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"Macroeconomic Effects of Bankruptcy & Foreclosure Policies"

by

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Abstract

Bankruptcy laws govern consumer default on unsecured credit. Foreclosure laws regulate default on secured mortgage debt. I investigate to what extent differences in foreclosure and bankruptcy laws can jointly explain variation in default rates across states. I construct a general equilibrium model where heterogeneous infinitely-lived households have access to unsecured borrowing and can finance housing purchases with mortgages. Households can default separately on both types of debt. The model is calibrated to match national foreclosure and bankruptcy rates and aggregate statistics related to household net worth and debt. The model can account for 83% of the variation in bankruptcy rates due to differences in bankruptcy and foreclosure law. I find that more generous homestead exemptions raise the cost of unsecured borrowing. Households in states with high exemptions therefore hold less unsecured and more mortgage debt compared to low exemption states, which leads to lower bankruptcy rates but higher foreclosure rates. The model also predicts recourse results in higher bankruptcy rates and a higher coincidence of foreclosure and bankruptcy. I use the model to evaluate how proposed and implemented changes to bankruptcy policy affect default rates and welfare. The 2005 Bankruptcy Abuse Prevention and Consumer Protection Act yields large welfare gains (1% consumption equivalent variation) but results in increases in both foreclosure and bankruptcy rates. I find that implementing the optimal joint foreclosure and bankruptcy policy, which is characterized by no-recourse mortgages and a homestead exemption equal to one quarter of median income, yields modest welfare gains (0.3% consumption equivalent variation).

Keywords: Bankruptcy, Foreclosure, Housing, Default Risk, Household Debt
JEL codes: E21, G11, K35, R21

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1 Introduction

In the United States, households hold two types of debt, secured and unsecured, and they hold large amounts of it, averaging more than 100% of disposable income. There are two channels for defaulting on this debt: bankruptcy for unsecured borrowing and foreclosure for mortgage borrowing. Bankruptcy and foreclosure are common - more than 1.5 million households file for bankruptcy per year and more than 275,000 homes are foreclosed - but vary greatly across states. In this paper I investigate to what extent differences in foreclosure and bankruptcy laws can jointly explain variation in default rates across states. Based on my findings I conduct counterfactual and optimal policy analysis.

Despite being separate legal processes, bankruptcy and foreclosure are closely related: if, in addition to seizing the home, banks can sue households who default on their mortgages, foreclosure may trigger a subsequent bankruptcy. Conversely, bankruptcy may prevent foreclosure by discharging a household's unsecured debt, thereby freeing up income for making mortgage payments. Understanding the interaction between foreclosure and bankruptcy laws is therefore crucial for evaluating how they affect default rates and for guiding policy analysis. In this paper, I focus on the most pertinent aspects of bankruptcy and foreclosure law: the homestead exemption and recourse. When a household files for Chapter 7 bankruptcy, the homestead exemption specifies how much home equity the household can keep after the discharge of unsecured debt. The homestead exemption provides insurance to households, but may affect unsecured debt prices and therefore the composition of the household debt portfolio. When a household defaults on a mortgage it must surrender the house. In addition, in a recourse state the household is also liable for the difference between the recovered value of the house and the face value of the mortgage. No-recourse states provide insurance to homeowners against declines in the value of the house, but may result in higher mortgage interest rates since households can walk away with no additional liability.

In this paper, I analyze theoretically and quantitatively the effects of the homestead exemption and recourse on household default and portfolio decisions. I construct a heterogeneous-agent general equilibrium incomplete markets model. The model has elements in common with the bankruptcy model of Chatterjee et al. (2007) and the foreclosure model of Jeske, Krueger, and Mitman (2010). Households can finance purchases of a risky housing good with mortgages, and can save in bonds or borrow in unsecured debt. Smoothing consumption in the face of uninsured idiosyncratic shocks to income provides households with a motive to borrow or save. Households can default separately on their mortgages and unsecured credit. Households who default on mortgages forfeit their housing collateral. In addition, in recourse states, the difference between the face value of the mortgage and the collateral may be converted into unsecured credit. Households who file for bankruptcy have all unsecured debts discharged and can keep home equity up to the homestead exemption, but are then excluded from filing for bankruptcy for a period of time.

My main theoretical contribution is to characterize how the bankruptcy decision depends on the entire household portfolio. I find that for each combination of unsecured debt, home equity and non-exempt home equity the set of income realizations that triggers bankruptcy is a closed interval (similar to that of Chatterjee et al. (2007)). Crucially, net worth is no longer sufficient for understanding a household's decision to go bankrupt. For a fixed level of net-worth, a household with more home equity is more likely to declare bankruptcy since it stands more to gain from having its unsecured debt discharged. This result is consistent with the empirical findings of Fay, Hurst, and White (2002). In addition, I show that the probability of going bankrupt is decreasing in the amount of non-exempt home equity households hold, as the non-exempt portion is seized in bankruptcy.

Quantitatively, I exploit cross-state variation in law to determine whether that variation can explain the differences in default rates across states. I find that the model can account for 83% of the variation in bankruptcy rates due to differences in law. Overall, the model explains close to 20% of the variance in default rates across states. The model predicts, consistent with state level data, lower bankruptcy rates in states with higher homestead exemptions (see Figure 8). While this result may seem counterintuitive, it highlights the importance of general equilibrium effects and modeling secured and unsecured credit together. More generous exemptions increase the cost of unsecured borrowing for homeowners because of increased default risk. With access to secured borrowing, however, households can substitute secured credit for unsecured by taking on higher leveraged mortgages. In states with higher exemptions the household portfolio is then more heavily weighted in secured debt, resulting in lower bankruptcy rates, but higher foreclosure rates. Recourse states are also predicted to have higher bankruptcy rates and higher coincidence of foreclosure and bankruptcy due to the additional liability that households face from mortgage default.

In the aggregate my model is able to replicate default rates, the relative share of household debt, and median net worth in the US. Average credit spreads on mortgages and unsecured credit are consistent with what is observed in the data. The model is also able to qualitatively match distributional features of debt and housing wealth in the economy. Households with low net worth are net debtors and borrow exclusively in unsecured credit. Households in the second quartile of net worth finance housing purchases with highly leveraged mortgages but hold relatively little unsecured credit. Households with non-exempt home equity take on more unsecured credit and at lower interest rates than households with only exempt home equity. Thus the model is capture that households with more home equity face lower interest rates borrowing in unsecured credit, elucidating how the homestead exemption can affect both bankruptcy and foreclosure rates by affecting the relative prices of the two types of debt and therefore the optimal portfolio that households hold.

I use my calibrated model to quantify the effects a major reform to bankruptcy law: the 2005 Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) that imposed income restrictions on who can file for bankruptcy. First, I investigate the hypothesis of Morgan, Iverson, and Botsch (2009) and Li, White, and Zhu (2010) that the reform contributed to the subsequent observed rise in foreclosure rates. Analyzing the transition induced by the reform, I find that foreclosure rates increase for four years and then converge to a level 0.08 to 0.46 percentage points higher (corresponding to a 15% to 102% proportional increase), with greater increases in recourse states. The increase is driven by households on average taking on more secured debt at higher leverage as compared to before the reform, resulting in higher foreclosure rates. The effect is most pronounced in states with low homestead exemptions, where homeowners had access to relatively cheap unsecured credit before the reform. After the reform, unsecured credit provides little insurance against housing risk, causing fewer households with non-exempt home equity to take on unsecured debt, resulting in debt portfolios more heavily weighted toward mortgage debt. I find that the reform also leads to *higher* bankruptcy rates in all states. Restricting bankruptcy only to households who earn below median income moves the unsecured debt contract closer to an insurance contract against low income realizations. Since income is highly persistent, households with above median income and substantial exempt home equity can take on unsecured debt at relatively low interest rates. In the event of a low income realization, the household can declare bankruptcy and keep the home equity. Households take advantage of this by taking on more debt: along the transition, the fraction of households in debt nearly triples from 5% to almost 15% and aggregate unsecured debt increases by 35%. The model also predicts that post-reform states with higher homestead exemptions will have higher bankruptcy rates, the reverse of the pre-reform relationship. By restricting who can file for bankruptcy, the reform helps mitigate the price effects of higher homestead exemptions. Higher homestead exemptions thus provides more insurance, but have little effect on the default probability because of the exclusion. Despite the increase in default rates, the policy unambiguously increases welfare - households are willing to pay more than 1% of annual consumption to implement the policy.

I also use my calibrated model to quantitatively determine the optimal joint bankruptcy and foreclosure policy from an ex-ante utilitarian welfare perspective. I consider transitional dynamics as it takes a significant amount of time for the economy to respond to changes in default policies. I find that the optimal joint policy is no-recourse foreclosure and a homestead exemption of roughly 25% of the state median income. The intuition for the result is as follows. Households in the economy face two types of risk: income and housing. By preventing recourse, secured debt can more effectively provide insurance against housing risk, since it does not expose households to the risk of also having to go bankrupt. The optimal size of the homestead exemption balances the insurance value of being able to keep home equity after bankruptcy with the increased cost of credit associated with the higher default risk. In the context of the income restrictions enacted in 2005, the negative price effects of higher homestead exemptions are mitigated for high income households, which drives part of the result. Households making less than median income, however, do not benefit as much from the restriction (since income is persistent they will likely be able to declare bankruptcy) and thus prefer lower exemptions. Thus, one quarter of median income balances insurance provision to high income households with borrowing costs for low income households.

1.1 Literature Review

This paper is also related to multiple areas of the literature on incomplete markets and household default. Chatterjee et al. (2007) and Livshits, MacGee, and Tertilt (2007) study economies with savings and competitively priced unsecured debt, with prices depending on loan size and household characteristics. In their models they abstract from a household portfolio of exempt assets and liabilities and only consider the net household position. In my framework I include an exempt housing asset and show that the net position is not sufficient to determine the default decision. I am also able to generate unsecured interest rates consistent with the data and to match distributional facts regarding holdings of unsecured debt. Jeske, Krueger, and Mitman (2010) build an equilibrium model of housing and endogenous leverage choice to study the effects of government subsidies to government sponsored mortgage enterprises, but consider no-recourse mortgages and do not model unsecured debt. Hintermaier and Koeniger (2009) analyze optimal debt portfolios in a lifecycle model of durable and non-durable consumption, but without the possibility of mortgage default.

Another strand of the literature has separately investigated the effects of homestead exemptions and recourse law. Gropp et al. (1997) find that in states with higher homestead exemptions households with lower wealth are more likely to be denied auto loans. Pavan (2008) shows that higher bankruptcy exemptions discourage the accumulation of durables, and Li and Sarte (2006) examine the general equilibrium effects of changes to homestead exemptions. Ghent and Kudlyak (2009) estimate that recourse laws significantly reduce the probability of foreclosure.

The paper is organized as follows. In Section 2, I describe the model economy. In Section 3, I provide theoretical characterizations of household decisions and endogenous prices. The calibration procedure and the relevant data targets are presented in Section 4. The characteristics of the calibrated economy are discussed in Section 5. I discuss the results of my policy experiments in Section 6. Finally, I conclude in Section 7.

2 Model

2.1 Economic Environment

I consider each state as a small, open, endowment economy, populated with a measure one continuum of households, a measure one continuum of financial intermediaries and a measure one continuum of real estate construction companies. Time is modeled discretely and all agents are infinitely lived.

There are two goods in the economy, a composite consumption good c and a housing good g. The housing good is produced according to a linear aggregate production function that converts the consumption good one-for-one into the housing good, $G_t = C_t$. Housing faces stochastic depreciation shocks δ, drawn from CDF $F(\delta)$. Each unit of the housing good generates a unit flow of housing services, h. Housing services are tradeable at a price P_h relative to the consumption good.

