Mortgages and Liquidity Traps*

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Abstract

We show that mortgage default mitigates liquidity traps even in the presence of reasonable foreclosures costs. Default redistributes wealth from the savers unwilling to consume at the given prices and interest rates towards the borrowers with high marginal propensity to consume. In the presence of long-term debt, mortgage recourse systems, by discouraging that redistribution, magnify the impact of nominal rigidities and cause deeper and more persistent recessions relative to a non-recourse economy. This mechanism can account for up to 30% of the recovery gap between the U.S. and Europe. Debt-relief is a better policy in a liquidity trap because it decouples redistribution from foreclosures. However, if anticipated it induces larger leverage and deeper crises.

Keywords: Aggregate Demand, Debt Relief, Default, Foreclosures, Housing, Liquidity Traps, Mortgages, Nominal Rigidities, Recovery

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1 Introduction

In this paper we analyze liquidity traps in a quantitative model with heterogeneous agents and long-term mortgages. The Great Recession has reignited the interest on liquidity traps, which we define as situations when downward nominal rigidities bind (the zero lower bound in nominal interest rates and wage norms), like in Schmitt-Grohé and Uribe (2017). There seems to be consensus that both Europe and the U.S. entered into a liquidity trap following the 2008 financial crisis (see for example Draghi 2008, Evans 2010, Hall 2011 or Yellen 2016). Moreover, Bernanke (2017) and Kiley and Roberts (2017) argue that the zero lower bound will happen often in the near future. In this paper we show that the structure of the mortgage system is a key determinant of the reaction of an economy to a liquidity trap.

Mortgage systems vary in striking ways through time and across countries. A key characteristic of a mortgage system is whether it allows for recourse or not. In a non-recourse mortgage, the debt obligation disappears when the lender repossesses the house that serves as collateral. In a recourse mortgage, the lender can pursue a defaulted borrower for the balance of the mortgage after foreclosing on the home. For example, in Ireland or Spain mortgage debt is never extinguished, not even after a personal bankruptcy. The U.S. is in practice mostly non-recourse because lenders rarely pursue borrowers for the difference between what the borrower owes and what the lender recovers from the foreclosure (Harris and Meir 2015, Willen 2014). Thus, for most U.S. borrowers, foreclosure results in the complete elimination of their mortgage obligations. This is not the case in most European countries that have recourse systems. Moreover, in most of Europe the length of a bankruptcy proceeding is measured in years, not months or weeks, as in the U.S., during which time almost all income must be devoted to debt service.

The main result of the paper is that mortgage default mitigates liquidity traps even in the presence of reasonable foreclosures deadweight losses. The intuition is that, in a liquidity trap, prices (including the nominal rate) do not fall enough to stimulate savers' consumption. Thus, there are gains from mechanisms that redistribute wealth from the savers unwilling to consume towards the borrowers with high propensity to consume. In most economies default is the only mechanism to do so. However, in recourse mortgages this redistribution is weak, especially when compared with non-recourse mortgages. We quantify this result by studying how fast Europe would have recovered if at the onset of the 2008 crisis it would have switched from being a recourse to a non-recourse system. Then we analyze debt relief policies, which are more efficient mechanisms because avoid the foreclosures associated with default. Agarwal et al. (2017) document that since the Great Depression, U.S. federal and state governments have regularly implemented such policies during harsh economic conditions.

The key mechanism of the model works as follows: following an exogenous shock to the value of the houses (a change in the depreciation parameter) aggregate demand falls and wage norms bind. Thus, wages do not fall enough to clear the labor market and there is involuntary unemployment (a "rationing equilibrium"). The economy becomes "demand-driven" with output below fundamentals. Korinek and Simsek (2016) or Schmitt-Grohé and Uribe (2017) are recent examples of this mechanism in models without default. The liquidity trap is reinforced when nominal rates hit the zero-lower bound. Deflation causes higher real rates. Basically, the price system stops working and cannot stimulate consumption from the savers.

Default with non-recourse mortgages improves the recovery from a liquidity trap. The over-indebted households default and can start afresh, rather than reduce their consumption for years.[1] Outside the liquidity trap, that is, when nominal rigidities do not bind, default is only about redistribution, there are no positive aggregate effects. However, in a liquidity trap there are positive gains for the economy from stimulating aggregate demand, reducing unemployment and escaping from the rationing equilibrium which has lower output. Thus, for the same negative shock, output falls less and recovers faster in a non-recourse economy than in a recourse one. The bulk of the disparity is accounted for the different consumption responses of the pre-crisis borrowers at the middle and bottom of the wealth distribution.

We estimate that the previous mechanism accounts for up to 30% the different recoveries of the U.S. and Europe from the 2008 financial crisis. As discussed by Gross (2014) the 2008 crisis affected Europe and the United States in a very similar way at the start. On both sides of the Atlantic, monetary policy hit the zero-lower bound, economic performance tanked in 2009, and started to recover in 2010. However, over the 2011-2013 period the U.S. economy grew by about 4.5 percentage points more on a per capita basis. The main reason for the gap is the difference in private consumption, which grew in the U.S., but fell in the Eurozone, especially in its periphery.[2] Our model can partially explain these differences since the European mortgage recourse system depressed the consumption of the low-income households unable to discharge their debts. This caused a deeper and more persistent recession because in a liquidity trap the price system is unable to encourage the savers to replace the consumption of the low-income households.

In the presence of deadweight losses from foreclosures, debt relief is superior to non-recourse default. The U.S. implemented large debt relief policies during the last crisis. For example the 2009 Home Affordable Modification Program (HAMP) subsidized payment reductions to more

[1] Long-term debt is key to prevent debt from disappearing after each period.

[2] Public consumption and investment actually subtracted more demand in the U.S. than in the European Union. The contraction of private investment in Europe accounted for one-third of the growth gap (Gross 2014).

than 1.6 million homeowners to avoid foreclosures (Willen 2014). The goal of these policies was to stimulate aggregate consumption, which is beneficial in a liquidity trap as discussed above. However, if the households anticipate that in a crisis they will get debt relief they will borrow more and make the crisis worse. Thus, since policy-makers cannot commit to not implementing debt relief (as Robert Lucas said, "we are all Keynesians in the foxhole") then our result justifies limits on loan-to-value.

This paper contributes to several literatures. First, it expands the literature that studies liquidity traps and aggregate demand externalities. Like Auclert and Rognlie (2016), Eggertsson and Krugman (2012), Eggertsson and Mehrotra (2016), Fahri and Werning (2016), Guerrieri and Lorenzoni (2017), Korinek and Simsek (2016) or Schmitt-Grohé and Uribe (2016, 2017). To the best of our knowledge, this is the first paper analyzing liquidity traps with mortgage default. This is relevant because the wealth redistribution induced by default mitigates the liquidity trap.

Second, we contribute to the growing literature that studies the macroeconomic implications of mortgage features. Campbell (2013) discussed several reasons why the housing finance system affects the reaction of the economy to shocks. Garriga, Kydland and Sustek (2017), Krishnamurthy, Guren and McQuade (2017) analyze fixed vs variable mortgages. Piskorski and Tchistyi (2017), Kung (2015) and Greenwald, Van Nieuwerburgh and Landvoigt (2017) study home equity insurance and shared appreciation mortgages. Hatchondo, Martinez and Sanchez (2015) show that recourse affects the choice of leverage before crises. Corbae and Quintin (2015) find that recourse economies are less sensitive to aggregate home price shocks. We obtain the opposite result because we analyze a model with downward rigidities that allows for demand-driven output.

