Default and Liquidity Traps. The Role of Recourse Mortgages in Slow Recoveries.*

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Abstract

Mortgage recourse systems, by discouraging default, magnify the impact of nominal rigidities and cause deeper and more persistent recessions in the presence of long-term debt. We study a quantitative model with agents heterogeneous in idiosyncratic income and housing values. Following a collapse of house prices, recourse mortgages induce lower default and, because of heterogeneity in the marginal propensity to consume, the zero-lower-bound in nominal rates and downward wage rigidities, depress aggregate consumption relative to a non-recourse economy. Recourse mortgages can account for 25% of the difference in recovery between the U.S. (mostly non-recourse country) and Spain (recourse country).

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

JEL Classification: E51, H81, G21, R2

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1 Introduction

In a liquidity trap, downward nominal rigidities (like the zero lower bound in nominal interest rates and wage norms) prevent the real interest rate from falling enough to stimulate consumption from the savers. The economy enters into a persistent period of low output and low employment. Reputed economists and policy-makers have associated the slow recovery of the 2007-08 financial crisis with a liquidity trap (see for example Draghi 2008, Evans 2010, Hall 2011 or Krugman 2014 among others).

In this paper we show that whether the mortgage system is recourse or non-recourse is key for the intensity and speed of recovery from a liquidity trap. Then, using a calibrated model, we show that the recourse nature of most of the European housing systems can explain up to 25% of the slower recovery of Spain relative to the U.S., that in practice is basically a non-recourse country (Corbae and Quintin 2014, Harris and Meir 2015).

In a non-recourse system, the debt obligation disappears when the lender repossesses the house that serves as collateral. However, in a recourse system the mortgage lender can pursue a defaulted borrower for the balance of the mortgage after foreclosing on the home. Recourse systems discourage default since default does not help to reduce the debt balance.

We analyze a quantitative general equilibrium model with long-term debt, default, a zero lower bound in nominal interest and downward rigidities in interest rates. Agents are heterogenous in idiosyncratic income, housing tenure choice, and house value shocks (that we model as house depreciation shocks). We use the model to compare two economies identical in every aspect, except that one has a recourse mortgage system while the other has a non-recourse system.

Following a negative shock to house values (i.e., houses depreciate faster), if all prices were perfectly flexible, all real prices and interest rates would fall to encourage households, especially the wealthy, to consume. Since labor is in fixed supply and the aggregate stock of housing is exogenous, neither aggregate output nor aggregate consumption would be affected. However, when the nominal rigidities bind (downward wage rigidities and zero-lower bound on nominal rates) they prevent prices from serving as shock absorbers. With the real interest rate disrupted the drop in borrowers' consumption is not compensated by an increase in the savers' consumption. In this case, the economy move into a "rationing equilibrium" (the liquidity trap) that is "demand-driven" and has output and employment below fundamentals.

The model shows that default can partially undo nominal rigidities. Default redistributes wealth from the lenders towards the borrowers. Since lenders are the wealthy households and borrowers are the low-income households, then default redistributes wealth towards the households with a higher marginal propensity to consume. The impact of the nominal rigidities on aggregate consumption and output is smaller. In other words, nominal rigidities prevent risk-free rates from encouraging savers' consumption. Default redistributes wealth away from the savers who are unwilling to consume

For the same initial shock, the non-recourse economy has higher default rates than the recourse economy. Households are more willing to default when lenders cannot seize their other assets and income. Since low-income households cut their consumption by a smaller amount when they can default on their debts, aggregate consumption falls less and recovers faster in the non-recourse economy. Mortgage recourse systems, by discouraging default, magnify the impact of liquidity traps and lead to deeper and more persistent recessions.

In our benchmark calibration we obtain that following a 20% drop in housing prices, the immediate drop in aggregate consumption is around 2% in both the recourse and the non recourse economy. This number is consistent with the dynamics of the U.S. and Spain between 2007-09. However, the two economies display different patterns of recovery. In the economy without recourse, foreclosures spike shortly after the housing price drop. This leads to wealth redistribution towards the pre-shock borrowers, which are the households with a higher marginal propensity to consume. However, in the recourse economy these borrowers are bound to their debts (long-term debt is key to prevent debt from disappearing after each period) and reduce their consumption accordingly. The result is a much larger and protracted drop in consumption in the recourse economy.

In the data, Spain and the U.S. experienced a similar fall in housing prices over the first three years of the crisis (also the initial output drop was similar), however in Spain it took four additional years for all the main macroeconomic variables to stabilize and start to recover. The average difference in aggregate consumption between Spain and the U.S. since the start of the crisis is 12 percentage points. For our benchmark calibration the recourse nature of the European system accounts for 25% of that difference. The bulk of the disparity is accounted for in the different consumption responses of the pre-crisis borrowers at the middle and bottom of the wealth distribution.

This paper confirms Campbell (2013) insight that the housing finance system affects the reaction of the economy to shocks. This is the first paper to study how the recourse or non-recourse nature of the system affects the intensity and duration of a recession.[1] Hatchondo, Martinez and Sanchez (2015) show that recourse affects the choice of leverage before crises.

[1] Rubio (2011) and Garriga, Kydland and Sustek (2013) show that variable or fixed payment mortgages alter the transmission mechanism of monetary policy.

Ghent and Kudlyak (2011) estimate that borrowers are 30% more likely to default in non-recourse states. 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.

The paper contributes to the growing literature that studies nominal rigidities and insufficient aggregate demand. Like Auclert and Rognlie (2016), Eggertsson and Krugman (2012), Eggertsson and Mehrotra (2016), Fahri and Werning (2016), Guerrieri and Lorenzoni (2011), Korinek and Simsek (2016) or Schmitt-Grohé and Uribe (2016, 2017). This literature has not studied the role of mortgage default as a palliative for the rigidities.

The rest of the paper is organized as follows. Section 2 discusses the motivating facts. Section 3 presents the model. Section 4 discusses the benchmark calibration. Section 5 contains the results. Section 6 concludes.

2 Motivation

During the 1996-2006 period Spain and the U.S. had similar patterns of rising housing prices and mortgage debt, together with large current account deficits (Gete 2009). Between 2007 and 2011 housing prices fell by around 20% in both countries. However, the length of the recession and the dynamics of the recovery have been very different across the two countries.

Figure 1 shows that in Spain it took 6 years for housing prices to reach the bottom and start to recover. In the U.S. it only took four years. Figure 2 shows that 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 Spain. The main reason behind the gap between U.S. and Spain after the crisis is the different dynamics of private consumption, which we plot in Figure 3. In 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.