2.2 Households

Each period households receive an idiosyncratic endowment of the consumption good y_t. The endowment is assumed to follow a stochastic process consisting of a persistent and a transitory component, $y_t = i_t\varepsilon_t$, where i_t follows a finite-state Markov chain with transition probabilities $\pi(i_{t+1}|i_t)$ and invariant distribution $\Pi_0(i)$ and ε_t is a mean one transitory shock with cumulative distribution function $P(\varepsilon)$. The initial measures of households with persistent shocks i are assumed to be drawn from the invariant distribution and a law of large numbers is assumed to hold, such that the initial measures of types are equal to those of the invariant distribution.

Households derive period utility $U(c, h)$ from consumption and housing services and discount the future with parameter β. Households' expected lifetime utility is given by:

$$\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t U(c_t, h_t) \right\}$$

Households can save or borrow unsecured by purchasing one-period bonds with face value b', with negative values interpreted as unsecured loans. The price of a bond with face value b' can be a function of all observable household characteristics as well as goods and asset choices and is denoted $P_b(\cdot)$. In my timing conventing $b' \times P_b(b', \cdot)$ represents the resources today that must be paid today to receive b' tomorrow.

Households can finance housing purchases with mortgages with face value denoted m'. The mortgage is secured by the housing good owned by the household, and the price can be a function of all observable household characteristics as well as goods and asset choices and is denoted $P_m(\cdot)$. I assume that neither households nor financial intermediaries can commit to long term mortgage contracts. A mortgage therefore is a contract to receive $m' \times P_m(m', \cdot)$ units of the consumption good in the current period and to repay m' in the subsequent period. Households are restricted from engaging in lending contracts amongst themselves: only financial intermediaries are allowed to issue lending contracts.

2.3 Legal Environment

2.3.1 Foreclosure

Households have the option to default on mortgages after the realization of the housing depreciation shock and the subsequent period's endowment. When a household defaults the depreciated housing collateral is seized via a foreclosure technology. If the depreciated housing collateral exceeds the face value of the mortgage, the excess is returned to the household, i.e. the household receives $\max\{\gamma(1-\delta')g' - m', 0\}$, where m', g' are the mortgage and house size before the default decision respectively, δ' is the realized depreciation shock, and $\gamma \leq 1$ represents the foreclosure technology. There is also a deficiency judgment technology. If the housing collateral (after depreciation and foreclosure) is less than the face value of the mortgage, the difference is converted into unsecured debt with probability

ψ:

$$\tilde{b}' = \begin{cases} b' + (\gamma(1-\delta')g' - m') & \text{w/prob } \psi \\ b' & \text{w/prob } 1-\psi \end{cases}$$

with $\psi \in [0,1]$.

2.3.2 Bankruptcy

Bankruptcy is modeled after Chapter 7 bankruptcy law. The level of the state homestead exemption is denoted by χ^s. The bankruptcy decision is made after the foreclosure decision and the realization of any deficiency judgment. The timing convention of deciding bankruptcy after foreclosure is chosen to preclude the possibility of the household having an empty budget set after the default decisions. If a household declares bankruptcy, in the subsequent period the following happens:

1. Secured credit is repaid
2. Households can keep remaining home equity up to the exemption
3. Any remaining home equity is applied to unsecured debt
4. Unsecured debt is set to 0
5. Households cannot accumulate bonds
6. Households cannot change their home equity balance
7. Households are in the bankruptcy credit history state

The restrictions on savings and home equity come from the process of liquidation and exemptions. Households can sell their homes in bankruptcy and keep the exempt equity only if they use or intend to use that equity to purchase another home. In some states, e.g. Florida and Texas, exempt equity proceeds from the sale of a home must be placed into a homestead account until the new homestead is purchased.

Households exit the bankruptcy state after one period and enter the bad credit history state. Households with bad credit histories are excluded from unsecured borrowing and cannot declare bankruptcy, but they are not excluded from the mortgage market. Further, households with bad credit histories receive a proportional consumption penalty λ to represent the increased difficulty of getting a cell phone or a lease, for households with a bankruptcy on a credit record. A household's credit history changes to a good history with probability α and remains bad with probability $1-\alpha$.

2.4 Household Decision Problem

Households can be in one of three credit history states, $\mathcal{H} = \{G, D, B\}$, G represents a good credit history, D the bankruptcy default state and B represents having a bad credit history. Let $a \in \mathbb{R}$ denote cash at hand, the net resource position of the household at the beginning of the period. The cash at hand consists of the period endowment, and the receipts and obligations from assets purchased in the previous period. When a household has a good or bad credit history, its state can be summarized by the credit history, cash at hand and persistent income shock (s, a, i). When a household is in the bankruptcy state the household needs to separately know its period endowment and any positive home equity it may have. Let η denote non-negative home equity, $\eta = \max\{g(1-\delta) - m, 0\}$. Let $X' = (b', g', m', y', \gamma', \delta', i')$ denote the portfolio choice and shock realizations for the household. The dynamic programming problem of the household can be written as follows:

An agent who begins the period with a good credit history, has lifetime utility given by:

$$v^G(a,i) = \max_{c,h,m',g'\geq 0,b'} \left\{ U(c,h) + \beta \sum_{i'} \pi(i'|i) \iint_{\delta'\ y'} \max\left\{ w_G^F(X'), w_G^{NF}(X') \right\} dF(\delta') dP(y'|i') \right\} \quad (1)$$

$$\text{subj. to} \quad c + P_h h + [1 - P_h] g' - m' P_m(b', g', m', i, G) + b' P_b(b', g', m', i, G) \leq a$$

where:

$$w_G^{NF}(X') = \max \left\{ \begin{array}{c} v^G(b' + (1-\delta')g' - m' + y', i'), \\ v^D\left(\min\left\{\chi^s, \max\left\{0, (1-\delta')g' - m'\right\}\right\}, y', i'\right) \end{array} \right\}$$

is the value of not declaring foreclosure (and depends on the subsequent bankruptcy choice), and

$$w_G^F(X') = \left\{ \begin{array}{c} \psi \max \left\{ \begin{array}{c} v^G\left(b' + \gamma g'(1-\delta') - m' + y', i'\right), \\ v^D\left(\min\left\{\max\left\{0, \gamma g'(1-\delta') - m'\right\}, \chi^s\right\}, y', i'\right) \end{array} \right\} + \\ (1-\psi) \max \left\{ \begin{array}{c} v^G\left(b' + \max\left\{\gamma g'(1-\delta') - m', 0\right\} + y', i'\right), \\ v^D\left(\min\left\{\max\left\{0, \gamma g'(1-\delta') - m'\right\}, \chi^s\right\}, y', i'\right) \end{array} \right\} \end{array} \right\}$$

is the value of declaring foreclosure, and depends on the stochastic deficiency judgment and the bankruptcy choice following the realization of any deficiency. Notice that the timing is such that the housing services generated by the house g' can be traded in the same period it is purchased.

An agent who declared bankruptcy at the end of the previous period has lifetime utility given by:

$$v^D(\eta, y, i) = \max_{c,h,m',g' \geq 0} \left\{ U(c,h) + \beta \sum_{i'} \pi(i'|i) \iint_{\delta' \; y'} \max\left\{w_D^F(X'), w_D^{NF}(X')\right\} dF(\delta')dP(y'|i') \right\} \tag{2}$$

$$\text{subj. to} \quad c + P_h h = y$$
$$[1 - P_h]g' - m'P_m(0, g', m', i, D) = \eta$$

where:

$$w_D^{NF}(X') = v^B(y' + (1-\delta')g' - m', i')$$
$$w_D^F(X') = \psi v^B\left(y' + \gamma(1-\delta')g' - m', i'\right) + (1-\psi)v^B\left(y' + \max\left\{\gamma g'(1-\delta') - m', 0\right\}, i'\right)$$

are the values for choosing foreclosure and not choosing foreclosure, respectively. Note that now there is no option to declare bankruptcy after the foreclosure choice.

Finally, the lifetime utility of an agent with a bad credit history is given by:

$$v^B(a, i) = \max_{c,h,m',g',b'} \left\{ U(c,h) + \beta \sum_{i'} \pi(i'|i) \iint_{\delta' \; y'} \left[\begin{array}{c} \alpha \max\left\{w_B^F(X'), w_B^{NF}(X')\right\} + \\ (1-\alpha)\max\left\{w_D^F(X'), w_D^{NF}(X')\right\} \end{array} \right] dF(\delta')dP(y'|i') \right\} \tag{3}$$

$$\text{subj. to} \quad \lambda(c + P_h h) + [1 - P_h]g' - m'P_m(b', g', m', i, B) + b'P_b(b', g', m', i, B) \leq a$$

where:

$$w_B^{NF}(X') = v^G\left(b' + g'(1-\delta') - m' + y', i'\right)$$
$$w_B^F(X') = \psi v^G\left(b' + \gamma g'(1-\delta') - m' + y', i'\right) + (1-\psi)v^G\left(b' + \max\left\{\gamma g'(1-\delta') - m', 0\right\} + y', i'\right)$$

and $w_D^F(X')$ and $w_D^{NF}(X')$ are defined as above.

If households are indifferent between either going bankrupt or not, it is assumed they do not go bankrupt. If households are indifferent between foreclosing or not foreclosing it is assumed they foreclose if they have negative equity and do not foreclose if they have positive equity. The value functions for agents with good and bad credit histories v^G and v^B may not be well defined as written. Since cash at hand can be negative, it is possible that there are no feasible choices (b', g', m') that result in non-negative consumption (c, h). In that case, households declare bankruptcy and receives no consumption for the period.

The solutions to these three coupled Bellman equations imply binary decision rules for foreclosure and bankruptcy, $f^*(X', s)$ and $d^*(X', J)$, respectively, (where a value of 1 implies default) where $J = 1$ if the household declared foreclosure and received a deficiency judgment. In addition, the solutions also imply policy rules for housing, mortgage and bond choice.

2.5 Financial Intermediaries

Banks can borrow at the risk-free interest rate, denoted r_b, which they take as given. Issuing debt, both secured and unsecured, is costly because of administrative and screening costs. To capture these costs, I impose a real resource cost r_a for issuing each unit of a mortgage or negative face value bond. Thus, the effective cost of financing one unit of debt is $r_b + r_a$. It is assumed that agents simultaneously apply for mortgages and unsecured loans and that banks can observe the portfolio choices b', g', m', persistent state i and the credit history. The banking sector is competitive, and banks are assumed to make zero expected profit loan-by-loan (as in Chatterjee et al. (2007) and Jeske, Krueger & Mitman (2010)). Specifically, cross-subsidization is not allowed across agents nor across loan types. Restricting the contract space to exclude subsidization across loan types is motivated by the legal difficulties in designing and enforcing a joint unsecured-secured debt contract. The zero-profit assumption allows me to analyze the mortgage and bond problems separately.