Finally, we provide a framework to study debt relief in general equilibrium. Eberly and Krishnamurthy (2014) show, in partial equilibrium, that when borrowers face liquidity constraints, mortgage modifications that reduce monthly payments are more effective, in a bang-for-the-buck sense, at helping consumers rebalance their consumption than principal reductions. We complement this insight by focusing on the moral hazard induced by the policies and by showing that their benefits crucially depend on the degree of wage stickiness. There is an growing empirical literature studying these policies, like for example Gabriel, Iacoviello and Lutz (2016), Ganong and Noel (2016) or Agarwal et al. (2017).

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 discusses the benchmark calibration. Section 4 studies a crisis in economies with and without mortgage recourse. Section 5 analyzes the pros and cons of debt relief. Section 6 concludes.

2 Model

We analyze an economy composed by a continuum of households, a continuum of lenders, a representative firm, and a central bank. The consumption good serves as numeraire. For simplicity, and to emphasize different channels that those studied in Garriga, Kydland and Sustek (2017), we assume that mortgages are real contracts.

2.1 Households

There is a continuum of infinitely lived households with mass one. Households have preferences over non-durable consumption c and housing services s. Preferences are time-separable and the future is discounted at rate β. The expected lifetime utility of a household is given by:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[(1-\eta)c_t^{\frac{\epsilon-1}{\epsilon}} + \eta s_t^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon(1-\sigma)}{\epsilon-1}}}{1-\sigma}. \tag{1}$$

The parameters β, σ, ϵ, and η are respectively the discount factor, intertemporal elasticity of substitution, intratemporal elasticity of substitution between non-housing consumption and housing services, and the share of housing services in total consumption. Households can obtain housing services s by owning a house or by renting. The owner of a house of size h enjoys a flow of housing services proportional to the size of the house, $s = h$.

Households are endowed with stochastic idiosyncratic labor e which they supply inelastically. This endowment is stochastic and follows a finite state Markov chain with transition probabilities $f_e(e'|e)$. We denote by $\bar{L}$ the aggregate labor endowment.

2.2 Deposits and Houses

There are one-period deposits a' paying the real interest rate r_{t+1} between periods t and $t+1$. Households cannot short deposits.

Houses are available in discrete sizes $h \in \mathcal{H} = \{\underline{h}, ..., \bar{h}\}$. The unit price of a house at time t is p_t^H. There are proportional transaction costs ζ_b and ζ_s buying and selling houses. These costs make housing wealth less liquid than financial wealth. For simplicity, we assume that owners can only have one house at the same time and cannot rent it. That is, owners cannot be landlords neither own multiple properties. Our rental market is basically exogenous as we assume a perfectly elastic supply of rental that generates a constant and exogenous unit price of rental p^S. The return from rental is distributed to the households as we discuss below.

To make the houses risky assets, there are stochastic idiosyncratic house depreciation shocks δ such that if a household has a house of size h today, then at the start of the next-period the size of the house is $(1-\delta)h$. Thus, these shocks alter the value of a house. The shocks are idiosyncratic across households are independent across time. Their probabilities are $f_\delta(\delta)$.

2.3 Mortgages, Foreclosures, and Policies

2.3.1 Long Term Mortgages

Mortgages are long-term. We model them following Chatterjee and Eyigungor (2015). The mortgagor chooses the size of the first payment m' to be made next period, she receives $q_t(m', h', a', e)m'$ funds today, where the mortgage price $q_t(\cdot)$ is a function defined below, and the subsequent mortgage payments decay geometrically at rate λ. The price function $q_t(\cdot)$ will account for the probability of borrower's default, prepayment, and borrower's assets. There is a cost of originating a mortgage which we model as a fixed numeraire amount ζ_m. This cost makes refinancing costly. Mortgage originations are subject to a maximum loan-to-value θ.

Households can prepay their mortgage and obtain a new one. In order to do so, a household has to make the current mortgage payment m and buy back the present value of the long-term mortgage, which is the promised sequence of payments discounted at the deposit rate:

$$Q_t m = m + \frac{\lambda m}{1+r_{t+1}} + \frac{\lambda^2 m}{(1+r_{t+1})(1+r_{t+2})} + ... \tag{2}$$

2.3.2 Default Regimes: Recourse and Non-recourse

If a household with house of size h and depreciation shock δ defaults on her mortgage at time t, then the lender seizes the house and sells it for $(1-\zeta_d)p_t^H(1-\delta)h$, where ζ_d is a foreclosure loss.

If the mortgage has non-recourse, the sale of the house extinguishes completely the mortgage debt. However, if the mortgage has recourse, if the revenue from the foreclosed house sale is not enough to cover the remaining mortgage, that is, if $Q_t m > (1-\zeta_d)p_t^H(1-\delta)h$, then the lender will be able to garnish a fraction ϕ of household's future income and assets until the outstanding debt is fully repaid.

2.4 Household's Income

We allow for the possibility of a rationing equilibrium in which the firm's labor demand L_t falls short of supply, that is, $L_t < \bar{L}$. In this case, households are symmetrically rationed such that they supply a fraction $\frac{L_t}{\bar{L}}$ of their endowment e. W_t and P_t denote the nominal wage and the price level.

Labor income is the real wage $\frac{W_t}{P_t}$ times the amount of labor that households are effectively supplying $e\frac{L_t}{\bar{L}}$. In addition, households receive firm's profits $\frac{\Pi_t}{P_t}$ and rental housing rents which are rebated according to their share on the aggregate endowment $\frac{e}{\bar{L}}$. We denote the household's income as

$$y_t(e) = \frac{W_t}{P_t} e \frac{L_t}{\bar{L}} + \left(\frac{\Pi_t}{P_t} + p^S S_t \right) \frac{e}{\bar{L}}, \tag{3}$$

where S_t is the aggregate demand for rental services at time t.

2.5 Household's Problem

A household enters period t in one of the following states: homeowner (O), renter (R), and defaulter (D). For a homeowner, the individual state variables are housing h, mortgage payment m, financial wealth a, idiosyncratic productivity e and house depreciation δ. For renters, the individual state variables are financial wealth a and productivity e. In addition, defaulters have debt payment m as a state variable. We denote the value function of a homeowner by $V_t^O(h, m, a, e, \delta)$, of a renter by $V_t^R(a, e)$, and of a past defaulter by $V_t^D(m, a, e)$.

2.5.1 Renter

A household entering the period as a renter with access to the mortgage market has two choices: 1) to buy a house and potentially take a mortgage loan, the value function in this case is $J_t^B(a, e)$; or 2) to keep renting, the value function in this case is $J_t^R(a, e)$. Therefore, the value of a household entering as renter is

$$V_t^R(a, e) = \max \left\{ J_t^B(a, e), J_t^R(a, e) \right\}.$$

The renter who buys a house must choose the size of the house h', savings a' and the amount borrowed $q_t(m', h', a', e)m'$, where m' denotes the next-period mortgage payment, that solves:

$$J_t^B(a,e) = \max_{c,h',m',a' \geq 0} \left\{ u(c,h') + \beta \mathbb{E}\left[V_{t+1}^O(h',m',a',e',\delta')\right] \right\} \quad \text{s.t.} \tag{4}$$
$$c_t + (1+\zeta_b)p_t^H h' + a' = y_t(e) + (1+r_t)a + q_t(m',h',a',e)m' - I_{m'>0}\zeta_m,$$
$$q_t(m',h',a',e)m' \leq \theta p_t^H h'.$$

The indicator function $I_{m'>0}$ equals 1 if the household takes a mortgage and ζ_m is the origination cost.