Figure 4 shows that U.S. households have reduced their debt burden from the peak in 2007 considerably faster than Spain. This is the motivation for this paper. Spain is a country with 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.

3 Model

We analyze a closed economy composed by a continuum of households, a representative lender, a residential investment trust (REIT), a representative firm, and a central bank. The consumption good serves as numeraire.

3.1 Households

The economy is populated by a continuum of households with mass one and preferences

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}, s_{it}), \tag{1}$$

where c_{it} is consumption of household i at time t and s_{it} is the service flow from housing. Households are endowed with stochastic idiosyncratic labor e_{it} which they supply inelastically. This shock follows a finite state Markov chain with transition probabilities $\lambda(e_{it+1}|e_{it})$. The cross-sectional distribution of labor endowments is a Markov chain $\Lambda(e)$ that is constant over time. The aggregate labor endowment $\bar{L}$ is constant over time.

Household i can obtain housing services s_{it} by renting at the price p_{st} or by owning a house. The price of a house is p_{ht}. One unit of housing stock h_{it} generates one unit of housing services s_{it}. To allow for well-defined renters and owners, and to ensure that a household is always capable of affording housing, we assume a minimum house size for ownership $h_{it} \geq \underline{h}$, but no minimum size for rental.

There are stochastic idiosyncratic depreciation shocks δ_{it} such that if household i buys a house of size h_{it} at time t, then at the start of time $t+1$ the size of the house is $(1-\delta_{it+1})h_{it}$. These shocks make the houses risky assets because their value can change over time. The idiosyncratic shocks δ_{it} are independent across time and their probabilities are $\omega(\delta_{it})$.

Households can invest in one-period risk-free deposits (d_{it}) with real interest rate r_t between periods t and $t+1$. There is a REIT that owns the stock of rental housing and pays as dividends its rental income. v_{it} denotes holdings of REIT shares of household i at time t. The price of a share of REIT at time t is p_{rt}. We normalize the number of REIT shares to equal the number of rental units such that the dividends for household i from the REIT are $p_{st}v_{it}$. Households cannot short deposits neither REIT shares. No arbitrage implies that the relation

$$1 + r_{t+1} = \frac{p_{st+1} + p_{rt+1}}{p_{rt}} \tag{2}$$

holds at any time and households are indifferent between holding deposits or REIT's shares. We denote the sum of these holdings as

$$a_{it+1} = d_{it+1} + p_{rt} v_{it+1},$$

and their return is $(1 + r_{t+1})a_{it+1} = (1 + r_{t+1})d_{it+1} + (p_{rt+1} + p_{st+1})v_{it+1}$.

If a household buys a house she can use it as collateral for long-term mortgage debt. If household i takes a mortgage at time t, she chooses the size of the first payment m_{it+1} to be made in period $t + 1$, while the subsequent mortgage payments decay geometrically at rate μ. That is, the payment in two periods is $m_{it+2} = \mu m_{it+1}$, and so on. For a household promising at time t a repayment m_{it+1} the loan size is $q_t(.)m_{it+1}$, where the function q_t is defined below. It accounts for the probability of borrower's default and for her future assets.

If household i sells the house at time t she has to pay the current mortgage payment m_{it}, and buy back the present value of the remaining promised sequence of mortgage payments discounted at the risk-free rate:[2]

$$Q_t m_{it} = m_{it} + \frac{\mu}{1 + r_{t+1}} m_{it} + \frac{\mu^2}{(1 + r_{t+1})(1 + r_{t+2})} m_{it} + ..., \tag{3}$$

where Q_t denotes the amount that the lender receives for a mortgage with current payment equal to one.

Households can default on their debts. We study two types of mortgage systems: recourse and non recourse. Under both systems, if household i defaults then the lender seizes her house and sells it for $p_{ht}(1 - \delta_{it})h_{it}$. In a non-recourse system the sale of the house extinguishes the mortgage debt. However, with recourse, if the revenue from the sale of the house is not enough to cover the household's debt, that is, if $p_{ht}(1 - \delta_{it})h_{it} < Q_t m_{it}$, then the lender garnishes the minimum between: 1) a fraction ϕ of the household's labor income and financial assets, $y_t(e_{it})+(1+r_t)a_{it}$; and 2) the remaining mortgage balance, $Q_t m_{it} - p_{ht}(1-\delta_{it})h_{it}$. The garnished amount cannot be negative. We summarize these conditions in the garnishment function:

$$\zeta_t(m_{it}, h_{it}, a_{it}, e_{it}, \delta_{it}) = \max \left\{ \min \left\{ \phi(y_t(e_{it}) + (1 - r_t)a_{it}), Q_t m_{it} - p_{ht}(1 - \delta_{it})h_{it} \right\}, 0 \right\}$$

The household has to make this transfer every period until the debt is paid, or until the borrower's obligation is extinguished, which happens with probability θ each period. In the expression above, ϕ parametrizes the degree of recourse. For example, if $\phi = 0$, then the defaulter does not have to make any additional transfer to the lender besides the house ($\zeta_t = 0$).

[2]This way of modeling long-term debt follows Chatterjee and Eyigungor (2015).

We assume that households must rent while they are making recourse payments.

As we explain below, we allow for the possibility that the firm's labor demand (L_t) falls short of supply, that is $L_t < \bar{L}$. In this case, we assume that all households are symmetrically rationed so that household i at time t supplies a fraction $\frac{L_t}{\bar{L}}$ of her full endowment e_{it}. Labor income is then given by the real wage $\frac{W_t}{P_t}$ times the amount of the endowment that households are effectively supplying $e_{it}\frac{L_t}{\bar{L}}$. In addition to their labor income, households receive real profits $\frac{\Pi_t}{P_t}$ from the representative firm that, to avoid creating a new channel of wealth redistribution, are rebated according to their share on aggregate endowment $\frac{e_{it}}{\bar{L}}$. $y_t(e_{it})$ summarizes the total household's income:

$$y_t(e_{it}) = \frac{W_t}{P_t} e_{it} \frac{L_t}{\bar{L}} + \frac{\Pi_t}{P_t} \frac{e_{it}}{\bar{L}}.$$

3.2 Households' value functions

Households observe the realization of their labor and housing depreciation shocks (if homeowners) before making decisions.