2.5.1 Mortgage Problem

The price for a mortgage depends on the foreclosure and bankruptcy decision rules of the household. Banks have access to foreclosure and deficiency judgment technologies as described in Section 2.3.1. The price of a mortgage of size m' to purchase a house of size g' will reflect all of the expected possible outcomes. If the household forecloses on a mortgage with face value m' used to purchase a house of size g', the bank recovers the depreciated value of the house processed through the foreclosure technology, $\gamma g'(1 - \delta')$. In addition, with probability ψ the bank wins a deficiency judgment, $m' - \gamma g$, but only recovers the value if the household does not file for bankruptcy. If a household goes bankrupt, the bank can recover any bonds held by the household[1]. Therefore, in general,

[1] The seizure of bonds is assumed to be efficient to represent the fact that secured debt is treated as senior debt in bankruptcy, and thus is paid before fees and administrative costs

the price of a mortgage will depend on all the observable characteristics of the household and the choice bonds/unsecured, debt in addition to m' and g'. The typical bank will only issue mortgage contracts with a return greater than or equal to the cost of funds:

$$m'P_m(g', m', b', i, G) \leq \frac{1}{1 + r_b + r_a} \times \tag{4}$$
$$\mathbb{E}_{\delta', y', i'|i} \left[\begin{array}{c} m' \left[(1 - f^*(X')) + f^*(X')\psi(1 - d^*(X', 1)) \right] + f^*(X')\psi d^*(X', 1) \max\{b', 0\} \\ + \{\gamma g'(1 - \delta') \left[f^*(X') \left((1 - \psi) + \psi d^*(X', 1) \right) \right] \} \end{array} \right]$$

A household in the bankruptcy or bad credit state cannot declare bankruptcy, and thus the mortgage price is characterized as above, but with $d^*(\cdot) = 0$. For a household with a bad credit history, the price also takes into account that the foreclosure decision is made after the realization of whether the household will enter the subsequent period with a good credit history, so there is an additional expectation. The conditions for the typical bank to issue a mortgage for those two cases can be found in the Appendix.

2.5.2 Unsecured Credit Problem

The price of a bond with negative face value b' depends on the household's default probability and its non-exempt assets. If a household declares bankruptcy and has home equity in excess of the homestead exemption χ^s the bank can recover a fraction of it. Let ξ' denote the non-exempt portion of a household's home equity, namely $\xi' = \max\{g'(1-\delta') - m' - \chi^s, 0\}$. Through the bankruptcy technology, the bank can recover $\max\{|b'|, \zeta\xi'\}$ from a household that declares bankruptcy, where $\zeta \leq 1$ represents the bankruptcy recovery technology. The bank will only issue unsecured debt if the expected return is greater than the cost of funds:

$$b'P_b(b', g', m', i) \geq \frac{1}{1 + r_b + r_a} \mathbb{E}_{\delta', y', i'|i} \left[b' \left[1 - d^*(X', J) \right] + d^*(X', J) \max\{b', -\zeta\xi'\} \right] \tag{5}$$

When households are saving,$b' \geq 0$, P_b represents the price of buying a bond that pays b' units of consumption good tomorrow. Now there is no default risk, so the bank will sell bonds as long as the discounted face value is less than the funds received today:

$$b'P_b(b', g', m', i) \geq \frac{1}{1 + r_b} \tag{6}$$

which from the zero profit condition immediately implies that $P_b(b', g', m', i) = \frac{1}{1+r_b}$ when $b' \geq 0$.

2.6 Equilibrium Definition

The pair (ψ, χ^s) summarizes the legal environment for state s. Each state is treated as a small open economy for the purpose of the bond and mortgage market, therefore the risk-free rate is given and the bond and mortgage markets need not clear. The housing market is closed, reflecting the fact that housing services must be consumed in the same geographic location as the housing good.[2]. Let μ denote the cross sectional distribution of households over the credit history, cash at hand, income and home equity. I am interested in a stationary recursive equilibrium.

Definition Given ψ, χ^s, a Stationary Recursive Competitive Equilibrium are:

- Value and policy functions for households, $\{v^s, c^s, h^s, b'^s, m'^s, g'^s : \{G, B\} \times \mathbb{R} \times I \to \mathbb{R}\}$, $\{v^D, c^D, h^D, m'^D, g'^D : \mathbb{R}_+ \times Y \times I \to \mathbb{R}\}$
- Default value functions $\left\{w : \mathcal{H} \times \mathbb{R}^3 \times [\underline{\delta}, 1] \times Y \times I \to \mathbb{R}\right\}$ and default decision rules $\left\{f^* : \mathcal{H} \times \mathbb{R}^3 \times [\underline{\delta}, 1] \times Y \times I \to \{0,1\}\right\}$ and $\left\{d^* : \mathbb{R}^3 \times [\underline{\delta}, 1] \times Y \times I \times \{0,1\} \to \{0,1\}\right\}$
- Price P_h, the interest rate r_b, pricing functions $\{P_m : \mathcal{H} \times \mathbb{R}^3 \times I \to \mathbb{R}_+\}$ and $\{P_b : \mathbb{R}^3 \times I \to \mathbb{R}_+\}$
- An invariant distribution μ^*

such that:

1. **Households Maximize:** Given prices and the pricing functions, the value functions solve (1)-(3), and c, h, b', m', g' are the associated policy functions, and d^*, f^* are the associated default rules.
2. **Zero Profit Mortgages:** Given f^*, d^* and r_b, P_m makes (4) hold with equality
3. **Zero Profit Unsecured Debt:** Given d^* and r_b, P_b makes (5) hold with equality
4. **Zero Profit Bonds:** $P_b = \frac{1}{1+r_b}$ when $b' \geq 0$.
5. **Rental Market Clearing:** $\int g' d\mu = \int h d\mu$
6. **Invariant Distribution:** The distribution μ^* is invariant with respect to the Markov process induced by the exogenous Markov process π and the policy functions m', g', b', d^*, f^*

[2]An alternative would be to define the economy with all states simultaneously and require market clearing in bonds and debt across states. The assumption of treating each state as a small open economy is made to maintain computational feasibility of the model

In order to evaluate the effects of different foreclosure and bankruptcy policies, as well as the 2005 reform I need to define a measure of welfare. I adopt a Utilitarian social welfare function defined as:

$$\mathbf{V}^* = \int v d\mu^* \tag{7}$$

3 Theoretical Results

3.1 Household Problem

I can simplify the household problem because of the static intra-temporal substitution between consumption and housing services. Thus, in the household problem define:

$$\begin{aligned} u(c; P_h) &= \max_{\tilde{c}, h \geq 0} U(\tilde{c}, h) \\ & \quad s.t. \\ \tilde{c} + P_h h &= c \end{aligned}$$

3.1.1 Existence of a Solution

In order to prove the existence of a solution to the household problem, I need to make an assumption on preferences and on the assets traded. I assume that the utility function is unbounded from below and bounded above, which guarantees that a household will always prefer to go bankrupt to having zero consumption in a given period. Second, in order to rule out Ponzi schemes, I assume maximum levels of borrowing for unsecured debt and mortgages. Under these assumptions, which are formalized in the appendix, a solution to the household problem exists. Further, consistent with the penalties associated with bankruptcy, a household with a bad credit history *ceterus paribus* has lower lifetime utility than one with a good credit history.

Proposition 1 Existence of a Solution to the Household Problem

(1) The household value functions v exist and are unique; (2) The value functions are bounded, increasing in a, v^D is strictly increasing in y; (3) A bad credit score reduces utility, i.e. $v^G(a,i) \geq v^B(a,i)$

The proof of the existence of a solution to the household problem follows from standard contraction mapping arguments. The details of all proofs can be found in the Appendix.

3.1.2 The Bankruptcy Decision

As one of the novel features of this paper is including the possibly non-exempt housing asset and mortgage default features of this paper, it is instructive to characterize how housing, foreclosure, and the homestead exemption affect the household bankruptcy decision. Since the bankruptcy decision is made after the foreclosure decision and realization of deficiency judgments I can characterize the bankruptcy decision in terms of a *bankruptcy set* $\overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$, where $\tilde{b}'$ is unsecured credit after deficiency judgments, η' is home equity, and ξ' is non-exempt home equity. The bankruptcy set is the set of realizations of the endowment y for which the household finds it optimal to declare bankruptcy as opposed to repaying $\tilde{b}'$. The bankruptcy set depends on those for variables alone because they capture the benefits of bankruptcy (the discharge of unsecured debt $\tilde{b}'$ and preservation of exempt equity $\eta' - \xi'$) as well as the costs (the loss of non-exempt equity ξ').

Proposition 2 Bankruptcy Characterization
Conditional on the foreclosure choice f^*:

(a) *For any values of unsecured debt $\tilde{b}'$, home equity η', and non-exempt home equity ξ', if the bankruptcy set is non-empty it is a closed interval, i.e. $\overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i') = [\underline{y}^B, \bar{y}^B]$, or $\overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i') = \emptyset$.*

(b) *The bankruptcy set expands with indebtedness $\tilde{b}'$, i.e. $\overline{\mathcal{B}}^*(\tilde{b}'_1, \eta', \xi', i') \subseteq \overline{\mathcal{B}}^*(\tilde{b}'_2, \eta', \xi', i')$ for $\tilde{b}'_2 < \tilde{b}'_1$.*

The proposition is illustrated graphically in Figure 2. The lifetime utility of not defaulting as a function of endowment is represented by the solid curve and the value of going bankruptcy plotted in the lower dashed curve. The strict concavity of the utility function guarantees that if the curves intersect, their intersection will form a closed set. The intuition for this result is that households with very low endowment realization prefer to take on more debt and consume more in the current period than they would if they declared bankruptcy. Households with high endowments prefer to maintain access to credit, and thus pay off the debt but may consume less than if they had declared bankruptcy. Unlike Chatterjee et al (2007), the default decision does not depend solely on the net asset position of the household: home equity and exemptions affect the bankruptcy decision.

Proposition 3 Home Equity, Exemptions and Bankruptcy

(a) *The bankruptcy set contracts in non-exempt home equity ξ', i.e. $\overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi'_1, i') \subseteq \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi'_2, i')$, for $\xi'_2 < \xi'_1$.*

(b) *Holding net assets constant (i.e. fixing $\eta' + \tilde{b}'$) the bankruptcy set is expanding in home equity, i.e.* $\overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i') \subseteq \overline{\mathcal{B}}^*(\tilde{b}' - x, \eta' + x, \xi', i')$ *for* $x > 0$. *Or equivalently, the bankruptcy set is increasing in the difference of home equity and debt* $\eta' - \tilde{b}'$.

(c) *When there is no homestead exemption, i.e.* $\chi^s = 0$, *the bankruptcy set only depends on the net asset position* $\eta' + \tilde{b}'$ *and the persistent income state* i'.

(d) *The bankruptcy set is empty if net assets exceed the homestead exemption, i.e. if* $\eta' + \tilde{b}' > \chi^s$, *then* $\overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i') = \emptyset$.

Non-exempt home equity decreases the probability of bankruptcy. Intuitively, as the household holds more non-exempt home equity the cost of going bankrupt in terms of lost housing wealth is increasing, but the benefit of going bankruptcy is constant. Thus, the set of endowment realizations for which the household goes bankruptcy contracts. Having a substantial amount of non-exempt home equity effectively increases the punishment of going bankrupt. This will be an important mechanism for understanding the general equilibrium price effects generated in the quantitative analysis.

The household portfolio composition is also important for understanding the bankruptcy decision. For a given net asset position having more home equity increases the chance of bankruptcy. This result is illustrated graphically in Figure 2. The solid line represents the value of repaying under both scenarios. Keeping the net asset position fixed but changing its composition does not affect the value of repaying, since after repayment the relevant state variable for the household is the consolidated asset position. The value of going bankruptcy is illustrated in the two dashed lines. The two lines represent the same net position, but the higher line is a household with more home equity and more unsecured debt. Since the household now has more home equity which can be preserved in bankruptcy, the lifetime utility of going bankrupt increases and therefore the set of endowment values for which the household goes bankruptcy expands.