The renter who continues renting chooses housing services s and savings a':

$$J_t^R(a,e) = \max_{c,s,a' \geq 0} \left\{ u(c,s) + \beta \mathbb{E}\left[V_{t+1}^R(a',e')\right] \right\} \quad \text{s.t.} \tag{5}$$
$$c + p^S s + a' = y_t(e) + (1+r_t)a.$$

2.5.2 Homeowner

A household entering the period as homeowner chooses among four options: 1) to keep her current house (and make the mortgage payment if any), the value function in this case is $J_t^K(h,m,a,e,\delta)$; 2) to refinance or prepay the mortgage while keeping the current house, the value function in this case is $J_t^F(h,m,a,e,\delta)$; 3) to sell the house (and prepay the mortgage if any), the value function in this case is $J_t^S(h,m,a,e,\delta)$; or 4) to default on its mortgage (if it has one), the value function in this case is $J_t^D(h,m,a,e,\delta)$. Therefore, the value of a household entering as homeowner is

$$V_t^O(h,m,a,e,\delta) = \max\left\{ J_t^K(\cdot), J_t^F(\cdot), J_t^S(\cdot), J_t^D(\cdot) \right\}.$$

The owner that keeps the house, makes the mortgage payment m, covers the depreciation of the house and chooses consumption and savings a':

$$J_t^K(h,m,a,e,\delta) = \max_{c,a' \geq 0} \left\{ u(c,h) + \beta \mathbb{E}\left[V_{t+1}^O(h,\lambda m,a',e',\delta')\right] \right\} \quad \text{s.t.} \tag{6}$$
$$c_t + p_t^H \delta h + m + a' = y_t(e) + (1+r_t)a.$$

The owner that refinances prepays her mortgage and chooses the next-period payment m'

of her new mortgage (or no mortgage, $m' = 0$),

$$J_t^F(h,m,a,e,\delta) = \max_{c,m',a'\geq 0} \left\{ u(c,h) + \beta \mathbb{E}\left[V_{t+1}^O(h,m',a',e,\delta)\right] \right\} \quad \text{s.t.} \tag{7}$$
$$c + p_t^H \delta h + Q_t m + a' = y_t(e) + (1+r_t)a + q_t(m',h',a',e)m' - I_{m'>0}\zeta_m,$$
$$q_t(m',h',a',e)m' \leq \theta p_t^H h.$$

If the household sells the house we impose she must be a renter next period. Moreover, the seller has to cover depreciation costs on the house before selling and prepay the existing mortgage $Q_t m$:

$$J_t^S(h,m,a,e,\delta) = \max_{c,s,a'\geq 0} \left\{ u(c,s) + \beta \mathbb{E}\left[V_{t+1}^R(a',e')\right] \right\} \quad \text{s.t.} \tag{8}$$
$$c + p^S s + p_t^H \delta h + Q_t m + a' = y_t(e) + (1+r_t)a + (1-\zeta_s)p_t^H h_t.$$

An owner who chooses to default on her mortgage loses the house and becomes a renter. We consider two mortgage regimes that differ in the treatment of default: a) recourse and b) non-recourse.

Recourse mortgage: under recourse, the defaulter does not cover the housing depreciation cost. The defaulter transfers to the lender a fraction ϕ of its income and financial assets (debt service). Any remaining debt is carried over to the next period.

$$J_t^D(h,m,a,e,\delta) = \max_{c,s,a'\geq 0} \left\{ u(c,s) + \beta \mathbb{E}\left[I_{m'=0}V_{t+1}^R(a',e') + I_{m'>0}V_{t+1}^D(m',a',e')\right] \right\} \quad \text{s.t.} \tag{9}$$
$$c + p^S s + a' = y_t(e) + (1+r_t)a - \phi(y_t(e) + (1+r_t)a),$$
$$m' = \max\left\{ \left[Q_t m - (1-\zeta_d)p_t^H(1-\delta)h - \phi(y_t(e) + (1+r_t)a)\right]\frac{(1+r_{t+1})}{Q_{t+1}}, 0 \right\}.$$

Non-recourse mortgage: under non-recourse, any remaining debt after the sale of the foreclosed house is extinguished:

$$J_t^D(h,m,a,e,\delta) = \max_{c,s,a'\geq 0} \left\{ u(c,s) + \beta \mathbb{E}\left[V_{t+1}^R(a',e')\right] \right\} \quad \text{s.t.} \tag{10}$$
$$c + p^S s + a' = y_t(e) + (1+r_t)a.$$

2.5.3 Defaulter

A household entering the period as a defaulter has to rent today and make debt service payments (if the defaulted mortgage is recourse). She faces a similar problem as the homeowner-defaulter defined above. Therefore, the value of a defaulter is given by $V_t^D(m, a, e) = J_t^D(0, m, a, e, 0)$.

2.6 Mortgage Pricing

Competitive lenders price mortgages to expect inflows that cover their cost of funds, which is the deposit rate r_{t+1}. That is, for a mortgage of size $q_t(\cdot)m'$ the intermediary needs to earn $(1 + r_{t+1})$ on it to break-even. The pricing function depends on next-period payment m', house h', borrower's financial wealth a' and current productivity e. We differentiate between the recourse and non-recourse case. We assume deadweight costs of foreclosures such that the value of a foreclosed house is reduced in a proportion controlled by the parameter ζ_d.

Recourse mortgage. In the case of recourse mortgages, $q_t(\cdot)$ is determined by:

$$(1 + r_{t+1})q_t(m', h', a', e)m' = \mathbb{E}\Big[\underbrace{I'_K(m' + q_{t+1}(\lambda m', h', a''_K, e')\lambda m')}_{\text{pay + continuation value}} + \underbrace{(I'_F + I'_S)Q_{t+1}m'}_{\text{prepay}} \tag{11}$$
$$+ \underbrace{I'_D[(1 - \zeta_d)p^H_{t+1}(1 - \delta')h' + \phi(y_{t+1}(e') + (1 + r_{t+1})a''_D) + q^D_{t+1}(m''_D, a''_D, e')m''_D]}_{\text{default (house sale + debt service + continuation value)}}\Big].$$

The left-side is the cost of funds for the lender. The right-side are the expected next-period payments. I'_K, I'_F, I'_S, and I'_D are indicator functions to denote the possible borrowers' decisions: repaying the mortgage, prepaying the mortgage (by either refinancing or selling the house) or defaulting. In case of default with recourse the lender will receive the fraction ϕ of borrowers' deposits and income. We denote by a''_K the deposits of the owner that keeps making mortgage payments and a''_D for the mortgagor in default. The value of a recourse mortgage in default is:

$$(1 + r_{t+1})q^D_t(m', a', e)m' = \mathbb{E}\Big[\underbrace{\phi(y_{t+1}(e') + (1 + r_{t+1})a') + q^D_{t+1}(m'', a'', e')m''}_{\text{debt service + continuation value}}\Big]. \tag{12}$$

Non-recourse mortgage. In the case of non-recourse mortgages, $q_t(\cdot)$ is determined by:

$$(1+r_{t+1})q_t(m',h',a',e)m' = \mathbb{E}\Big[\underbrace{I'_K(m'+q_{t+1}(\lambda m',h',a''_K,e')\lambda m')}_{\text{pay + continuation value}} + \underbrace{(I'_F+I'_S)Q_{t+1}m'}_{\text{prepay}} + \underbrace{I'_D(1-\zeta_d)p^H_{t+1}(1-\delta')h'}_{\text{default (house sale)}}\Big]. \tag{13}$$

Given the transaction costs associated with selling and buying houses and with new mortgages the default decision depends on household's income and assets.

2.7 Firm

There is a competitive firm that hires labor to maximize period-by-period profits. In nominal terms, the problem of the firm is:

$$\Pi_t = \max_{L_t} P_t Y_t - W_t L_t \quad \text{s.t.} \tag{14}$$

$$Y_t = L_t^{\alpha}. \tag{15}$$

where $\alpha < 1$ is a parameter and L_t is firm's labor demand, which is a function of the real wage and comes from the first-order condition:

$$\frac{W_t}{P_t} = \alpha L_t^{\alpha-1}. \tag{16}$$

2.8 Wage Norms and Involuntary Unemployment

Nominal wages are downwardly rigid, like in Schmitt-Grohé and Uribe (2016, 2017). That is, nominal wages cannot fall from period to period below a wage norm:

$$W_t \geq \gamma W_{t-1}. \tag{17}$$

The parameter γ controls the degree of rigidity. If $\gamma = 1$, then nominal wages are perfectly downwardly rigid. If $\gamma = 0$, then nominal wages are fully flexible.