A household entering the period as a renter with no debt has two choices: 1) to buy a house and potentially take a mortgage loan, $J_t^B(a_{it}, e_{it})$ denotes the value of this option; or 2) to keep renting, $J_t^R(a_{it}, e_{it})$ denotes the value of this option. The household chooses the maximum of the two options:

$$V_t^R(a_{it}, e_{it}) = \max\left\{ J_t^B(a_{it}, e_{it}), J_t^R(a_{it}, e_{it}) \right\}.$$

The value function for the renter buying a house is:

$$J_t^B(a_{it}, e_{it}) = \max_{c_{it}, h_{it}, a_{it+1}, m_{it+1} \geq 0} \left\{ u(c_{it}, h_{it}) + \beta \mathbb{E}\left[V_{t+1}^O(h_{it}, m_{it+1}, a_{it+1}, e_{it+1}, \delta_{it+1}) \right] \right\} \quad \text{s.t.} \tag{4}$$
$$c_{it} + p_{ht} h_{it} + a_{it+1} = y_t(e_{it}) + (1 + r_t) a_{it} + q_t(m_{it+1}, h_{it}, a_{it+1}, e_{it}) m_{it+1}$$
$$h_{it} \geq \underline{h}.$$

Where $V_t^O(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it})$ is the value function of an owner. The mortgage rate function $q_t(m_{it+1}, h_{it}, a_{it+1}, e_{it})$ depends on the mortgage payment m_{it+1}, house size h_{it}, assets a_{it+1} and current labor endowment e_{it}.

If the renter chooses to rent again she solves:

$$J_t^R(a_{it}, e_{it}) = \max_{c_{it}, s_{it}, a_{it+1} \geq 0} \left\{ u(c_{it}, s_{it}) + \beta \mathbb{E} \left[V_{t+1}^R(a_{it+1}, e_{it+1}) \right] \right\} \quad \text{s.t.} \tag{5}$$
$$c_{it} + p_{st} s_{it} + a_{it+1} = y_t(e_{it}) + (1 + r_t) a_{it}.$$

Where $V_t^R(a_{it}, e_{it})$ is the value function of a renter with no debt. Renters cannot borrow from mortgage markets.

A homeowner chooses among three options: 1) to keep her current house (and make the mortgage payment if any to avoid default), we denote the value of this option by $J_t^K(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it})$; 2) to sell the house (and prepay the mortgage if any), $J_t^S(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it})$ denotes the value of this option; or 3) to default and become a renter, we denote the value of this option by $J_t^D(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it})$.

$$V_t^O(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it}) = \max \left\{ J_t^K(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it}), J_t^S(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it}), J_t^D(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it}) \right\}$$

An owner keeping the house has to cover the housing depreciation costs and pay her mortgage payment (if any). Her problem is:

$$J_t^K(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it}) = \max_{c_{it}, a_{it+1} \geq 0} \left\{ u(c_{it}, h_{it}) + \beta \mathbb{E} \left[V_{t+1}^O(h_{it}, m_{it+1}, a_{it+1}, e_{it+1}, \delta_{it+1}) \right] \right\} \quad \text{s.t.}$$
$$c_{it} + p_{ht} \delta_{it} h_{it} + m_{it} + a_{it+1} = y_t(e_{it}) + (1 + r_t) a_{it}, \tag{6}$$
$$m_{it+1} = \mu m_{it}.$$

An owner selling the house has to cover housing depreciation costs, buy back the promised sequence of future mortgage payments, and be a renter in the current period (for simplicity we preclude owner to owner transitions). She solves:

$$J_t^S(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it}) = \max_{c_{it}, s_{it}, a_{it+1} \geq 0} \left\{ u(c_{it}, s_{it}) + \beta \mathbb{E} \left[V_{t+1}^R(a_{it+1}, e_{it+1}) \right] \right\} \quad \text{s.t.} \tag{7}$$
$$c_{it} + p_{st} s_{it} + Q_t m_{it} + a_{it+1} = y_t(e_{it}) + (1 + r_t) a_{it} + p_{ht}(1 - \delta_{it}) h_{it}.$$

An owner that chooses to default on her mortgage does not cover the housing depreciation cost, and must rent in the current period. With a probability θ the debt obligation disappears next period. In this case the household becomes a renter with no debt. However, with probability $1 - \theta$ the debt remains and the lender garnishes a fraction of labor income and assets next period unless the debt is fully paid ($m_{it+1} = 0$). The indicator function $I_{m_{it+1}=0}$ denotes when the household is clear of debt. Owners that default on their mortgage solve:

$$J_t^D(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it}) = \max_{c_{it}, s_{it}, a_{it+1} \geq 0} \left\{ u(c_{it}, s_{it}) + \beta \mathbb{E} \left[\begin{array}{l} (\theta + (1-\theta) I_{m_{it+1}=0}) V_{t+1}^R(a_{it+1}, e_{it+1}) \\ + : (1-\theta) I_{m_{it+1}>0} V_{t+1}^D(m_{it+1}, a_{it+1}, e_{it+1}) \end{array} \right] \right\}$$

$$\text{s.t.} \tag{8}$$

$$c_{it} + p_{st} s_{it} + a_{it+1} = y_t(e_{it}) + (1 + r_{t-1}) a_{it} - \zeta_t(h_{it}, m_{it}, a_{it}, e_{it}, \delta_{it}),$$

$$m_{it+1} = \frac{(Q_t m_{it} - p_{ht}(1-\delta_{it}) h_{it} - \zeta_{it})(1 + r_t)}{Q_{t+1}}.$$

$V_t^D(m_{it}, a_{it}, e_{it})$ is the value function of a renter with debt (a household that defaulted on her mortgage). A household that enters the period as a renter with debt solves the same problem of an owner who decides to default but when the house has already been seized:

$$V_t^D(m_{it}, a_{it}, e_{it}) = J_t^D(h_{it} = 0, m_{it}, a_{it}, e_{it}, \delta_{it} = 0).$$