3.1.3 The Foreclosure Decision

Modeling secured and unsecured debt together is one of the key innovations of this paper, so it will be useful to establish how the household will decide whether to foreclose and how that relates to the subsequent bankruptcy decision. The decision to foreclose and how it is related to bankruptcy will depend crucially on the probability of a deficiency judgment, ψ. In order to understand how ψ controls the complementarity between foreclosure and bankruptcy, first I characterize when households repay their mortgages for sure. Since the housing market is frictionless, if the foreclosure technology is inefficient ($\gamma < 1$), households will always repay their mortgages if the depreciated value of the house is greater than the face value of the mortgage. This is formalized in Lemma 1.

Lemma 1 *If the foreclosure technology is inefficient, $\gamma < 1$, $f^*(b', g', m', \delta', y', i', s) = 0$ for all b', i', s, and y' when $g'(1 - \delta') \geq m'$.*

For two special cases the foreclosure decision follows a cutoff rule in the depreciation shock δ'. If banks cannot obtain deficiency judgments (no-recourse, $\psi = 0$), households will choose to foreclose on their mortgages whenever they have negative equity. Since households face no additional cost of foreclosure, it is always optimal to "walk away." Thus, under no-recourse Lemma 1 becomes and if and only if statement - households only repay their mortgage when the value of the house exceeds the value of the mortgage (formalized in Lemma 2). In no-recourse states, therefore, the foreclosure decision is independent of bond position or income of the household making the foreclosure and bankruptcy essentially independent decisions.

Lemma 2 *If there is no recourse, $\psi = 0$, the foreclosure decision follows a cutoff rule in δ', i.e. there exists $\delta^*(g', m')$ such that $f^*(b', g', m', \delta', y', i', s) = 1$ for all $\delta' \geq \delta^*(g', m')$ and 0 otherwise for all b', y', i', s. Further, the cutoff depends only on the leverage $\kappa' = \frac{m'}{g'}$, and $\delta^*(\kappa') = 1 - \kappa'$.*

Consider now the other extreme, one where deficiency judgments always occur, $\psi = 1$. If the foreclosure technology is inefficient, a household will either repay or foreclose and go bankrupt:

Lemma 3 *If deficiency judgments always occur, $\psi = 1$, the foreclosure decision follows a cutoff rule in δ', which in general will depend on b', g', m', y', i'. Further, any household with a good credit history that chooses foreclosure will subsequently choose bankruptcy. Households in the bankruptcy or bad credit will optimally choose b', g', m' such that foreclosure is never optimal.*

If foreclosure is inefficient, the household can repay by paying $m' - (1 - \delta')g'$ or choose foreclosure and have additional unsecured debt $m' - \gamma(1 - \delta')g'$. If the household does not subsequently go bankrupt, it will always prefer to repay, since it yields a higher net asset position. Therefore, whenever the household forecloses it will subsequently go bankruptcy to erase the deficiency.

Lemmas 2 & 3 show that in the limiting cases of ψ the foreclosure decision follows a cutoff rule. In addition, ψ partially controls the complementarity between foreclosure and bankruptcy: when $\psi = 0$ the foreclosure decision is independent of the subsequent bankruptcy decision, but when $\psi = 1$ foreclosure always results in bankruptcy.

Conjecture 1 *If the foreclosure technology is inefficient, $\gamma < 1$, the foreclosure decision follows a cutoff rule in δ'.*

In all computed equilibria the foreclosure decision follows a cutoff rule in δ'.

3.2 Financial Intermediaries

Characterizing the intermediary pricing of mortgages and unsecured credit is limited by my ability to characterize the household foreclosure decision. However, the sharp characterization of the foreclosure decision when there is no recourse ($\psi = 0$) admits useful characterizations of the mortgage and unsecured debt prices.

3.2.1 Unsecured Debt Prices

When there is no recourse, the foreclosure decision is independent of the level of unsecured debt and the bankruptcy decision. From Proposition 2, since the bankruptcy set is expanding in indebtedness, the price of unsecured debt will be decreasing in indebtedness. Further, from Proposition 3, if there is no homestead exemption, the bankruptcy set depends only on the net asset position. Since the net asset position is increasing in the size of the house and decreasing in the size of the mortgage, unsecured debt prices will increase in house size and decrease in mortgage size. Recall that because of the timing convention, decreasing prices P_b are equivalent to increasing implied interest rates. Formally:

Lemma 4 *If there is no recourse ($\psi = 0$):*

1. $b \leq \hat{b}$ *implies* $P_b(b, g', m', i, G) \leq P_b(\hat{b}, g', m', i, G)$.
2. *If in addition the homestead exemption is zero,* $\chi^s = 0$*:*
   (a) $g \leq \hat{g}$ *implies* $P_b(b', g, m', i, G) \leq P_b(b', \hat{g}, m', i, G)$
   (b) $m \geq \hat{m}$ *implies* $P_b(b', g', m, i, G) \leq P_b(b', g', \hat{m}, i, G)$

3.2.2 Mortgage Prices

Using Lemma 2, if there is no recourse, mortgage prices have a closed form solution. Using the zero-profit condition for competitive banks and equation (4), I conclude mortgages are priced exclusively based on leverage κ':

$$P_m(g', m', b', i, s; \psi = 0) = \frac{1}{1 + r_b + r_a}\left\{F(\delta^*(\kappa')) + \frac{\gamma}{\kappa'}\int_{\delta^*(\kappa')}^{1}(1-\delta')dF(\delta')\right\}$$
$$= P_m(\kappa'; \psi = 0)$$

where κ' and $\delta'^*(\kappa')$ are defined as in Lemma 3. Note that $P_m(\kappa')$ is strictly decreasing in κ', thus mortgage interest rates are increasing in leverage κ'. The interest rates are increasing to reflect the increasing risk of foreclosure. In no-recourse states the mortgage interest rates are independent of the credit history of households, since the bankruptcy decision has no effect on the ability of the bank to recover the housing collateral in the case of foreclosure.

The mortgage price function and Lemma 4 imply that when there is no recourse and no homestead exemption ($\psi = 0$ and $\chi^s = 0$) there is an endogenous maximum leverage.

Lemma 5 *If $\psi = 0$, $\chi^s = 0$ and $F(\delta)$ is C^2 and log-concave, there exists an endogenous maximum leverage κ^*. That is, it is optimal for a household to choose leverage $\kappa \leq \kappa^*$.*

The intuition is that for a fixed choice g, by increasing the household's leverage the household can increase receipts today up to a maximal point. And since increasing leverage weakly decreases assets in all states tomorrow, it is never optimal to choose a higher leverage than the point that maximizes receipts today.

4 Calibration

The goal of the calibration is to validate that the model can account for aggregate facts related to both secured and unsecured borrowing, foreclosure, and bankruptcy. In order to capture the heterogeneity in state law but still match national level data I treat each state as a small open economy and aggregate state-level moments. I allow states to vary only in the homestead exemption χ^s, whether there is recourse ($\psi > 0$, and the level of median income, keeping technology and preference parameters constant across states. For each trial of technology and preference parameters, the model needs to be solved for every combination of homestead exemption and recourse, χ^s and ψ. To balance richness in variation with computational feasibility, I restrict the current calibration to consider seven configurations of the homestead exemption and recourse law. I refer to the seven state economies as Washington, California, Minnesota, Maryland, Michigan, Massachusetts and Florida. However, for each state economy I use as the homestead exemption the weighted average of several states that have laws similar to the four mentioned above. The relative weight of the seven economies in calculating aggregate statistics is determined by the relative proportion of households from those states. Similarly, I construct the median household income for each of the seven states by weighted average. The state policy parameters are summarized in Table 1.

The values for the homestead exemption χ^s are constructed from state laws and state-level median household income estimates from the Current Population Survey published by the U.S. Census Bureau. The values used for the homestead exemption and income are taken from the year 2000 (see Appendix C for details). For each state, median income is normalized to 1, so χ^s is in units of state median income. For example, median household income in Pennsylvania was $40,106, with an exemption of $30,000 for couples, yielding a $\chi^{PA} = 0.75$.

Good data on deficiency judgments do not exist, so I take the value of ψ as a parameter to calibrate. Li and White (2009) analyze a sample of prime and sub-prime mortgages and find that roughly 18% of prime and 72% of sub-prime mortgages that are foreclosed eventually end up in bankruptcy. In 2004, sub-prime mortgages accounted for roughly 18% of the mortgage market, thus roughly 28% of households who have foreclosure proceedings initiated against them also file for bankruptcy. I take this value as my target for calibrating ψ.

In addition to state-specific laws regarding bankruptcy, the legal environment is described by α and λ, the parameters governing how long a household has a bad credit record and the consumption penalty, respectively. By law, households cannot file for Chapter 7 bankruptcy twice in any six year period. The Fair Credit Reporting Act stipulates that bankruptcy filings cannot remain on a household's record for more than 10 years. Since one period in the model represents a year, the logical bounds for α are between $[1/10, 1/6]$. I set $\alpha = 1/6$ to match the legal exclusion from being able to declare bankruptcy since there is evidence households regain access to credit while the bankruptcy notation still appears on their credit report. The parameter λ is then determined jointly to match the unsecured share of household debt. Data from the Flow of Funds Accounts of the U.S. published by the Federal Reserve (Table Z.1 D.3) indicate that consumer credit accounted for roughly 24% of household debt outstanding from 1983 to 2004. Over that same period, approximately 37% of consumer credit consisted of revolving credit, which is the closest analogue to unsecured debt in the model (non-revolving credit includes secured auto loans, student loans, etc). I target an aggregate share of unsecured credit of $0.24 \times 0.37 = 0.089$. I aggregate unsecured debt and total debt across the four legal environments (weighted by households and income) and compute the unsecured share.

Table 1: Legal Environments Considered

States	Homestead Exemption	Recourse	Median HH Income	Weight
Washington, N. Carolina	0.64	No	42334	0.053
California, Alaska, N. Dakota	1.58	No	47211	0.112
Minnesota, Arizona, Montana	3.33	No	42154	0.050
Maryland, Ohio, Georgia, Illinois, Tennessee, Indiana, Virginia Kentucky, S. Carolia, Alabama	0.23	Yes	42146	0.248
Michigan, Missouri, Louisiana, New York, Wyoming, New Jersey, Nebraska, Michigan, Pennsylvania, Hawaii, Oregon, West Virginia, Utah, Wisconsin, Arkansas, Delaware, Colorado, Idaho	0.677	Yes	42650	0.305
Massachusetts, New Mexico, Maine, New Hampshire, Mississippi, Nevada, Connecticut, Vermont, Rhode Island	3.65	Yes	44872	0.075
Florida, Texas, Kansas Oklahoma, S. Dakota, D.C.	∞	Yes	38944	0.158

4.1 Technology

Endowment Process: In order to capture the persistent (i) and transitory ($y|i$) features of income in the model (and in the data), I assume that log income has a persistent component represented by a continuous state $AR(1)$ and a purely transitory component:

$$
\begin{aligned}
\log y' &= z' + \varepsilon \\
z' &= \rho z + \sqrt{1-\rho^2}\eta \\
\eta &\sim N\left(0, \sigma_\eta^2\right) \\
\varepsilon &\sim N\left(-\frac{\sigma_\varepsilon^2}{2}, \sigma_\varepsilon^2\right)
\end{aligned}
$$

The persistence of the income process (one-period autocorrelation) is calculated to be ρ. The variance of log income from the above process is $\sigma_\varepsilon^2 + \sigma_\eta^2$. Following Storesletten et al. (2004), I set $\rho = 0.98$ and $\sigma_\varepsilon^2 = 0.06$. Estimates for the variance of log annual income range from 0.04 to 0.16 . I thus set $\sigma_\eta^2 = 0.09$, generating a variance of log annual income of 0.15. Using the method of Tauchen and Hussey (1991), I approximate the persistent component with a two state Markov chain. The two labor productivity shocks are $z = \{0.7087, 1.2912\}$.