The existence of downward nominal rigidities implies that the labor market may not clear at the inelastically supplied level of labor $\bar{L}$. In this case, the economy will experience involuntary unemployment. This feature is captured with a complementary slackness condition in wages and labor:

$$L_t \leq \bar{L} \tag{18}$$

$$(\bar{L} - L_t)(W_t - \gamma W_{t-1}) = 0. \tag{19}$$

Therefore, if the wage norm is not binding, then there is full employment ($L_t = \bar{L}$). Conversely, if there is rationing in the labor market, that is, involuntary unemployment ($L_t < \bar{L}$), then the wage norm is binding.

2.9 Central Bank

The inflation rate between period t and $t+1$ is

$$\pi_{t+1} = \frac{P_{t+1}}{P_t} - 1. \tag{20}$$

The central bank sets the nominal interest rate i_t using a Taylor-type rule, where the gross nominal interest rate is an increasing function of inflation and the output gap:

$$1 + i_t = \max\left\{1, 1 + i^* + \alpha_\pi(\pi_t - \pi^*) + \alpha_y \ln\left(\frac{Y_t}{Y^*}\right)\right\}, \tag{21}$$

where i^*, π^*, α_π and α_y are coefficients of the policy rule that we keep constant. π^* is the target for inflation, and Y^* denotes the steady state (flexible-wage) level of output, that is $Y^* = \bar{L}^\alpha$. The first argument in the max function (21) accounts for the zero lower bound on the nominal interest rate ($i_t \geq 0$).

Under perfect-foresight, the Fisher relation links nominal, real interest rates and inflation:

$$1 + r_{t+1} = \frac{1 + i_t}{1 + \pi_{t+1}}. \tag{22}$$

The model displays monetary neutrality when the wage norm is not binding. That is, nominal variables have no real effects.

2.10 Equilibrium

The economy has a constant aggregate stock of owner-occupier housing (H).

Definition. An *equilibrium* is a sequence of prices, wages, interest rates, house prices, and mortgage price functions $\{P_t, W_t, i_t, r_t, p_t^H, q_t(m,h,a,e), q_t^D(m,a,e)\}_{t=0}^{\infty}$, household decision rules, distributions over states $\{\Psi_t^O(h,m,a,e,\delta), \Psi_t^R(a,e), \Psi_t^D(m,a,e)\}_{t=0}^{\infty}$, and corresponding quantities, such that, given initial distributions $\Psi_0^O(h,m,a,e,\delta)$, $\Psi_0^R(a,e)$ and $\Psi_0^D(m,a,e)$,

1. The household decision rules are optimal.
2. The mortgage pricing functions hold.
3. The firm maximizes profits.
4. The central bank follows the Taylor rule.
5. The distribution of households is consistent with the exogenous law of motion and the decision rules.
6. All markets clear, except possibly for the labor market:
   (a) Owner-occupier housing market: $\int h_t \, d\Psi_t = H$.
   (b) Labor market either clears or the wage norm binds.
   (c) Goods market: $\int c_t \, d\Psi_t + I_t^H + Z_t^{\zeta} = Y_t$, where I_t^H is the investment to cover both the housing net depreciation and the foreclosure costs, and Z_t^{ζ} denotes aggregate spending on housing transaction and mortgage origination costs which are deadweight costs.

3 Calibration

We calibrate the model to an economy that plausibly resembles the U.S. and several European countries prior to the Great Recession. We divide the parameters into two groups. First, those that we assign exogenously following micro-evidence and standard values in the literature. Second, those parameters endogenously selected to match some targets. Table 1 summarizes the parametrization. A period in the model corresponds to a year.

Exogenous parameters: the risk aversion parameter is set to $\sigma = 2$. Several papers have argued that the elasticity of intratemporal substitution ϵ is below one. We set $\epsilon = 0.5$, a value within the accepted range. The remaining preference parameters (discount factor β and share of housing parameter η) are jointly determined in the calibration.

To calibrate the earnings process, we follow the literature and assume

$$\ln e' = \bar{e} + \rho \ln e + \varepsilon, \qquad (23)$$
$$\varepsilon \sim N(0, \sigma_\varepsilon^2).$$

We set the standard deviation of the innovations σ_ε to 0.129 like Storesletten, Telmer and Yaron (2004), and the persistence parameter ρ to match the earnings Gini index 0.43 of the 2004 Survey of Consumer Finances (SCF) for prime age households with positive wage income.[3] The value for $\bar{e}$ is chosen so that the aggregate labor endowment $\bar{L}$ is normalized to one.

We set $\underline{\delta} = 0$ and $\bar{\delta} = 0.22$, following Pennington-Cross (2006), who find that the loss in value of a foreclosed house is about 22%. The benchmark economy features recourse and thus we set the fraction of labor income and deposits garnished by lender to $\phi = 0.5$. We set $\alpha = 0.7$ to match the U.S. labor share.

We assume perfectly downward rigid wages ($\gamma = 1$). Schmitt-Grohé and Uribe (2016) provide evidence on downward nominal wage rigidity. They estimate a similar process as in (17) and provide estimates of γ based on the case of Argentina and peripheral European countries during the great recession of 2008. The values that they report are close to one. Daly and Hobijn (2015) argue that many U.S. firms were unable to reduce wages during the recession.

We set the maximum loan-to-value (LTV) at mortgage origination to $\theta = 1$. Many new mortgages during the housing boom had LTVs above 100% in Europe and in the U.S.

We set the proportional cost of buying and selling a house to $\zeta_b = 0.025$ and $\zeta_s = 0.05$. Using the Survey of Consumer Finances, Gruber and Martin (2003) find that the median household reported buying costs of 2.5% and selling costs of 7.5% of the house value. Following Hatchondo, Martinez and Sanchez (2015), we set the cost of signing a mortgage to $\zeta_m = 0.15$. Like in Pennington-Cross (2006), we assume deadweight costs of foreclosures such that the residual value of a foreclosed house $(1 - \zeta_d)$ is 0.78.

Regarding the Taylor rule parameters, we set $\alpha_\pi = 1.5$, $\alpha_y = 0.125$, $\pi^* = 0.02$ (annual inflation rate target of 2%), and $i^* = 0.025$ (steady state nominal rate of 2.5%).

Parameters calibrated endogenously: the remaining parameters of the model are the discount factor β, share of housing in total consumption η, minimum house size $\underline{h}$, and probability of high depreciation shock $f_\delta(\bar{\delta})$. We calibrate them to match the following targets: 1)

[3] We approximate equation (23) with a 17-state Markov chain using the method of Rouwenhorst (1995). The Online Appendix reports the values for the income realizations (e), Markov transition matrix $f_e(e'|e)$ and invariant distribution $F(e)$.

An equilibrium risk-free rate of 0.5% (annual). 2) An aggregate share of housing services over total consumption expenditures of 14.1%. This is the average value over the last 40 years from NIPA data reported by Jeske, Krueger and Mitman (2013). 3) A homeownership rate of 70%. This is slightly higher than the one observed in the U.S. during the housing boom (69% in 2004) and closer to the all time high of 73.2% observed for the European Union in 2008. 4) A median LTV ratio for mortgagors of 61%, this value comes from the 2004 SCF. 5) A foreclosure rate for mortgagors of 1%. This is lower than the U.S. mortgage foreclosures between pre-2006 and post-2015 (1.5%) in order to account for the lower foreclosure rates observed in Europe. Table 2 compares the empirical targets with the model-generated moments. The model matches well the targets.