3.3 Lender

There is a risk-neutral representative lender who collects deposits at the risk-free rate r_t and gives mortgages. If household i promises at time t to pay m_{it+1} next period then the lender lends $q_t(m_{it+1}, h_{it}, a_{it+1}, e_{it}) m_{it+1}$ to the household today. The lender takes into account the optimal choices of the household (and therefore the possibility of default) when making its origination decision. Competition ensures that the lender makes in expectation zero-profits. That is, the mortgage price function q_t satisfies that the loan granted equals the expected repayments:

$$\begin{aligned} & q_t(m_{it+1}, h_{it}, a_{it+1}, e_{it}) m_{it+1} = \\ & \quad \frac{1}{1 + r_{t+1}} \mathbb{E} \Big[I_{it+1}^K \big(m_{it+1} + q_{t+1}(\mu m_{it+1}, h_{it}, a_{it+2}, e_{it+1}) \mu m_{it+1} \big) + I_{it+1}^S Q_{t+1} m_{it+1} \\ & \qquad + I_{it+1}^D \big(p_{ht+1}(1 - \delta_{it+1}) h_{it} + \zeta_{it+1} + q_{t+1}^D(m_{it+2}, a_{it+2}, e_{it+1}) m_{it+2} \big) \Big], \end{aligned} \tag{9}$$

where $I_t^K(h, m, a, e, \delta)$, $I_t^S(h, m, a, e, \delta)$, and $I_t^D(h, m, a, e, \delta)$ are, respectively, indicator functions for household's optimal decision of repaying the mortgage flow, repaying the full mortgage amount or defaulting. The value of a mortgage in default is given by the expected payments that the defaulted household will make:

$$q_t^D(m_{it+1}, a_{it+1}, e_{it}) m_{it+1} = \frac{1}{1 + r_{t+1}} (1 - \theta) \mathbb{E} \Big[\zeta_{it+1} + q_{t+1}^D(m_{it+2}, a_{it+2}, e_{it+1}) m_{it+2} \Big]. \tag{10}$$

3.4 Firm

There is a representative firm that takes prices as given. The firm hires labor to maximize period-by-period profits. The problem of the representative firm is:

$$\Pi_t = \max_{L_t} \left\{ P_t Y_t - W_t L_t \right\} \quad \text{s.t.} \quad Y_t = L_t^\alpha.$$

The firm's labor demand is:

$$\frac{W_t}{P_t} = \alpha L_t^{\alpha-1}. \tag{11}$$

3.5 Wage rigidities

We follow Auclert and Rognlie (2016), Eggertsson and Mehrotra (2015) and Schmitt-Grohé and Uribe (2016, 2017) in assuming that nominal wages cannot fall from period to period below a *wage norm*:

$$W_t \geq \gamma W_{t-1}. \tag{12}$$

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 downward nominal rigidities imply that the labor market may not clear at the labor supply $\bar{L}$ and there is involuntary unemployment.

In equilibrium all markets will clear, except possibly the labor market as captured with the complementary slackness equation in the wage rigidity constraint:

$$L_t \leq \bar{L} \tag{13}$$

$$(\bar{L} - L_t)(W_t - \gamma W_{t-1}) = 0. \tag{14}$$

If the wage norm is not binding then the real wage is given by (11) evaluated at $L_t = \bar{L}$. However, when labor market clearing requires lower nominal wages than the norm then the norm becomes binding, households are rationed through the labor market ($L_t < \bar{L}$) and are constrained to supply a fraction $\frac{L_t}{\bar{L}}$ of their labor endowment e_{it}.

3.6 Central bank

The inflation rate is

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

The central bank sets the nominal interest rate i_t on nominal bonds.[3] Under perfect-foresight, the Fisher relation links nominal, real interest rates and inflation:

$$1 + r_{t+1} = \frac{1 + i_t}{1 + \pi_{t+1}}. \tag{15}$$

Monetary policy takes the form of a Taylor-type feedback rule, where the gross nominal interest rate is set as a function of inflation and output gap:

$$1 + i_t = \max \left\{ 1, 1 + i^* + \alpha_\pi (\pi_t - \pi^*) + \alpha_y \ln \left(\frac{Y_t}{Y^*} \right) \right\}, \tag{16}$$

where i^*, π^*, $\alpha_\pi > 0$ and $\alpha_y > 0$ are coefficients of the policy rule that we hold constant. Y^* denotes the steady state (flexible-wage) level of output, that is $Y^* = \bar{L}^\alpha$. The first argument in the max function accounts for the zero lower bound on nominal interest rates, $i_t \geq 0$. Remark that when the wage norm is non-binding the model displays monetary neutrality and nominal variables have no real effects.

3.7 Equilibrium

The economy has constant aggregate stocks of owner-occupied housing (H_o) and rental housing (H_r).

Definition. An *equilibrium* is a sequence of prices, wages, interest rates, REIT share prices, owner occupier prices, rents, and mortgage price functions $\{P_t, W_t, i_t, r_t, p_{ht}, p_{rt}, p_{st}, q_t(m, h, a, e)\}_{t=0}^{\infty}$, household decision rules, and distributions $\{\Psi_t^O(h, m, a, e, \delta), \Psi_t^R(a, e), \Psi_t^D(m, a, e)\}_{t=0}^{\infty}$ such that, given initial distributions $\Psi_0^O(h, m, a, e, \delta)$, $\Psi_0^R(a, e)$ and $\Psi_0^D(m, a, e)$, the decision rules solve (8), the mortgage pricing function satisfies (9), the firm FOC (11) holds, the Fisher equation holds, the non-arbitrage condition (2) holds, the central bank follows (16), distribution of households is consistent with the exogenous law of motion and the decision rules, and the owner-occupied housing, rental housing, credit, and goods market clear, except possibly for the labor market

[3] We did not model explicitely the bonds to save in notation but these nominal bonds are assets in zero net supply.

when the downward wage rigidity constraint (12) binds.

[To be added] Put here market clearing equations.

4 Calibration

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 parameters. A period in the model corresponds to a year.

A. Parameters calibrated exogenously. We assume CRRA utility over a CES aggregator for non-durable and housing consumption:

$$u(c,s) = \frac{\left[\eta c^{\frac{\epsilon-1}{\epsilon}} + (1-\eta)s^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon(1-\sigma)}{\epsilon-1}}}{1-\sigma} \tag{17}$$

Several papers have argued that the elasticity of intratemporal substitution ϵ is below one. We set ϵ to 0.5, a value within the accepted range.

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

$$\begin{aligned} \ln e_{it+1} &= \bar{e} + \rho \ln e_{it} + \varepsilon_{it}, \\ \varepsilon_{it} &\sim N(0, \sigma_{\varepsilon}^2), \end{aligned} \tag{18}$$

and 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.[4] The value for $\bar{e}$ is chosen so that the aggregate labor endowment in the the cross section $\bar{L}$ equals 1.

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 mortgage decay parameter μ is set to 0.985. The benchmark economy features no recourse and thus we set the fraction labor income and deposits garnished by lender ϕ to 0. For the recourse economy, we set ϕ to 0.5. The probability that debt obligation disappears θ is set to 0.25. We set α to 0.7 to match the labor share.