Foreclosure Technology: The foreclosure loss parameter, γ, is set to match the additional depreciation incurred in a foreclosure (e.g., it captures effects such as decreased maintenance by the occupants). The average loss was estimated by Pennington-Cross (2006) to be 22%. He estimates the loss by comparing reveneue from foreclosed home sales to a market price constructed via the Office of Federal Housing Enterprise Oversight (OFHEO) repeat sales index. I therefore set $\gamma = 0.78$ for all states in the model.

Bankruptcy Technology: In order to map the bankruptcy recovery rate from the U.S. to the model, I must determine if 1) there is any loss in the forced sale of the home in bankruptcy; and 2) what fraction of assets recovered are actually distributed to creditors. First, note that if the house has been foreclosed the secured creditors seize it and there is nothing for unsecured creditors to collect (see Lemma 1). Campbell et al. (2009) estimate the discount due to bankruptcy in Massachussetts, and find it to be less than 5%. Thus, if a homeowner has positive equity in the home and declares bankruptcy, I assume that there is no loss in the sale of the house. The proceeds of the sale are first used to repay secured creditors. Next, the costs of administering the bankruptcy (including court costs, fees and administrative expenses) are paid. Finally, unsecured creditors are repaid from anything that remains. According to the "Preliminary Report on Chapter 7 Asset Cases 1994 to 2000" prepared by the U.S. Department of Justice, roughly \$10.5 billion was collected in asset cases over that seven year period. Only 52.3% was dispersed to secured and unsecured creditors. Thus, I set the parameter recovery parameter $\zeta = 0.52$.

The Depreciation Process: As in Jeske, Krueger & Mitman (2010), I calibrate the depreciation process to simultaneously match foreclosure rates and house depreciation moments from the data. Consistent with data from the Mortgage Banker's Association on foreclosure rates from 1990-2003, I target an aggregate foreclosure rate of 0.55 percent. I also target the mean house depreciation, calculated at 1.48% annually, based on mean depreciation of residential housing reported by the Bureau of Economic Analysis. Further, I target house price volatility of 10% to match data reported by the OFHEO.

I find that I need a fat tailed distribution to simultaneously match the price volatility and foreclosure rates. I assume that the depreciation shock follows a generalized Pareto distribution. The generalized Pareto distribution has three parameters, a shape parameter, k, a scale parameter, μ, and a cutoff parameter which I choose as $\underline{\delta}$. The upper bound for

Table 2: Externally Calibrated Parameters

Parameter	Value	Target
ρ	0.98	
σ_ν	0.3	Income process (Storesletten et al, 2004)
σ_ε	0.245	
θ	0.8590	Housing share of consumption 14.1%
γ	0.78	Foreclosure Sale Loss
ζ	0.52	Distributions to Creditors
r_b	0.01	Risk-free rate
r_w	0.00011	Bank administration cost
α	0.167	File for Chapter 7 every 6 years

the support is set to 1. The cumulative distribution function is :

$$F(\delta) = 1 - \left(1 + \frac{k(\delta - \underline{\delta})}{\mu}\right)^{\left(-\frac{1}{k}-1\right)}$$

4.2 Preferences

For the utility function I assume Cobb-Douglas preferences over consumption and housing services nested in a constant relative risk aversion (CRRA) function:

$$U(c,h) = \frac{\left(c^{\theta}h^{1-\theta}\right)^{(1-\sigma)} - 1}{1-\sigma}$$

Notice that this implies the solution to the intra-temporal consumption optimization problem is:

$$P_h h = \frac{1-\theta}{\theta} c$$

which allows me to independently calibrate θ to match the share of housing in total consumption. According to NIPA data, the housing share of total consumption has been relatively stable at 14.1% over the last forty years, thus I set $\theta = 0.8590$.

The CRRA parameter σ is calibrated jointly to match median net worth observed in the data. I use the 2004 Survey of Consumer Finances to compute the median net-worth of prime age households (head age ≤ 50). Median net-worth divided by median income is found to be 1.19. Note that I have restricted the calculations to households under age 50 because housing and mortgage choices exhibit strong life cycle effects, and thus comparing the results of my model along those dimensions to the data more closely correspond to prime age households.

Table 3: Jointly Determined Parameters

Parameter	Value	Target	Data	Model
Preferences				
Risk aversion, σ	2.755	Bankruptcy rate	1.06%	1.09%
Discount factor, β	0.943	Median net worth/income:	1.19	1.19
Depreciation Process				
Shape parameter, k	0.688	Foreclosure rate	0.55%	0.55%
Scale paramete,r μ	6.77×10^{-3}	Average depreciation	1.48%	1.48%
Cutoff parameter, $\underline{\delta}$	1.49×10^{-3}	House price variance	0.01	0.01
Legal Technology				
Probability of deficiency judgment, ψ	0.184	Probability of bankruptcy conditional on foreclosure	0.28	0.28
Consumption penalty, λ	5.66×10^{-3}	Revolving share of debt	8.9%	8.8%

I calibrate the time discount factor β to match the aggregate bankruptcy rate. I construct bankruptcy rates from state bankruptcy filings and the number of households per state. I use annual non-business bankruptcy filings by state from 1995-2004 published by the American Bankruptcy Institute and obtain data on the number of households by state from the Census. Recent research (e.g., Chakravarty and Rhee (1999) and Himmelstein et al. (2009)) suggests that medical expenditures account for a significant fraction of household bankruptcies in the United States. Chakravarty and Rhee (1999) report that 16.4% of respondents in the Panel Survey of Income Dynamics who filed for bankruptcy listed health-care bills as the cause. I therefore target 83.6% of the observed bankruptcy rate in the data, since my model abstracts from such health shocks.

The full list of externally calibrated parameters are listed in Table 2. The internally calibrated parameters and relevant model moments are listed in Table 3.

4.3 Model Fit

Aggregated statistics across the seven computed economies are listed in Table 4. The model performs well accounting for non-targeted moments in the data. The model slightly over-predicts average holdings of housing. This is perhaps to be expected, given that in the context of the model housing is a proxy for all risky assets, as compared to bonds being safe assets. In the data, however, households have the ability to hold risky equity in addition to housing, which can rationalize the over-prediction. The model does successfully account for the fact that prime age households primarily allocate their wealth in risky assets, as indicated by the low levels of bond holdings. The high level of housing leads to an over-prediction of mortgage holdings and of unsecured debt holding (by construction since the ratio is targeted). The model under-predicts the fraction of households with zero or negative net-worth, which perhaps can be attributed to life-cycle effects. In the context of my infinite-horizon model it is difficult to capture young households who begin life with little or no assets and have strong motives to borrow (to the extent they can) against their human capital[3].

Table 4: Aggregate Results

	Model	Data	Source
Housing, H	5.25	4.10	Residential Property, SCF 2004
Debt	-3.88	-2.36	SCF 2004
Bonds, B_+	0.16	0.18	Savings/Bonds, SCF 2004
Unsecured debt, B_-	-0.34	-0.21	Unsecured Debt, SCF 2004
Mortgages M	3.54	1.93	SCF 2004
Median Leverage	71%	62%	SCF 2004
Fraction with net worth ≤ 0	5.3%	9%	SCF 2004
Fraction with Unsecured Debt	38.3%	54.2%	SCF 2004

5 Results

5.1 Accounting for State Differences in Bankruptcy Rates

By calibrating the model to aggregate bankruptcy and foreclosure rates, I do not directly target the effects that the homestead exemption and recourse have on default rates. Thus, while the model successfully captures the average effect of bankruptcy and foreclosure law, a priori it may not be able to capture the differences in default rates that can be attributed to differences in laws. Comparing the model predictions with how actual default rates vary by law provides a strong test to validate the mechanisms outlined in the model. However, states vary in demographic and legal characteristics that are abstracted from the model, but which may be relevant to default. Therefore, I control for additional observables and decompose to what extent variance in law explains the variance in bankruptcy rates, since that is the relevant benchmark to which to compare the model. The model can account for 83% of the variance in bankruptcy rates that can be attributed to variance in law, and

[3]If student loans are taken out of the net worth calculations in the SCF then the percentage of households with non-positive net worth drops to 6.7%.

20% of the overall variance in bankruptcy rates across states. The details of the accounting procedure are described below.

First, I regress the state level bankruptcy rate on log median household income, log median house value, the average household size, a dummy indicating lenient garnishment law, a dummy for recourse, the homestead exemption, a dummy for unlimited exemption, and a constant. The three variables related to recourse and the homestead exemption I denote $x_{L,i}$ to represent the legal differences that are varied in the model, and the remainder of the regressors I label $x_{D,i}$. The coefficients on the legal variables are significant and indicate that recourse increases bankruptcy rates and that more generous homestead exemptions lower bankruptcy rates. The full coefficients are in Table 5. To decompose the fraction of the variance in bankruptcy rates that can be explained by law, I take the ratio of the variance of the fitted bankruptcy rates using the coefficients of the legal regressors over the variance of bankruptcy rates:

$$\text{Variance explained by law} = 1 - \frac{var(x_{L,i}\hat{\beta}_L)}{var(bankrate_i)}$$

which I calculate to be 0.25, implying that variance in bankruptcy and foreclosure laws accounts for 25% of the variance in bankruptcy rates. To compare my model to the predictions from the regression, I compare the variance of the residual between the fitted value and the data, $\hat{e}_{L,i} = bankrate_i - x_{L,i}\hat{\beta}_L$, with the residual between the model generated bankruptcy rate, m_i, and the fitted value from the regression, $\hat{e} = m_i - x_{L,i}\hat{\beta}_L$. The ratio of the variances is 0.17, meaning that the model accounts for 83% of the variance that can be attributed to variance in law. The predicted bankruptcy rates from the regression and from the model are plotted in Figure 4. Except for the very high homestead exemptions, the model predicts nearly identical bankruptcy rates as the regression. Thus, analyzing the mechanisms in the model will be a useful tool for understanding how the differences in law lead to different default rates. The model-predicted bankruptcy rates and the actual bankruptcy rates by state are plotted in Figure 3. Overall, the model can account for close to 20% of the variation in bankruptcy rates across states.

5.2 Effects of the Homestead Exemption

In this section I elucidate the mechanism in the model that delivers lower bankruptcy rates in states with higher homestead exemptions. In the theoretical results I proved that households with less non-exempt home equity are more likely to go bankrupt. Thus, from the perspective of the household's default decision one might expect higher bankruptcy rates in states with higher homestead exemptions, since a household with the same portfolio in

Table 5: Decomposing Bankruptcy Rates
$bankrate_i = \beta_0 + \beta_L x_{L,i} + \beta_D x_{D,i} + \epsilon_i$

Variable	Coefficient	(Std. Err.)
Demographic		
log(Median house value)	-0.0002	(0.0017)
log(Median household income)	-0.0050	(0.0050)
Average household size	0.0131*	(0.0035)
Weak garnishment law	-0.0044*	(0.0010)
Bankruptcy & Foreclosure Law		
Recourse	0.0035*	(0.0012)
Homestead Exemption	-0.0010*	(0.0004)
Unlimited Exemption	-0.0029*	(0.0014)
Constant	0.0341	(0.0388)
R^2	0.52	

* indicates significance at 5% level

a state with a higher exemption would be more likely to go bankrupt. Households must therefore be holding different portfolios across the different states. Since the prices of unsecured credit reflect the implied default probabilities, a household with less non-exempt home equity should face a higher cost of borrowing in unsecured credit than one with more non-exempt home equity. To illustrate this effect, in Figure 6 I have plotted unsecured interest rates as a function of the amount borrowed for households holding identical portfolios living in the Maryland and Michigan economies. The household owns a house worth five times median income and has an 80% mortgage, implying home equity equal to 1 (median income is normalized to 1 in the model). The homestead exemptions in the Maryland and Michigan economies are 0.23 and 0.68, respectively. Thus, the household in Maryland has non-exempt home equity worth 0.73, compared to 0.32 for the household in Michigan. For small levels of debt, both households face low interest rates. As the level of unsecured debt approaches the level of non-exempt home equity (the point at which the pure financial gain from going bankruptcy becomes positive), the interest rates steadily rise. Once the level of unsecured debt significantly exceeds the amount of non-exempt home equity, the financial benefit from going bankrupt outweighs the punishment for most income realizations, causing sharp increases in the interest rate.