4 Liquidity Traps and Default Regimes

This section illustrates the novel mechanism of the model. Then we place the results in context by comparing Europe vs the U.S.

4.1 Recourse vs Non-Recourse

Figure 1 studies an unexpected shock to housing values, namely, an increase in the probability of realization of the high depreciation shock $\bar{\delta}$. The shock is calibrated to trigger a collapse in housing prices of about 20% at impact. Since homeowners must cover the depreciation of their houses, an unexpected increase in depreciation risk triggers a subsequent increase in foreclosures and a decrease in housing demand from non-owners, putting downward pressure on housing prices.

Figures 1 shows that after a similar fall in housing prices in the non-recourse and recourse economies, the recourse economy displays a slower recovery in housing prices and aggregate consumption. In both economies, the increase in foreclosures and the drop in housing demand reduces house prices, housing wealth and consumption for defaulters. The decrease in demand for mortgage credit triggers a drop in the real interest rate. Output becomes demand-driven once the downward nominal rigidities bind. The labor market becomes rationed and households (especially high-LTV, recent defaulters and renters) suffer unemployment. Lower demand generates a fall in prices. The central bank reacts to the fall in output and prices by lowering the nominal rate until the zero-lower bound binds. The drop in inflation rises the real rate, further discouraging borrowing and consumption from savers. The drop in output from the reduction in consumption and the raise in foreclosures (Figure 2) feedbacks into lower labor earnings, further reducing consumption.

Figure 3 plots the consumption response by percentiles of the pre-shock wealth distribution in the stationary equilibrium. The shock has asymmetric effects on consumption across households depending on their tenure, default status, and balance sheet. This heterogeneity translates into the marginal propensity to consume (MPC).

In both economies households in the lowest percentile of the wealth distribution reduce consumption the most. Most of these households are renters and high leveraged mortgagors. These households are characterized by a large MPC out of transitory income changes. Consumption for these households falls strongly because housing wealth falls and labor earnings drops. Mid-wealth households, who are mostly mid-leveraged mortgagors, homeowners with no debt, and wealthier renters, display a smaller reduction in consumption as their MPC is lower. On the contrary, rich-wealth households, who are low leveraged mortgagors, homeowners with no debt and large assets in the form of deposits and real estate shares, increase their consumption. Rich-asset, low risk renters benefit from lower mortgage rates and access homeownership. The drop in the interest rate encourages rich households to reduce their savings and increase consumption.[4]

The different dynamics of the two economies can be explained with the different paths of foreclosures shown in Figure 2. Under non recourse mortgages, households can reduce their debt burden faster. However, many mid and low-wealth, high-indebted households that would have defaulted under non-recourse prefer not to do so under recourse. Moreover, households that default under recourse are still liable for the outstanding mortgage debt, reducing their consumption. Under non-recourse those households have their debt extinguished even if the value of the house did not cover the debt balance.

The faster debt discharge of the high MPC households in the non-recourse economy encourages faster consumption growth and higher housing demand that raises housing prices. Higher aggregate demand helps the non-recourse economy to recover faster and enjoy lower unemployment.

4.2 Europe versus U.S.

To place the previous results in perspective, it is useful to compare Europe and the U.S. During the 1996-2006 period several European countries and the U.S. had similar patterns of

[4] Gete and Zecchetto (2017) study a model with wealth redistribution from renters to landlords.

rising housing prices and mortgage debt, together with large current account deficits (Gete 2009).

Figure 5 shows that in 2007 housing prices fell by a similar amount in Ireland, Spain and the U.S. However, in the U.S. it only took four years for prices to start to recover while in Spain or Ireland it took more than 6 years. In terms of real output, the pattern is even more striking. While GDP had returned to pre-crisis levels in the U.S. after 3 years, the recovery took much longer in Europe. The main reason behind the gap between U.S. and Europe after the crisis is the different dynamics of private consumption (Gross 2014). In Ireland or Spain it took nearly seven years for aggregate consumption to stop falling. By then GDP and consumption were only about 90-95% of their pre-crisis levels. Thus, it is clear from Figure 5 that the length of the recession and the dynamics of the recovery have been very different across the two continents.

Figure 5 shows that U.S. households have reduced their debt burden from the peak in 2007 considerably faster than Ireland or Spain. These two countries have a strong recourse mortgage system that grants lenders full recourse to the borrowers' personal assets and future income until all the mortgage debt is paid. In the U.S., even if most states are in theory recourse states, in practice they mostly behave as non-recourse because of the legal hurdles and costs associated with pursuing deficiency judgments. For example, FHFA data suggest a recovery rate of less than 1/4 percent on the difference between what the borrower owes and what the lender recovered from the foreclosure (see FHFA 2012).

Comparing output in Figures 1 and 5 shows that the difference predicted by the model for the non-recourse and recourse economies during the recovery period (that is, the first seven years after the house value shock hits) is around 30% of the actual output recovery gap between the U.S. and an average of Spain and Ireland during 2008-2014. Thus, it seems the mechanism we highlight is quantitatively relevant.

5 Debt Relief

This section first discusses debt relief in a liquidity trap. Then it shows some side effects if the policy is anticipated.

5.1 Debt Relief and Foreclosures

We introduce debt relief in the model following HAMP implemented in 2009 in the U.S. We assume that one period after the unanticipated shock to housing depreciation, there is an unexpected policy such that mortgagors receive a proportional reduction g on their mortgage payments for the next four years. The policy only applies to mortgagors with mortgage payments-to-labor earnings ratio above 31% and with deposits less than three times their current debt payment m. This debt relief is financed through a proportional tax on labor income. Thus, by definition, this policy is targeted towards high LTV, high MPC mortgagors near their default threshold.

Figure 6 displays the dynamics of the economies with only non-recourse mortgages and with also debt relief after the unexpected shock to house values studied in Section 4. Both economies display the same behavior in period $t = 1$ (when the shock hits) since the debt relief policy is unexpected. At the beginning of $t = 2$ the policy is announced and starts operating immediately. As shown in Figure 6, debt relief induces lower foreclosures since it allows the high LTV mortgagors to avoid default. The higher consumption by these households relative to the case when the policy is not in place raises aggregate consumption and therefore output, further increasing labor earnings for all households. The lower foreclosures translate into more resources available for aggregate consumption. House prices recover more rapidly as demand for housing raises, further relaxing borrowing limits and allowing for a faster rebuilding of house equity.

5.2 Debt Relief and Moral Hazard

Figure 7 shows what happens before the shock if the households expect debt relief in case of a crisis. The figure the cross-sectional distribution of loan-to-value when the households do not expect debt relief (blue bars) and then they expect it (yellow bars). The anticipation of the relief encourages the high leveraged households to leverage even more. Thus, making a potential crisis even worse.

Figure 7 highlights that policies that are good in a crisis can make the crisis more likely and worse if they are anticipated. Given that households know that in a crisis policymakers may intervene (Agarwal et al. 2017 document that since the Great Depression, U.S. federal and state governments have regularly implemented debt relief policies during harsh economic conditions) Figure 7 strongly suggests the need of macroprudential policy, for example, loan-to-value caps for low-income households.

6 Conclusions

In this paper we studied economies with agents heterogenous in their marginal propensities to consume, long-term mortgages and downward nominal rigidities. We show that non-recourse mortgages, by potentiating the wealth redistribution associated with default, mitigate liquidity traps. In a liquidity trap, downward nominal rigidities prevent interest falls from stimulating demand from the wealthy households, who are the savers of the economy. Default redistributes wealth away from those households and this cushions the aggregate consequences of their lack of consumption reaction. Outside the liquidity trap there are no aggregate gains from the wealth redistribution associated with default, only the deadweight losses associated with foreclosures.