[4] We approximate equation (18) with a seven-state Markov chain using the method of Rouwenhorst (1995). The Online Appendix reports the values for the income realizations (e), Markov transition matrix $\lambda(e_{it+1}|e_{it})$ and invariant distribution $\Lambda(e)$.

Schmitt-Grohé and Uribe (2016) provide evidence on downward nominal wage rigidity. They estimate a similar process as in (12). They provide estimates of γ based on the case of Argentina and peripheral European countries during the great recession of 2008. The values they report are close to one (annual). Therefore, we assume perfectly downwardly rigid wages ($\gamma = 1$).

B. Parameters calibrated endogenously. The remaining parameters of the model (β, σ, η, $\underline{h}$ and ω), are calibrated to match the following targets for the U.S. (non recourse economy): 1) An equilibrium risk-free rate of 1%. 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 66%, that is the U.S. average during the period 1970-2014. 4) A median leverage ratio for mortgagors of 61%, this value comes from the 2004 SCF. 5) A foreclosure rate for mortgagors of 1.5%, which is consistent with U.S. mortgage foreclosures between pre-2006 and post-2015. Table 2 compares the empirical targets with the model-generated moments.

5 Results

We consider an unexpected shock to housing values, namely, an increase in the probability ω of the high realization of the depreciation shock $\bar{\delta}$. The shock is calibrated to trigger a collapse in housing prices of 20% at impact, as Figure 5 shows. 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. Figure 6 displays the transition path for the aggregate foreclosure rate while Figure 7 shows that the aggregate consumption dynamics.

Figures 5 and 7 show 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. First we discuss the common mechanisms and then the differences.

In both economies, the increase in foreclosures and the drop in housing demand raises rental rates, thus reducing consumption for renters and 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 suffer unemployment.

Figures 8 and 9 plot 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 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 or because rents increase. 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 REIT 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.[5]

The different dynamics of the two economies can be explained with the different paths of default shown in Figure 6. 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, preventing them from discharging their debt burden faster. Moreover, households that default under recourse are still liable for the outstanding mortgage debt. 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. With recourse, households who default need to devote a fraction of their total income to recourse payments, reducing their consumption. The depressing effects on consumption are much larger.

6 Conclusions

In this paper we studied economies with agents are heterogenous in their marginal propensities to consume, long-term mortgages and downward nominal rigidities. We show that non-recourse mortgages, by encouraging 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 house-

[5] The no-arbitrage condition between deposits and REIT shares implies that REIT share prices raise as interest rate falls and rents increase. Gete and Zecchetto (2016) study a model with wealth redistribution from renters to landlords.

holds making less painful their lack of consumption reaction. Thus, our paper shows that the structure of the housing finance system can alter the reaction of the economy to housing shocks.

Quantitative simulations of the model show that the results are non-trivial. In a liquidity trap, a non-recourse economy has up to 3 percentage points higher aggregate consumption relative to a recourse economy. That is 25% of the average gap between the U.S. and 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. A caveat to our results is that this model ignores the negative externalities from default discussed in the literature (see Hedberg and Krainer 2012 or Mian, Sufi and Trebbi 2015 for example). Future research will evaluate how incorporating them would alter the results.

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Tables

Table 1: Parameters (benchmark calibration).

Exogenous Parameters		
Parameter	Value	Description
ϵ	0.5	Intratemporal elasticity of substitution
ρ	0.986	Persistence labor earnings
σ_ε	0.129	Volatility labor earnings
γ	0.78	Foreclosure recovery rate
$\underline{\delta}$	0	Low realization housing depreciation
$\bar{\delta}$	0.22	High realization housing depreciation
μ	0.985	Mortgage decay
ϕ	0	Assets garnishment ($\phi = 0.5$ if recourse)
θ	0.25	Probability debt disappears
α	0.7	Production function
γ	1	Downward nominal wage rigidity
Endogenous Parameters		
η	0.508	Housing share in consumption
σ	2.43	CRRA parameter
β	0.952	Discount factor
$\underline{h}$	4.71	Minimum house size
ω	0.087	Probability high depreciation shock

Table 2: Steady state moments: recourse and no recourse.

Variable	Recourse	No recourse
Risk-free rate (%)	1	0.98
Homeownership rate (%)	66.8	64.4
% of homeowners with debt	83.5	57.8
Foreclosure rate (%)	0.93	1.56
Mean mortgage spread (%)	0.464	0.792
Wealth Gini index	0.54	0.58
Median debt-to-value mortgagors (%)	72.3	68.7
% mortgagors with debt-to-value $\geq$ 90%	14.5	0
Mortgage stock / GDP	1.42	1.06
House price	1	0.97
Shelter price	0.0342	0.0352
Price-to-rent ratio	29.2	27.6

Note: This table compares the steady state moments of the economy with recourse and with no recourse. Bp means basis points.

Figures

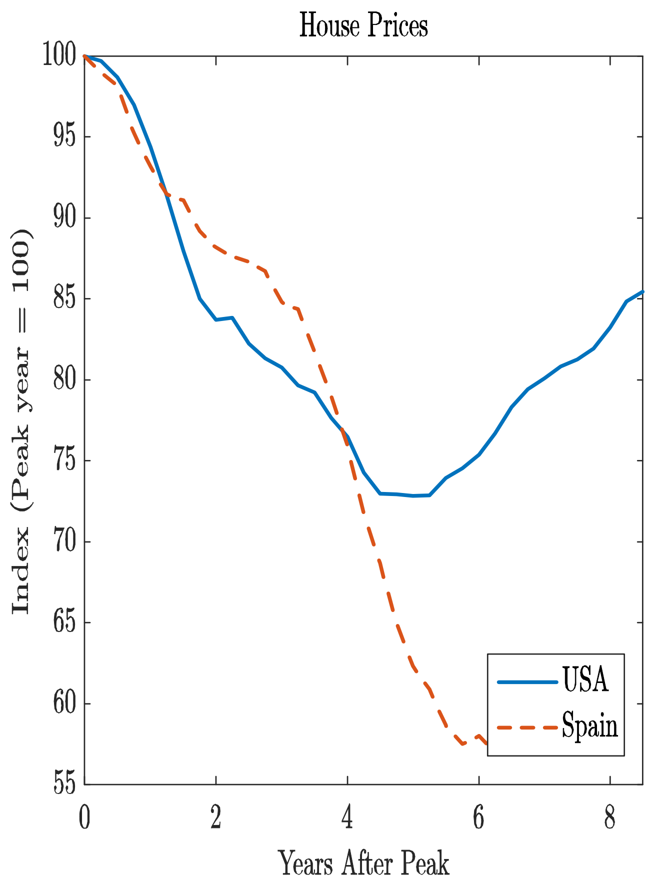

Figure 1. Real Housing Prices in Spain and the U.S. after the 2007-08 Crisis.
Source: Analytical House Price Database (OECD).