What is important to note is that because of the non-exempt home equity, the Maryland household has access to significantly more unsecured borrowing at low interest rates. However, that does not imply that the household in Maryland has a reason to borrow unsecured, especially since it has access to secured borrowing at much lower interest rates. In equilibrium, however, households in Maryland will choose to hold relatively more unsecured debt and less secured debt, as can be seem from the state level aggregates in Table 6. The intuition is that the household in Maryland is able to use unsecured debt to partially insure against *housing risk*. A household with only a mortgage is partially insured against large shocks to housing since it has the option of foreclosure. However, in foreclosure the household loses all of its housing wealth. By borrowing the same amount, but as a mixture of secured and unsecured credit, the household essentially creates two types of insurance against housing shocks.

Consider the following example examining two possible portfolios that a Maryland household could hold. The first is a \$200K house and an \$160K mortgage, and the other is \$200K house and an \$140K mortgage and \$20K in unsecured debt. The homestead exemption is roughly \$10K. Imagine the value of the house falls to \$180K. Under the first portfolio, the household would have \$20K in home equity. Under the second portfolio, the household would have \$40K in home equity and \$20K in unsecured debt. The second household could go bankrupt, which would discharge \$20K but would also forfeit \$30K in home equity, meaning that the household would never find it optimal to do so (per Proposition 3). Now imagine that the value of the house falls to \$150K. The first household has no home equity and even if it defaulted on its mortgage, it would have lost all of its housing wealth. The second household, however, still has \$10K in home equity. Further, by going bankrupt, the household could keep all of its home equity and discharge \$20K of credit card debt. What I find is that households in low homestead exemption states adopt exactly the type of portfolio of the second household. Since the probability of large home price drops are small, the default premium using unsecured credit as a form of insurance is rather small. The reason why households in high exemption states do not hold the same type of portfolio is that the financial benefit of going bankrupt is large for households with significant home equity. That translates into higher unsecured interest rates, which make holding unsecured credit an unattractive way to partially insure.

In Table 8 I display average unsecured interest rates and the fraction of households with unsecured credit in the four recourse states. In the aggregate, interest rates are increasing with the homestead exemption and the number of households holding unsecured debt decreases. The average interest rate paid on unsecured debt is 11.2%. This number is very close to the 12.3% reported in the SCF. In addition, I show the average mortgage interest rates across the four states. While the homestead exemption has virtually no effect on the price of mortgages, in different states households endogenously select different mortgages (as evidenced by the difference in median leverage), yielding differences in the average mortgage rate across states. The model is able to successfully replicate the default premium. The average mortgage interest rate is calculated to be 1.24%, corresponding to a default premium of 24%. By comparison, the implied default premium for a 1-year-adjustable rate mortgage (MORTGAGE1US from St. Louis FRED) over the 1-year Treasury constant maturity rate (GS1) during the inter-recession period March 1991-2001 was 22%. Unfortunately, no publicly available data exists on which to evaluate this state level variation. The variation in interest rate with respect to the homestead exemption is perhaps too high, suggesting that perhaps the informal collateral effect of non-exempt home equity is too strong in the model.

Table 6: State Results - Recourse

	Maryland	Michigan	Massachusetts	Florida
	$\chi^s = 0.23$	$\chi^s = 0.68$	$\chi^s = 3.7$	$\chi^s = \infty$
Unsecured debt, B_-	-0.59	-0.48	-0.04	-0.01
Mortgages M	3.34	3.39	3.81	3.83
Bankruptcy rate	1.24%	1.22%	0.91%	0.88%
Foreclosure rate	0.45%	0.54%	0.61%	0.62%
Joint	42%	36%	21%	21%
In debt	5.5%	5.4%	4.9%	4.9%

Table 7: State Results - No Recourse

	Washington	California	Minnesota
	$\chi^s = 0.64$	$\chi^s = 1.57$	$\chi^s = 3.32$
Unsecured debt, B_-	-0.38	-0.20	-0.04
Mortgages M	3.54	3.64	3.78
Bankruptcy rate	1.15%	1.00%	0.62%
Foreclosure rate	0.53%	0.58%	0.63%
Joint	23%	10%	2%
In debt	5.3%	5.2%	5.0%

5.3 Effects of Recourse

Recourse has surprisingly little effect on foreclosure and mortgage interest rates. Comparing the foreclosure rates in Tables 6 and 7, recourse and no recourse states with the same homestead exemption have nearly identical foreclosure rates. To understand why the effect is so small, I plot the mortgage interest schedule for recourse and no-recourse state in Figure **??**. For the no-recourse state the interest rate is independent of the income or bond holdings and only depends on the levarage of the household (see Lemma 2). For

Table 8: Average Interest Rates & Median Leverage

	Maryland $\chi^s = 0.23$	Michigan $\chi^s = 0.68$	Massachusetts $\chi^s = 3.7$	Florida $\chi^s = \infty$
Average r_m	1.20%	1.23%	1.28%	1.28%
Median Leverage	67%	69%	73%	74%
Average r_b	5.5%	7.0 %	10.43%	11.42%
Households with Unsecured Debt	60%	46%	24%	22%

the recourse state the household has high persistent income and no bonds or unsecured debt, the house is three times median income. The interest rate charged is nearly identical for leverage ratios less than 0.9, indicating the large downpayments significantly mitigate foreclosure risk. Since the majority of households that take on mortgages with leverage ratios less than 0.9, the fraction of foreclosures will be similar. Further, if the household holds unsecured debt in the recourse state, the mortgage interest rate schedule is virtually identical to the no-recourse one for all levels of leverage. This can be explained because if the household already has debt, if it forecloses and receives a deficiency judgment it will go bankrupt almost with probability one. While the cutoff in the housing shock, δ, for choosing foreclosure may be different in the recourse state, as the amount of unsecured debt increases that cutoff approaches the one from the no-recourse state. Thus, for households with unsecured debt, even at high leverage the mortgage rates and foreclosure probabilities are similar, indicating that the effect of the law will be small on foreclosure.

In addition, the model predicts that recourse states will have higher bankruptcy rates than no-recourse states. The result is intuitive, since in recourse states foreclosing households face additional liability, which may trigger bankruptcy following foreclosure. Comparing the fraction of households that file for bankruptcy following foreclosure (Jonit in Tables 6 and 7), in recourse states 10-20% more households default on both in recourse states compared to no-recourse states. That number directly reflects the effect of the parameter ψ which reflects the probability of a deficiency judgment. At this time, no publicly available data is available to test whether the implied difference across states is reasonable.

6 Policy Experiments

I use my calibrated model to conduct two policy experiments. In the first policy experiment I consider the effects of the 2005 Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA). The reform made it more difficult for households earning more than the median income in their state from filing for Chapter 7 bankruptcy. In the second experiment I quantitatively determine the optimal joint foreclosure and bankruptcy policy taking under a utilitarian welfare criterion.

6.1 BAPCPA

To simulate the effects of BAPCPA in the model I prevent households with below median income realizations from filing for bankruptcy unless doing so would result in non-positive consumption. I compute the transition from the original steady state to the new steady state equilibrium with means testing. I find that it takes several years for default, housing and debt to reach the new steady state levels. Taking into account the costs of transition will therefore be important for understanding the welfare implications of the policy.

6.1.1 Effects on Allocations

The aggregate implications of the reform are quite substantial in terms of default rates and total borrowing in the economy, as shown in Table 9. The aggregate amount of mortgage debt increases slightly, but total unsecured debt increases 30%, but takes several periods to reach the new level, shown in Figure 7. The increase in unsecured debt is small, however, relative to the increase indebtedness of households. After reform, as more households take on unsecured debt the fraction of households with non-positive net worth almost triples to more than 15%, as can be seen in Figure 8. Surprisingly, however, the percentage of households that file for bankruptcy and foreclosure surprisingly each more than double from 1% to 2.5% and 0.55% to 1.15% respectively. How can a policy that is intended to make it more difficult for households to go bankrupt result in *increased* bankruptcy rates?

Before the reform, households with high incomes, high levels of exempt housing equity and low levels of non-exempt home equity faced high interest rates on unsecured borrowing because the gains from bankruptcy were very high regardless of the shocks to income and depreciation. In equilibrium, these households held very little unsecured debt. After the reform, however, due to the high persistence of income, these households will be precluded from filing bankruptcy in the subsequent period with high probability, causing the equilibrium interest rate on unsecured credit to fall. In equilibrium households now borrow more unsecured, since essentially unsecured borrowing has been converted into an insurance contract against below-median income realizations in the subsequent period. Households with high incomes but otherwise low net worth now file for bankruptcy roughly 14% of the time, whereas before the reform these households hardly ever filed for bankruptcy. These results contrast those of Chatterjee et al (2007) who find no significant change in the bankruptcy rate after imposing the income restriction for filing. This stark difference highlights the importance of considering exempt assets as well as liabilities in any analysis of the effects of bankruptcy policy.

Table 9: Aggregate Effects of BAPCPA

	Baseline	BAPCPA
Housing, H	5.25	5.21
Unsecured debt, B_{-}	-0.34	-0.46
Mortgages M	3.54	3.64
Fraction with net worth ≤ 0	5.3%	15.1%
Bankrupty Rate	1.09%	2.56%
Foreclosure Rate	0.55%	1.15%

The reform also significantly reduces the cost of unsecured borrowing. The interest rates for various levels of unsecured borrowing for a household with a house worth five times median income and an 80% mortgage in the Maryland ($\chi = 0.23$) economy is plotted in Figure 9. The interest rates for both high and low persistent endowment are several percentage points lower post-reform. In addition, as the amount of debt exceeds the amount of non-exempt home-equity (the dashed line in the picture), the interest rate (and implied default probability) do not increase nearly as much as pre-reform. This change is behavior can be explained by two effects. The most direct is simply that households with above median income the subsequent period are restricted from filing for bankruptcy even though they would benefit financially from doing so. The second channel comes from maintaining access to credit. Since interest rates are lower access to credit is more valuable post-reform, implying a greater direct financial benefit is required for a household to choose to go bankrupt. Another striking difference post reform is the difference in interest rates between households with high or low persistent income. Pre-reform, agents with high income did receive lower interest rates on unsecured borrowing, but not substantially so. Now, because of the high persistence of income, even when the financial benefit of going bankruptcy is very high, the chance that households will be legally prevented from filing for bankruptcy keeps interest rates relatively low.

6.1.2 Effect of Homestead Exemption under BAPCPA

Before the reform, higher homestead exemptions lead to lower bankruptcy rates because of the price effect with unsecured credit. Post-reform, however the relationship is reversed - higher levels of the homestead exemption lead to higher levels of bankruptcy. The state by state default rates are displayed in Table 10.