This paper shows that the structure of the housing finance system is key for the reaction of the economy to shocks. Quantitative simulations of the model show that the results are relevant. In a liquidity trap, a non-recourse economy has up to 3 percentage points higher aggregate consumption relative to a recourse economy. That is 30% of the average gap between the U.S. and Ireland or Spain. Thus, our paper suggests that European countries may want to consider reforming their housing finance systems to facilitate default in case of liquidity traps. However, debt relief is an even better policy as it decouples foreclosures from the wealth redistribution that stimulates demand. If debt relief policies are anticipated they should be associated with macroprudential measures that mitigate moral hazard.

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Tables

Table 1: Parameters (benchmark calibration).

Exogenous Parameters		
Parameter	Value	Description
ϵ	0.5	Intratemporal elasticity of substitution
σ	2	CRRA parameter
ρ	0.977	Persistence labor earnings (annual)
σ_ε	0.129	Volatility labor earnings (annual)
$\underline{\delta}$	0	Low realization housing depreciation
$\bar{\delta}$	0.22	High realization housing depreciation
α	0.75	Production function
$\bar{L}$	1	Aggregate labor endowment
γ	1	Downward nominal wage rigidity
θ	100	Maximum LTV at mortgage origination (%)
ζ_b	0.025	Cost of buying
ζ_s	0.05	Cost of selling
ζ_m	0.15	Mortgage origination
α_π	1.5	Taylor rule parameter
α_y	0.125	Taylor rule parameter
π^*	0.02	Inflation target (2% annual)
i^*	0.025	Nominal interest rate (2.5% annual)
Endogenous Parameters		
β	0.947	Discount factor
η	0.492	Housing share in consumption
$\underline{h}$	4.03	Minimum house size
$f_\delta(\bar{\delta})$	0.076	Probability high depreciation shock
λ	0.913	Mortgage decay

Table 2: Steady state moments.

Targeted moments		
Variable	Model	Data/Target
Risk-free rate (% annual)	0.5	0.5
Share of housing on consumption (%)	15.4	14.1
Homeownership rate (%)	72.3	70
Foreclosure rate (% annual)	0.89	1
Median LTV (%)	65.2	61

Figures

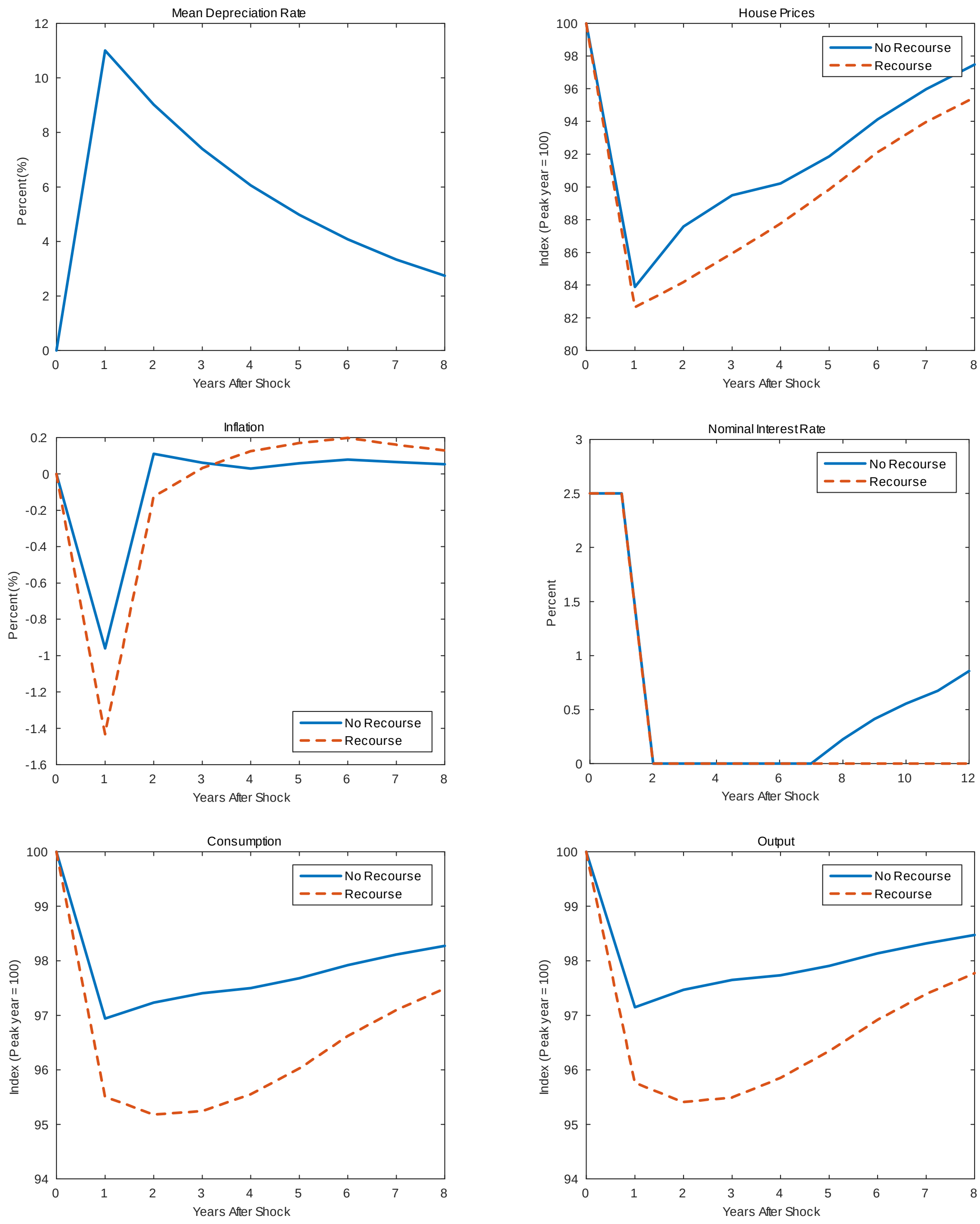

Figure 1. Responses to unexpected housing depreciation shock in recourse and non-recourse economies. The panels compare the response of the economies with and without mortgage recourse to a change in the parameter that controls the expected depreciation of a house.

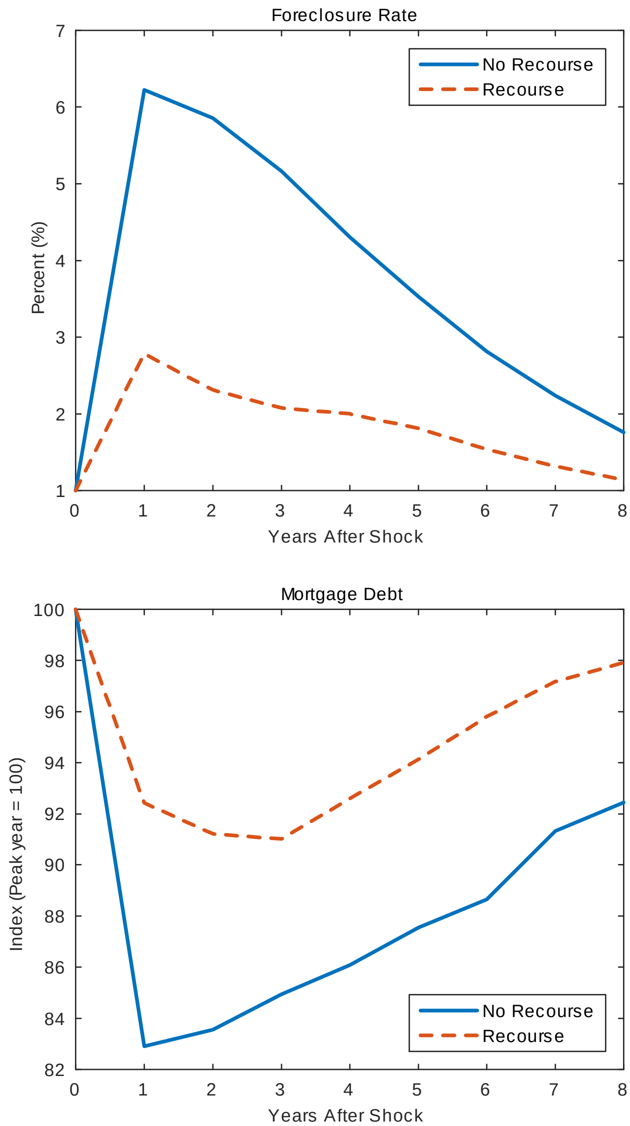

Figure 2. Foreclosures and mortgage debt after unexpected housing depreciation shock in recourse and non-recourse economies. The panels compare the response of the economies with and without mortgage recourse to a change in the parameter that controls the expected depreciation of a house.