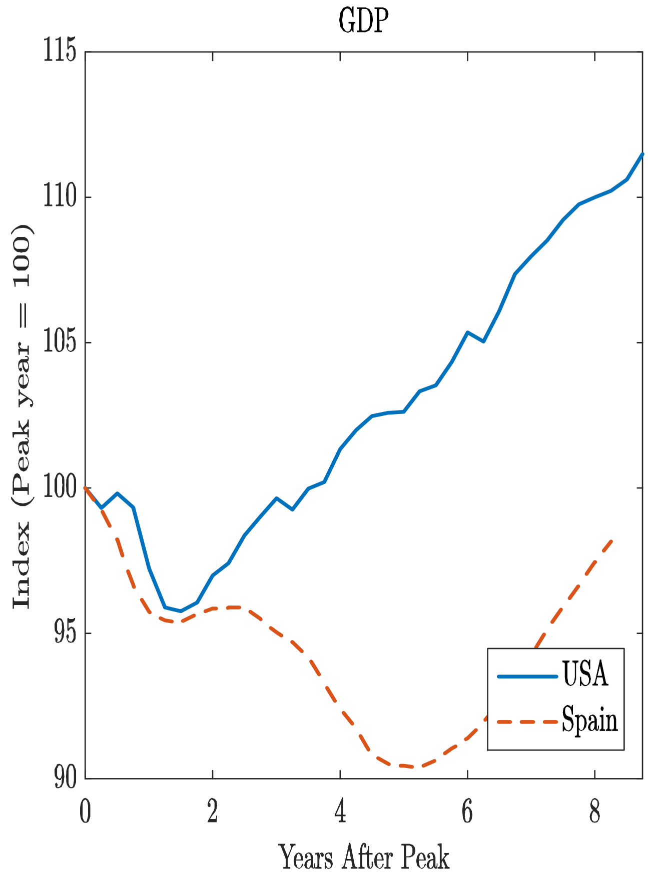

Figure 2. Real Gross Domestic Product in Spain and the U.S. after the 2007-08 Crisis. Source: OECD National Accounts

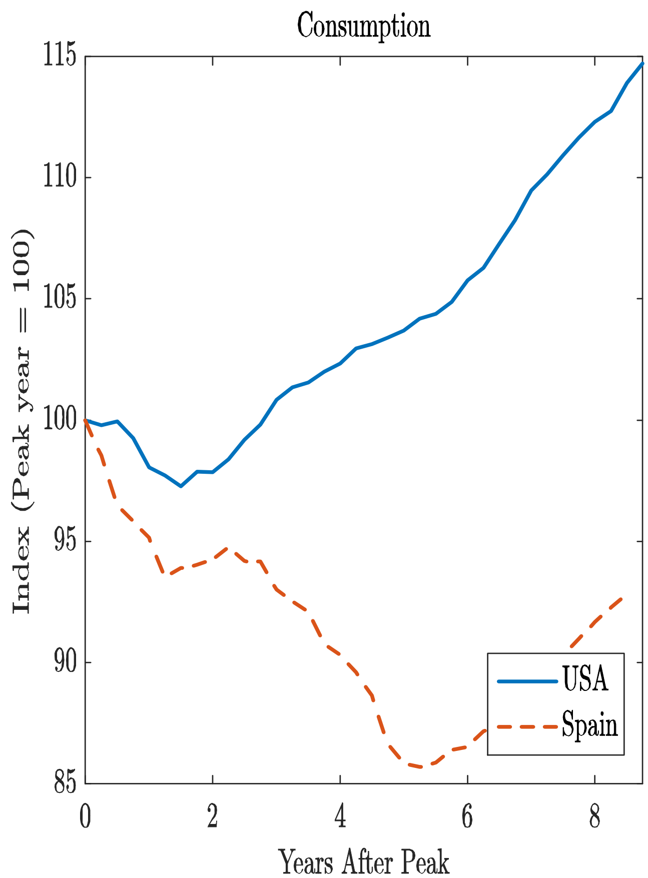

Figure 3. Real Aggregate Consumption in Spain and the U.S. after the 2007-08 Crisis. Source: OECD National Accounts.

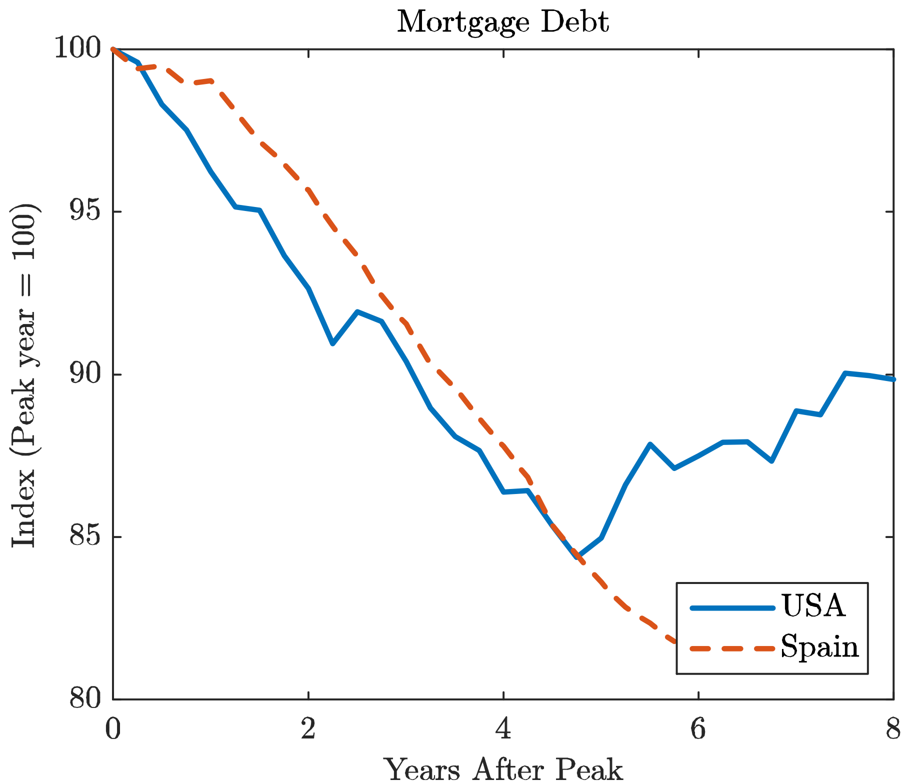

Figure 4. Household Mortgage Debt Balances in Spain and the U.S. after the 2007-08 Crisis. Source: Datastream.