Table 10: State Level Implications of BAPCPA

State	Foreclosure Rates		Bankruptcy Rates	
	Baseline	BAPCPA	Baseline	BAPCPA
Maryland	0.45%	1.28%	1.24%	2.27%
Michigan	0.54%	1.29%	1.22%	2.32%
Massachusetts	0.61%	1.30%	0.91%	2.57%
Florida	0.62%	1.31%	0.88%	2.58%
Washington	0.53%	0.61%	1.14%	2.44%
California	0.58%	0.69%	1.00%	2.77%
Minnesota	0.63%	0.71%	0.62%	2.86%

The income restriction imposed under BAPCPA significantly mitigates the price effect of higher exemptions since high income households are prevented from going bankrupt even when there is a financial benefit of doing so. As described in the previous section, unsecured credit is closer to an insurance contract against low income realizations. Now, however, the level of insurance is essentially the level of the exemption (since that is the amount that households get to keep after going bankruptcy). Therefore, households will be more willing to take on unsecured debt and increase home equity in high exemption states.

6.1.3 Welfare Consequences of the Reform

Despite the higher levels of default across all states, households are strictly better off from the reform. Taking into account transitional dynamics, on average households would be willing to pay 1.4% of lifetime consumption to adopt the policy reform. Further, since households are heterogeneous, there could be disagreement over whether the reform is welfare improving. In this case support for the policy is unanimous - all households strictly benefit from the policy change. However, the consumption equivalent gain is much higher for low net worth households than middle and high net worth ones.

6.2 Optimal Joint Policy

In my second policy experiment I pose the normative question of how the government should optimally set the homestead exemption and recourse law to maximize utilitarian welfare. The federal government has the power to adopt uniform bankruptcy law, but in the past has allowed states to opt-out of the federally mandated exemptions.

In order to solve for the optimal policy I take as my initial condition the economy along the transition path induced by the passage of BAPCPA. I solve for the policy that maximizes current welfare taking into account the new transition path induced by the change in exemption law. I find that the optimal joint policy prescribes no recourse and a homestead exemption of roughly one quarter of median state income.

Eliminating recourse may at first seem counterintuitive since in problems providing insurance the strongest punishments typically yield the best outcomes. However, households in this economy face two types of uncorrelated risk: house price risk and income risk. Having no recourse mortgages allow the two debt instruments to more effectively span the space of possible shocks. When there is recourse housing risk could result in bankruptcy which reduces the ability of the household to use savings or unsecured debt to insure against income risk. A no-recourse mortgage policy is in some sense regressive, however, as the households that benefit the most are high income and high net worth households that have large homes and large mortgages. Lower net worth households get less insurance, but face the higher borrowing cost.

The intuition for why a positive homestead exemption is optimal relates to the discussion in the previous section on how unsecured debt is no closer to an insurance contract. While the tradeoff between price and insurance is lower post reform, since default is costly it is optimal to keep the exemption relatively low, which yields lower bankruptcy and foreclosure rates. In addition, the lower exemption disproportionately benefits households with low network, since their assets would be mostly exempt. Since I have adopted a utilitarian welfare function setting the exemption to benefit mostly low net worth households may represent a tradeoff with no-recourse mortgages, which disproportionately benefit high net worth households.

The welfare gains from adopting the optimal exemption and recourse policy are non-negligible - on average households gain 0.4% of average lifetime consumption by the switching to the optimal policy. The gains are not uniform across states, as the states with recourse and high exemptions see the largest welfare gains.

7 Conclusions

In this paper I have accomplished several goals. First, I have constructed a tractable general equilibrium model where households can purchase housing, have access to mortgage and unsecured debt, and have the ability to default on that debt. Second, the model is able to replicate aggregate default behavior and facts related to debt and wealth. Third, I find the model can account for nearly all of the variation bankruptcy rates due to variance in state law, and for roughly 25% of overall variation. Fourth, I have investigated one mechanism under which higher homestead exemptions led to lower bankruptcy rates and higher foreclosure rates. The model predicted a significant interaction between the homestead exemption,and foreclosure and bankruptcy rates, highlighting the importance of studying both types of default simultaneously. I predict the 2005 bankruptcy reform will result in higher levels of foreclosure and bankruptcy, but was ultimately welfare improving. Finally, I solve for the optimal level of the homestead exemption and recourse policy, and find that a homestead exemption of one quarter of median income and no recourse mortgages maximize consumer welfare.

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8 Figures

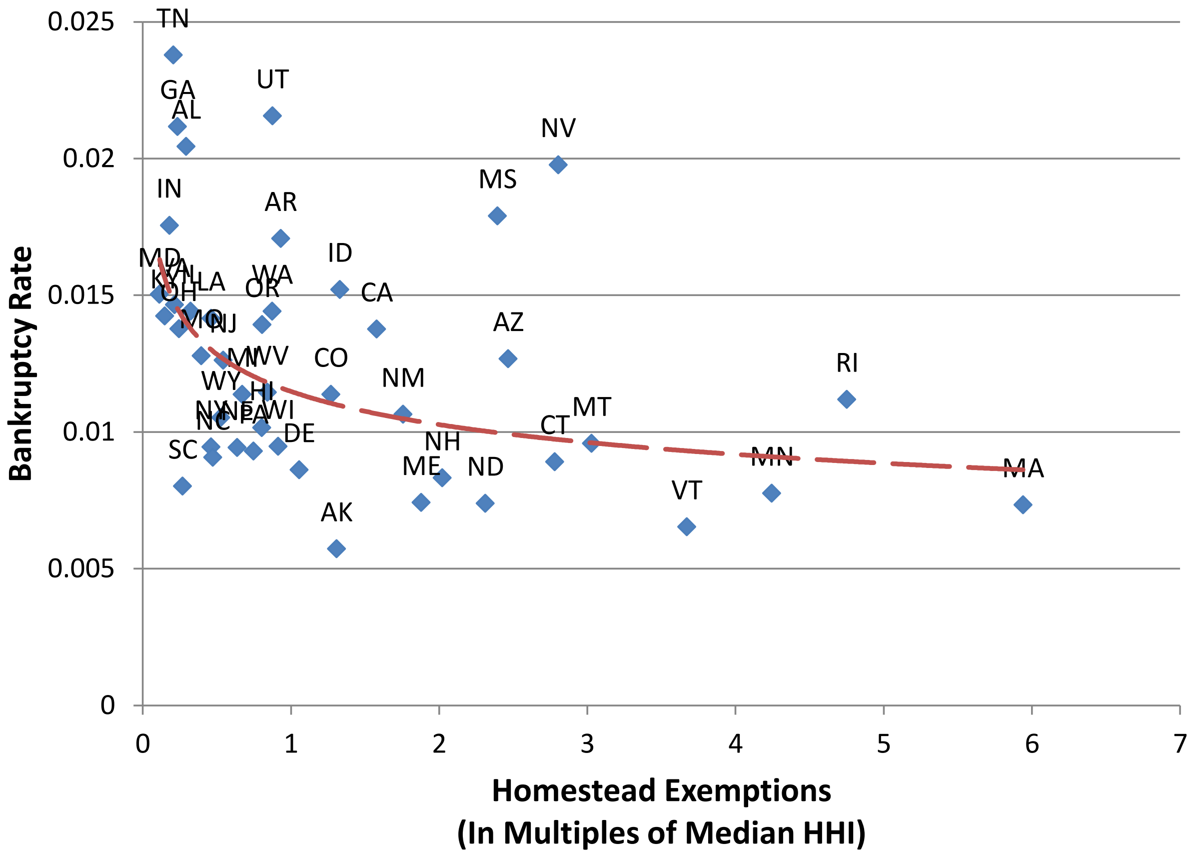

Figure 1: State bankruptcy rate as a function of homestead exemption

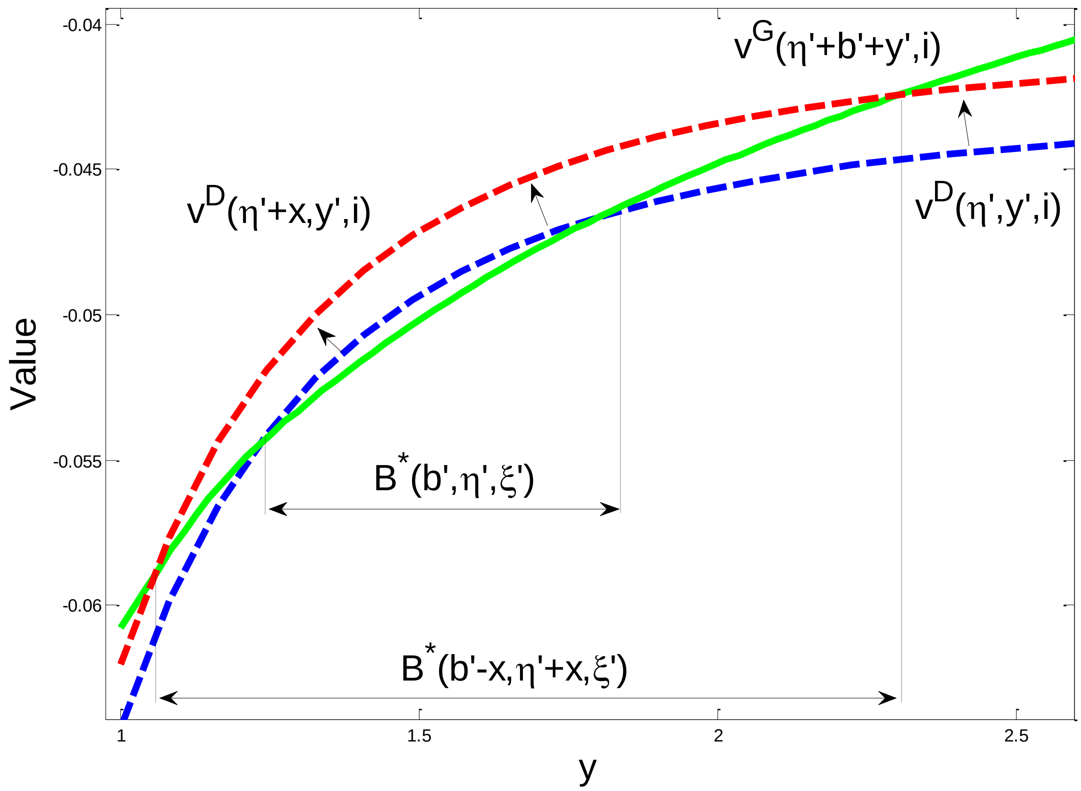

Figure 2: Holding the net asset position $\eta' + b'$ constant, the bankruptcy set is increasing in η'

