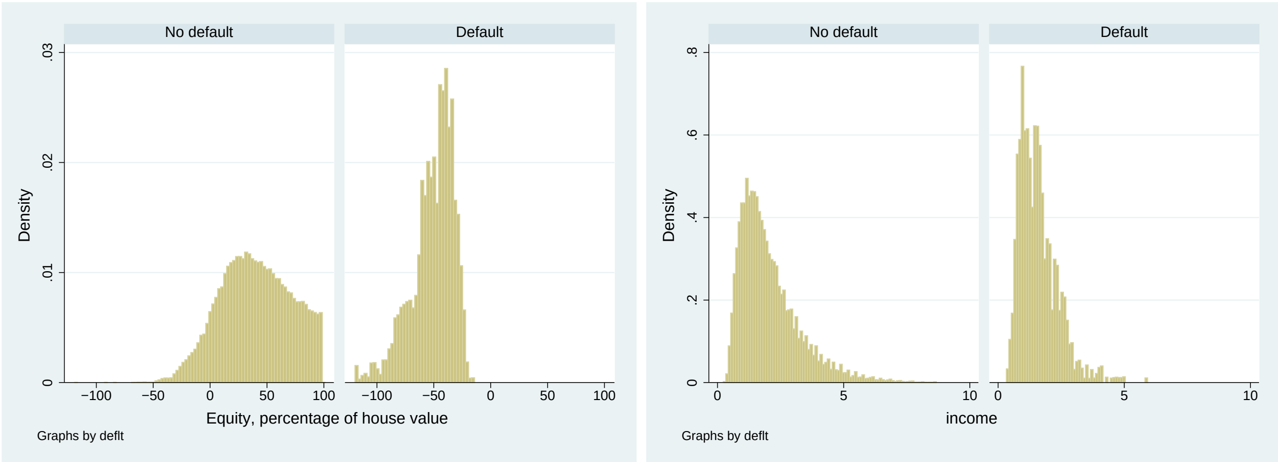


The default option could be welfare enhancing if it allowed individuals to transfer resources to states with low income. However, Figure 4.2 shows that in our benchmark economy (without recourse), the mean income of defaulting households is lower than the mean income in the economy, but defaults by households with high income are frequent. Thus, facilitating mortgage defaults does not seem to be a very effective tool to help households smooth income shocks. Figure 4.2 also shows that mortgage defaults are much more correlated with negative house price shocks than with negative income shocks. Intuitively, households with positive equity and low income would rather sell their house than default, while households with sufficiently negative equity default even if they have high income. Thus, individuals are not much more impaired to transfer resources from states with high income to states with low income when foreclosures become more costly.

4.3 Sources of the welfare gain

Next, we attempt to measure different sources of the welfare gain from reducing mortgage defaults through a recourse rule presented above. First, we estimate the gains from increasing home

Figure 4: Distributions of home equity and income, non-recourse economy



ownership. We consider two gains from being a homeowner. First, we approximate ex-housing consumption gain equal to the difference between the cost of renting and the cost of financing a house, $r - r * p$, where $r*$ is the average financing cost in the benchmark economy. Second, we consider the utility from owning a house θ. We give to renters in each of the economies we simulated an ex-housing consumption transfer of $r - r * p$ and a utility transfer of θ. Note that the total size of this transfer is larger in the benchmark economy where the home ownership rate is lower. Using simulated data we compute the expected utility in the economies with the three different recourse rules we studied, and then we compute the corresponding welfare gains. We consider these gains as excluding gains from the increase in home ownership. We use the difference between these gains and the original gains as a measure of the gains from the increase in home ownership, which we report in Table 4.

In addition, Table 4 presents a measure of the welfare gain from reducing a dead weight cost, the lenders' cost of selling a house $\xi_L p$. Lenders sell more houses in economies with higher default rates. This results in a welfare gain from reducing the default rate with harsher recourse rules. We measure this gain by giving a transfer equal to the lender's cost of selling a house to households to households who default, in the economy with the transfers to renters described

Table 4: Consumption equivalent welfare gains

	Recourse	
	$\phi = 0.21$	$\phi = 0.45$
Lenders' cost of selling a house	0.50%	0.08%
Better life-cycle smoothing	2.08%	1.69%
Rise in Ownership	2.26%	2.10%

above.[9] Note that the total size of this transfer is larger in the benchmark economy where the default rate is higher. Using simulated data we compute the expected utility in the economies with the three different recourse rules we studied, and then we compute the corresponding welfare gains. We consider these gains as excluding gains from the reduction in the lenders' cost of selling a house. We use the difference between these gains and the gains in the economies with transfers to renters as a measure of the gains from reducing the lenders' cost of selling a house.

Table 4 also presents a measure of welfare gains from the improvement of life-cycle smoothing. As illustrated in Figure 3, the average life-cycle profile of consumption is flatter with recourse. In order to approximate the welfare gain from the improvement of life-cycle smoothing, we compute the life-time utility at age 22 implied by the average life-cycle profiles of consumption for each of the recourse rules we study, with the transfers to renters and defaulters described above. Comparing these life-time utilities, we measure the welfare gains from the improvement of life-cycle smoothing.

[9]Lenders transfer their cost of selling a house to borrowers through the interest rate on mortgage loans. Thus, this cost is higher for borrowers with a higher risk of default. We could measure this gain transferring this cost back to all borrowers, but this would be more difficult to implement.

5 Conclusions

We presented a model of equilibrium mortgage default that reproduces several features of the data. Results from our policy experiment indicate that eliminating legislation that facilitates mortgage defaults could result in sizable welfare gains.

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