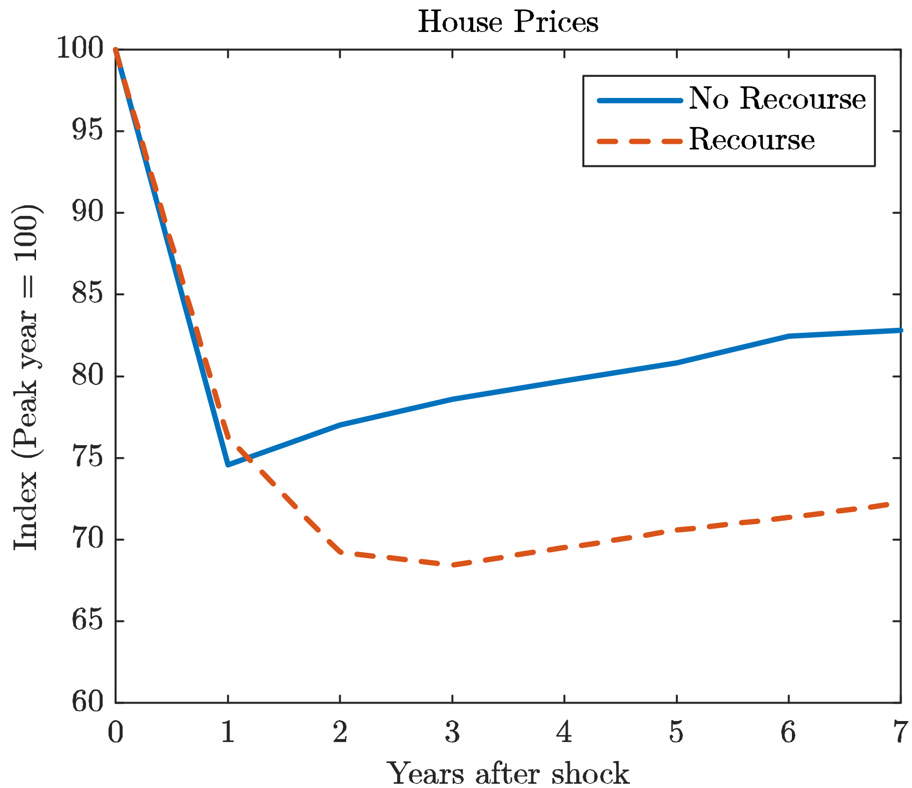

Figure 5. Simulated paths of housing prices in economies with and without recourse for same initial drop.

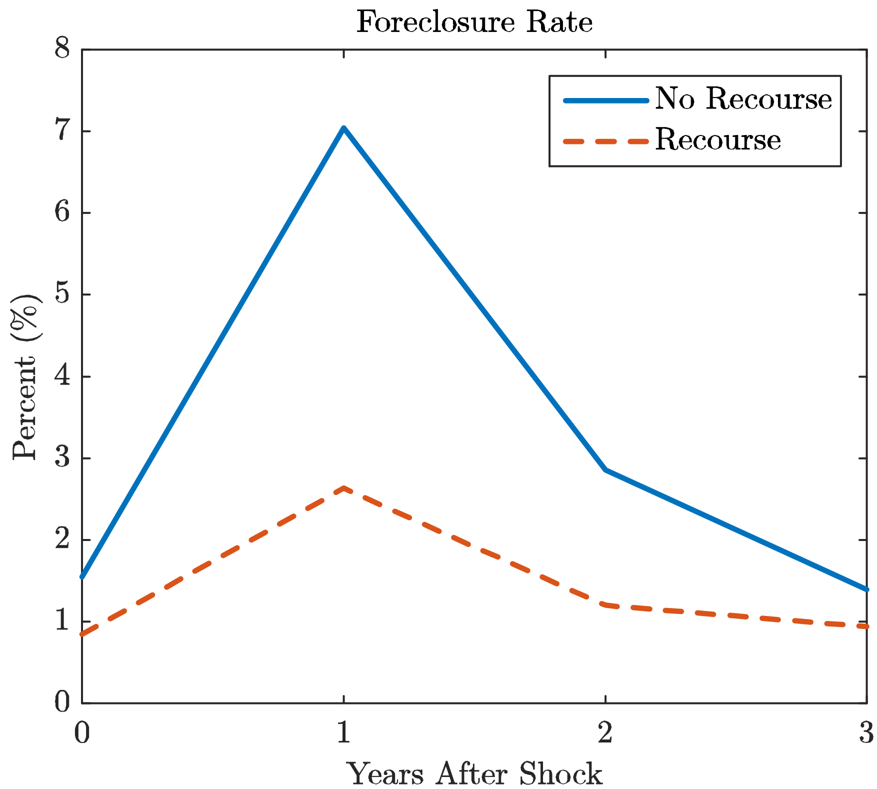

Figure 6. Simulated paths of housing foreclosures with and without recourse for same initial drop of housing prices.