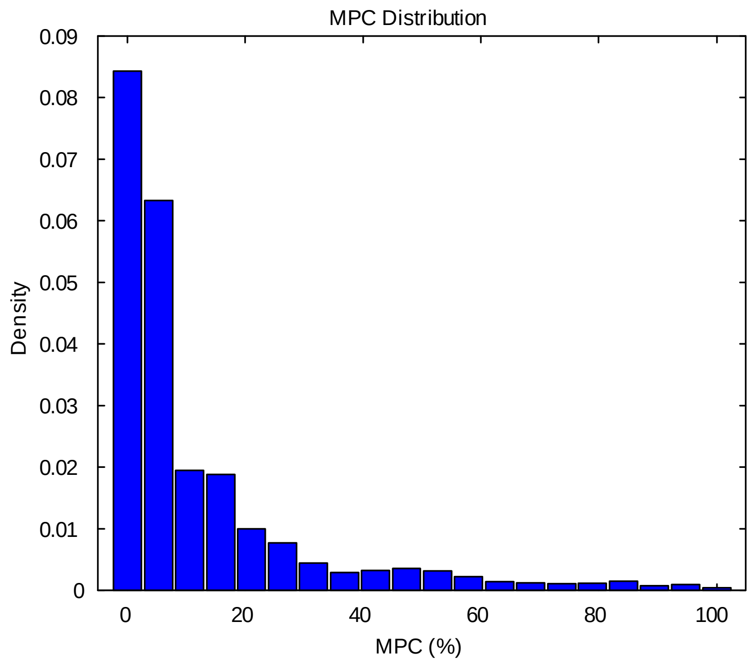

Figure 3. Cross-sectional distribution of the marginal propensity to consume (MPC) in the non-recourse economy.

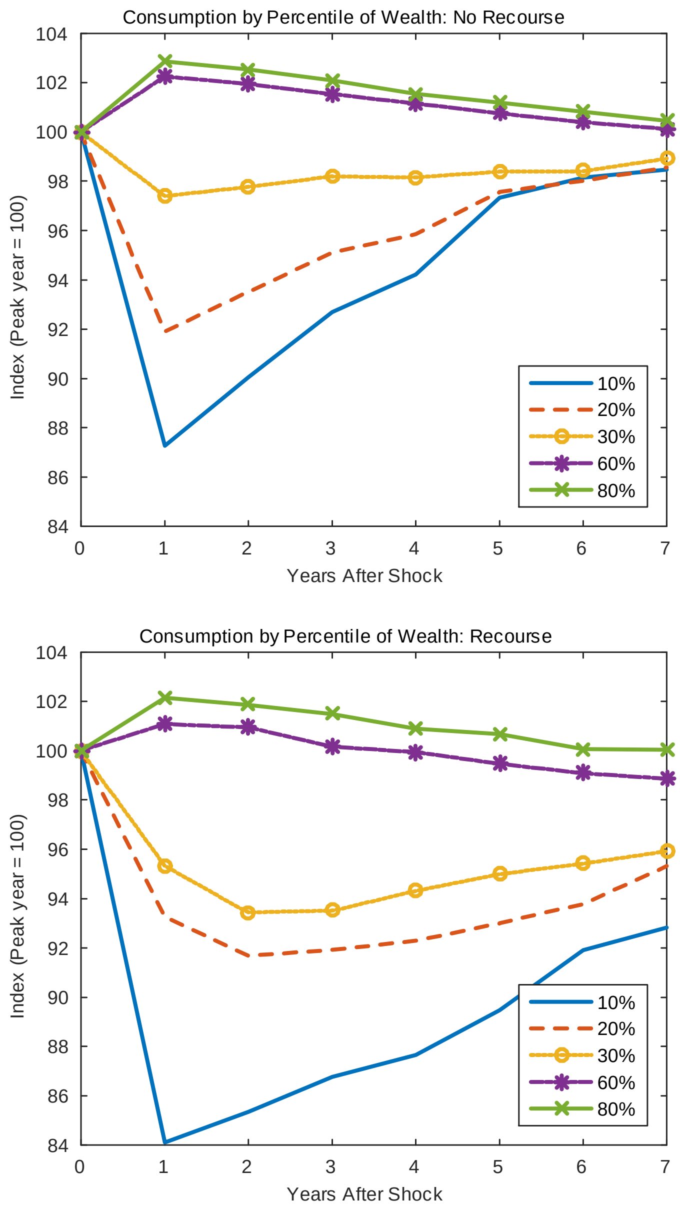

Figure 4. Consumption per wealth percentile in the recourse and non-recourse economies.