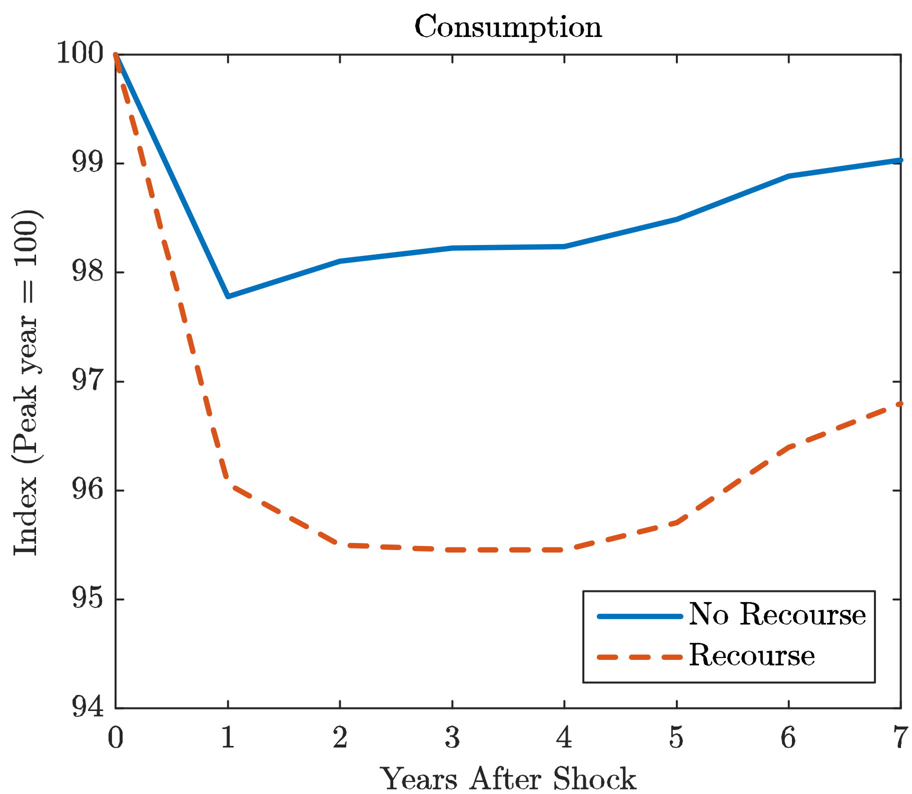

Figure 7. Simulated paths of consumption with and without recourse for same initial drop of housing prices.

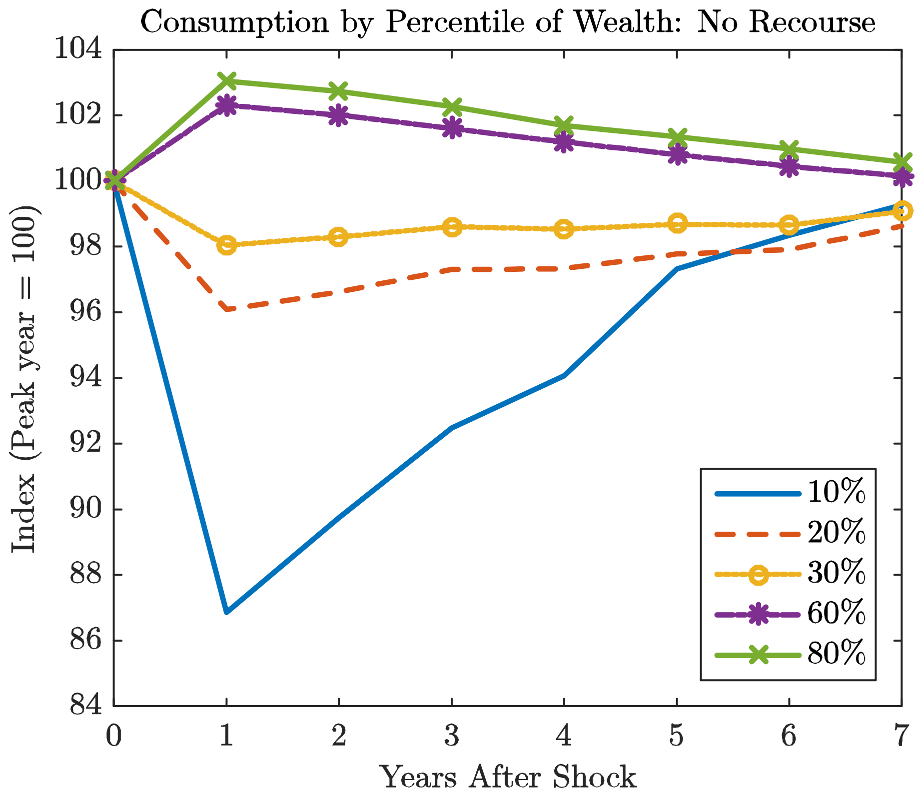

Figure 8. Simulated paths of consumption per wealth percentile in the non-recourse economy.

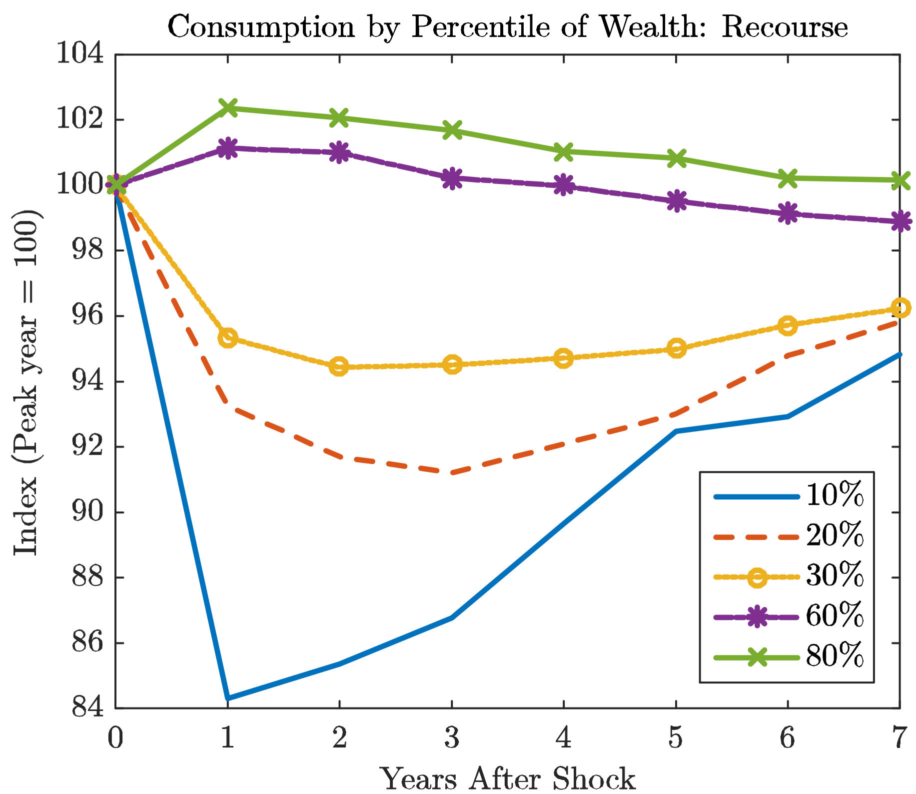

Figure 9. Simulated paths of consumption per wealth percentile in the recourse economy.