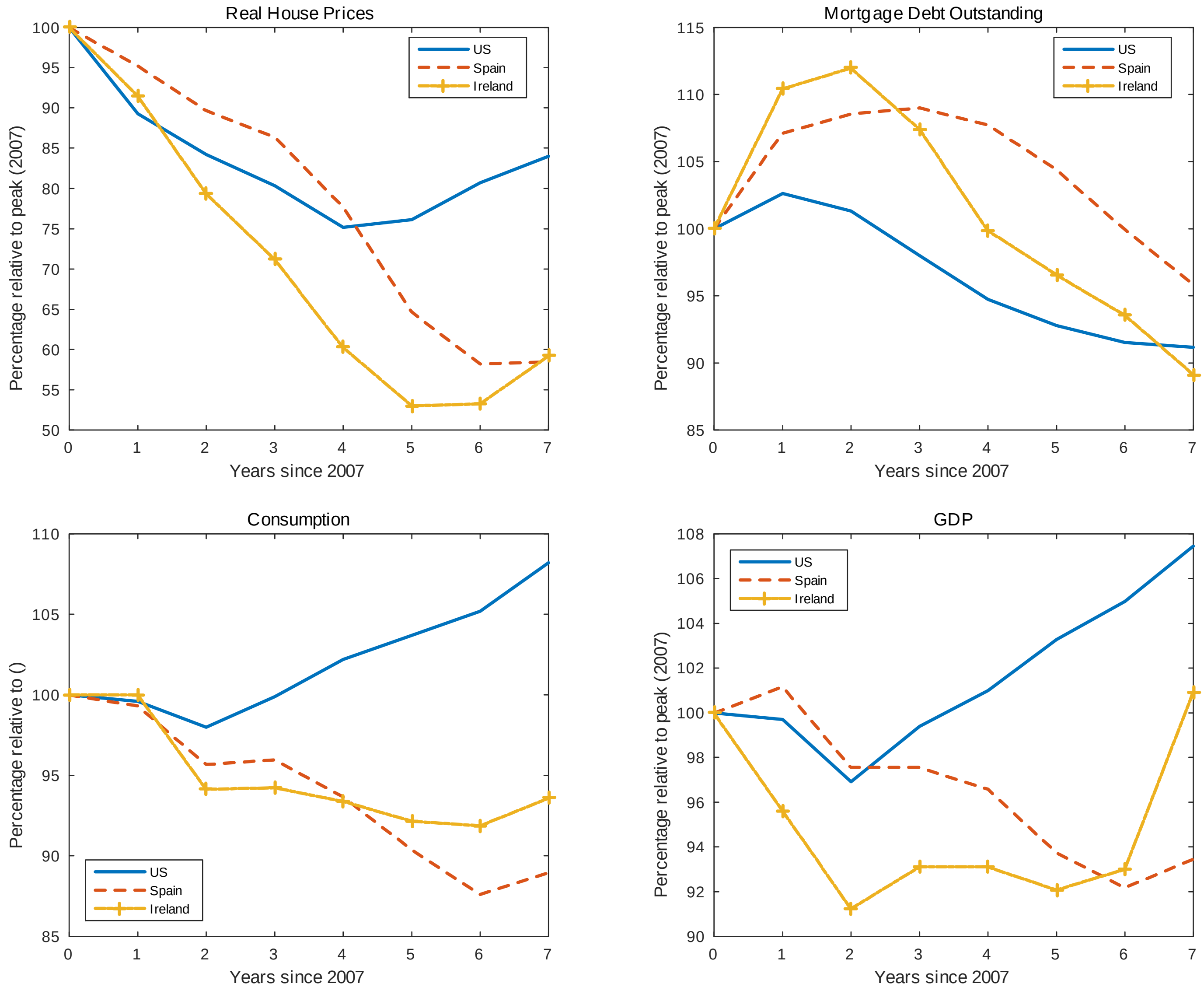

Figure 5. Comparing Ireland, Spain and the U.S. since 2007. The U.S. is basically a non-recourse economy while Spain and Ireland are full recourse countries.

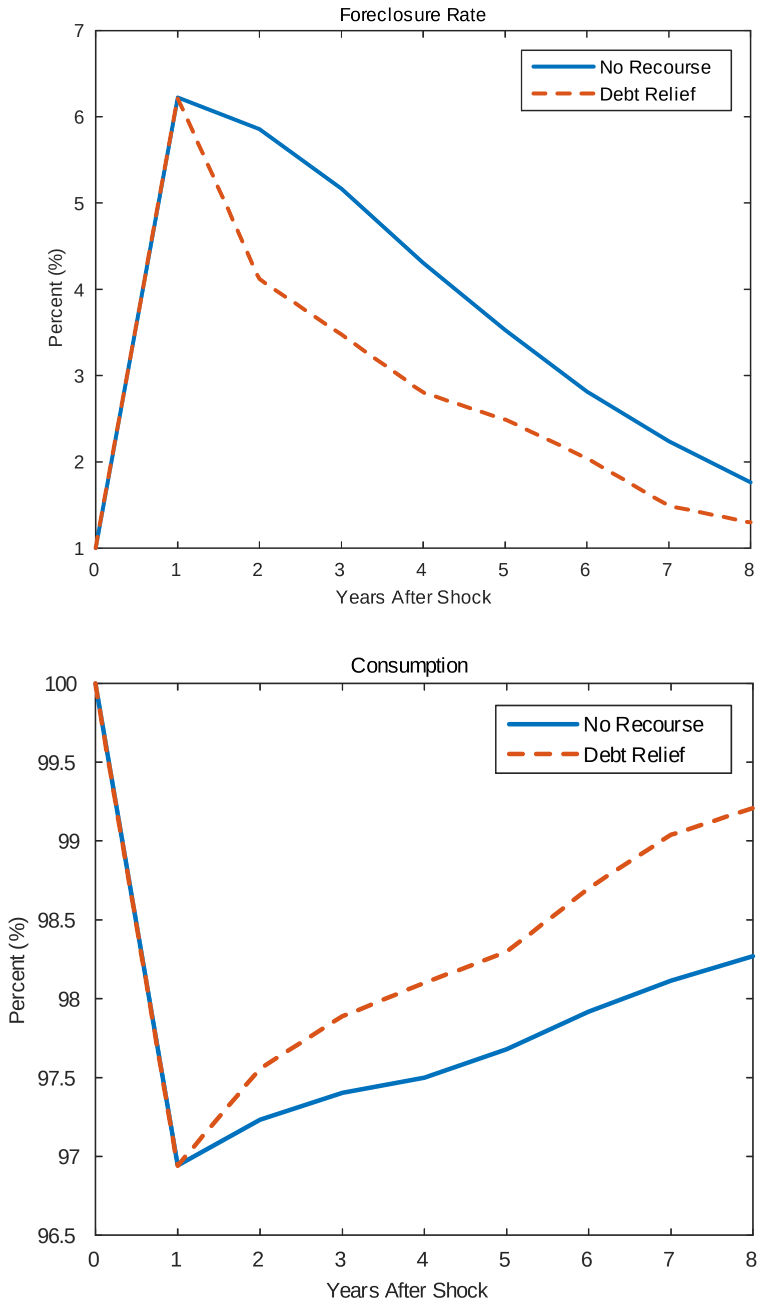

Figure 6. Foreclosures and consumption in the non-recourse economy with and without debt-relief. The panels compare the response of a non-recourse economy with and without debt relief to an increase in the parameter that controls the expected depreciation of a house. The exogenous shock is as in Figure 1.

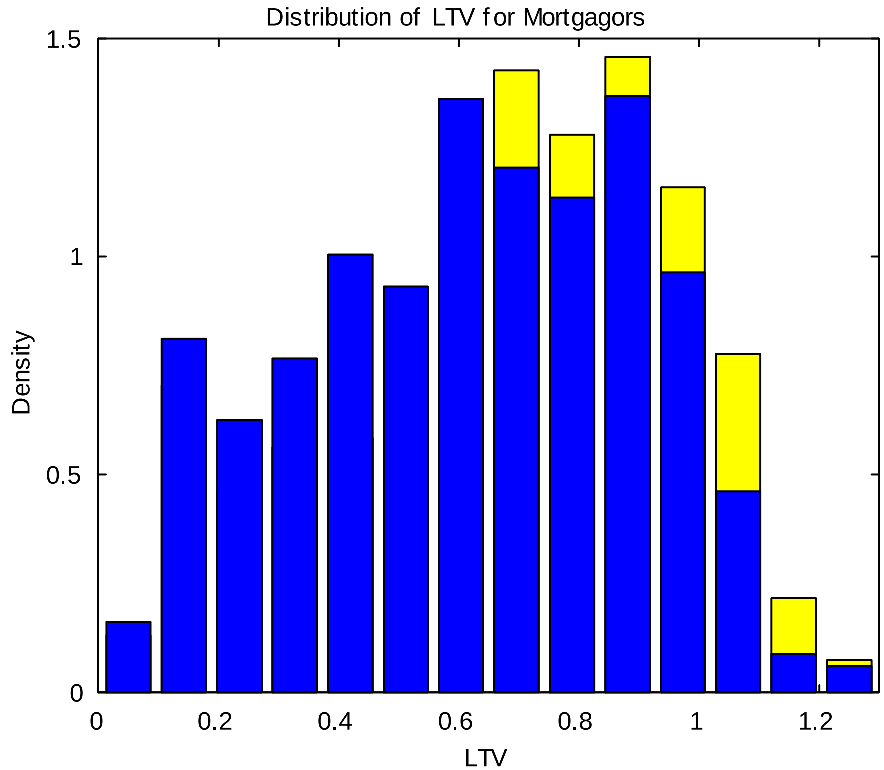

Figure 7. Cross-sectional distribution of loan-to-value when debt relief is anticipated and when there are no expectations of debt relief. The blue bars report the cross-sectional distribution of loan-to-value when there is no debt relief. The yellow bars display the cross-sectional distribution of loan-to-value when the households anticipate that in a liquidity trap there will be debt-relief.