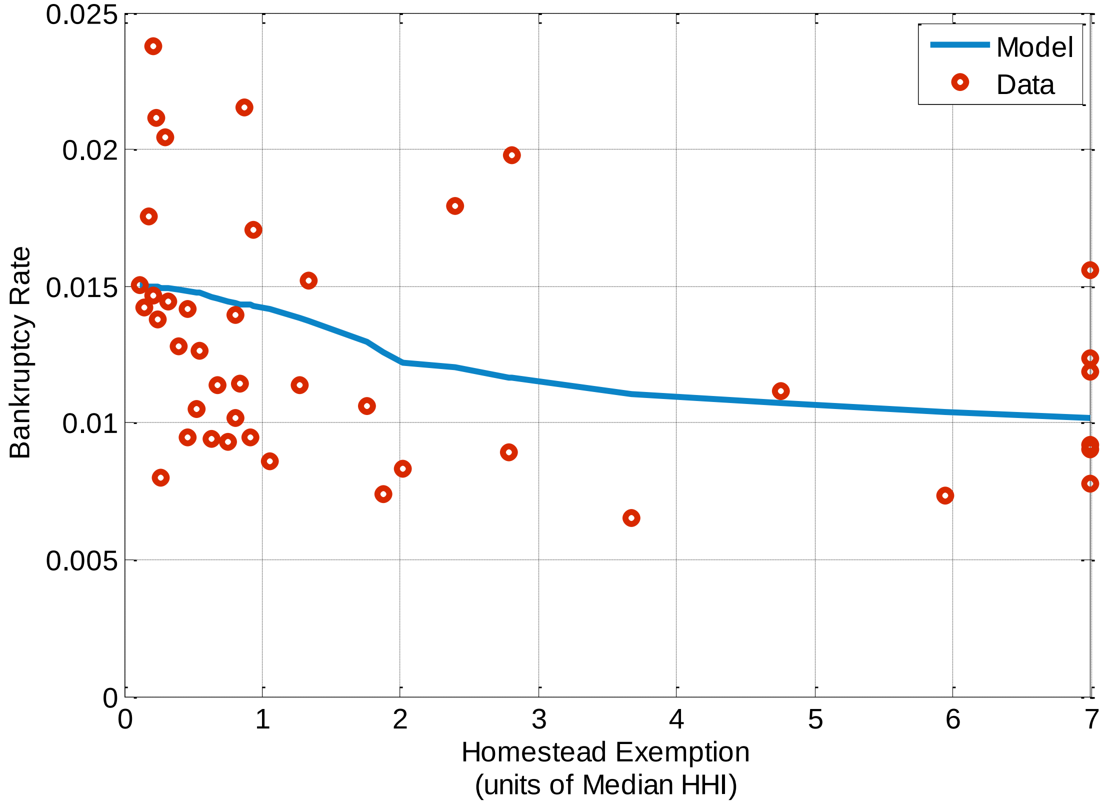

Figure 3: Bankruptcy rates and model predictions as a function of homestead exemption

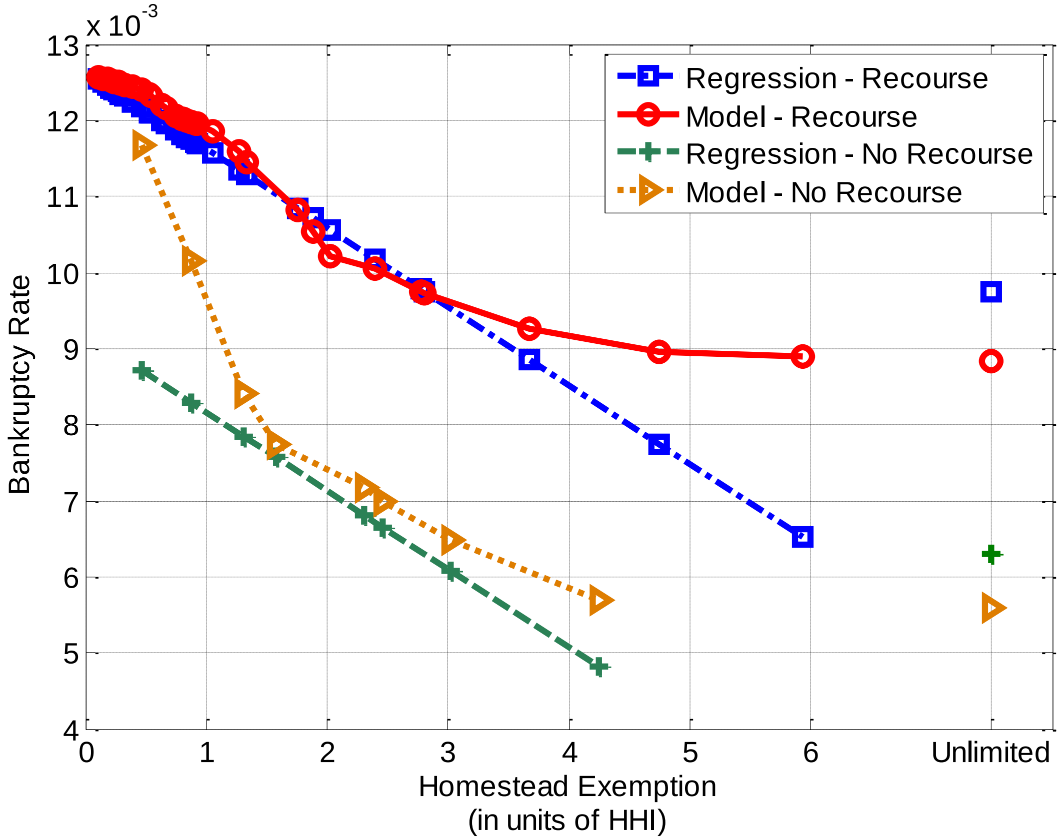

Figure 4: Model and regression predictions

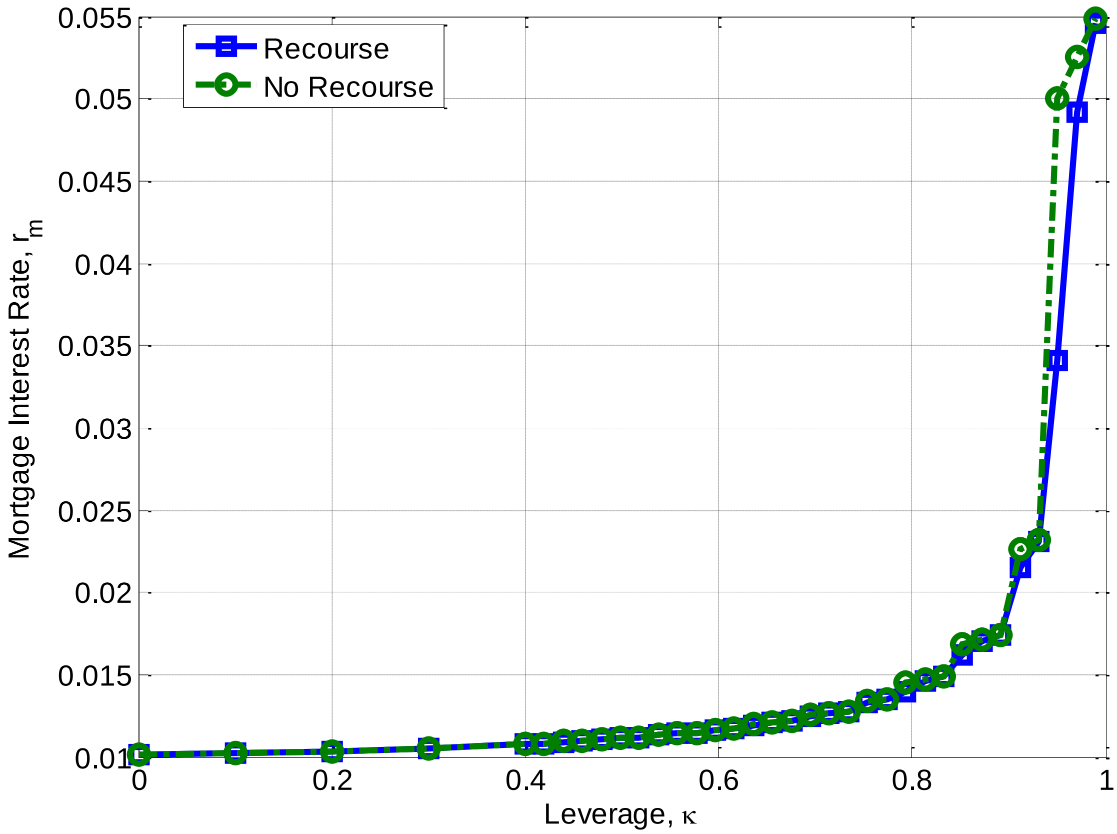

Figure 5: Mortgage interest rate as a function of leverage, $\kappa' = \frac{m'}{g'}$ for a household with $b' = 0$, for a house size equal to three times median income

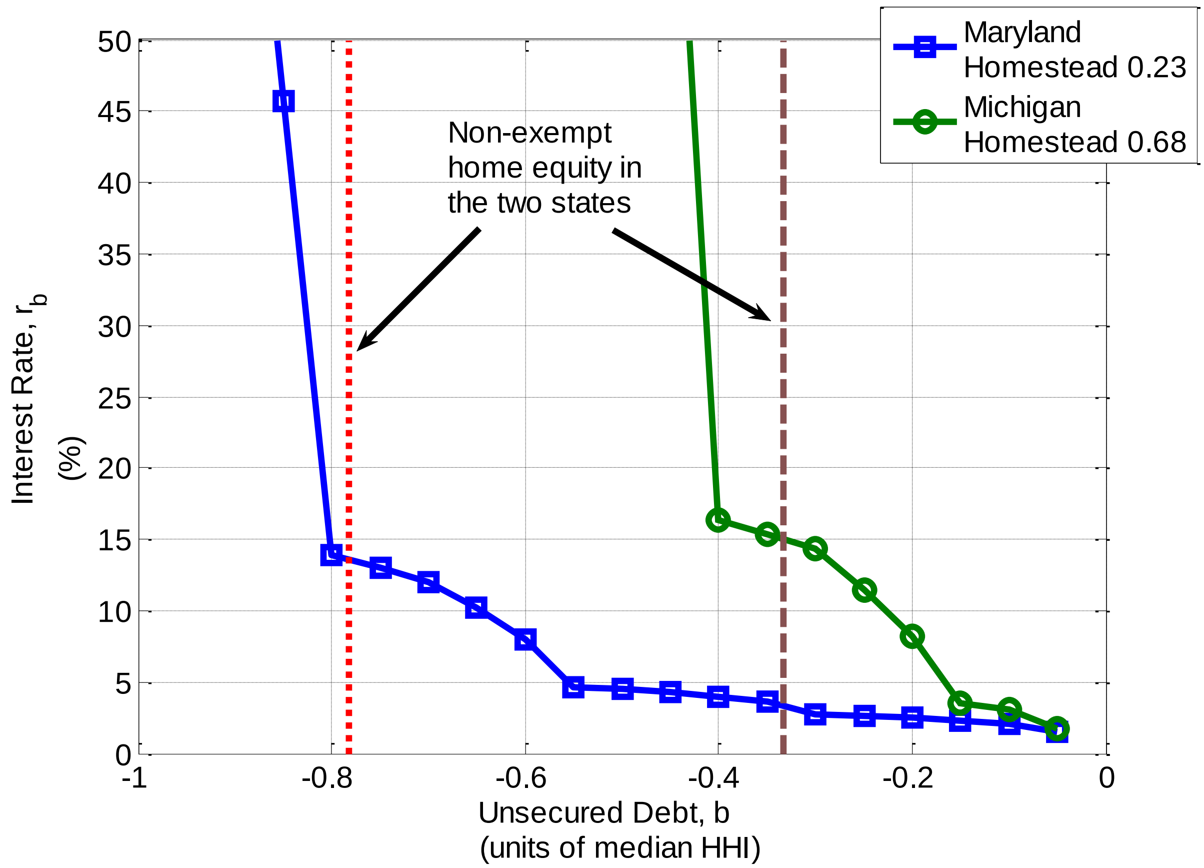

Figure 6: Interest rates on unsecured debt as a function of debt for a household with a house size equal to five times the median income and and 80% leveraged mortgage. The dashed lines represent the amount of non-exempt home equity (ξ) that the household has.

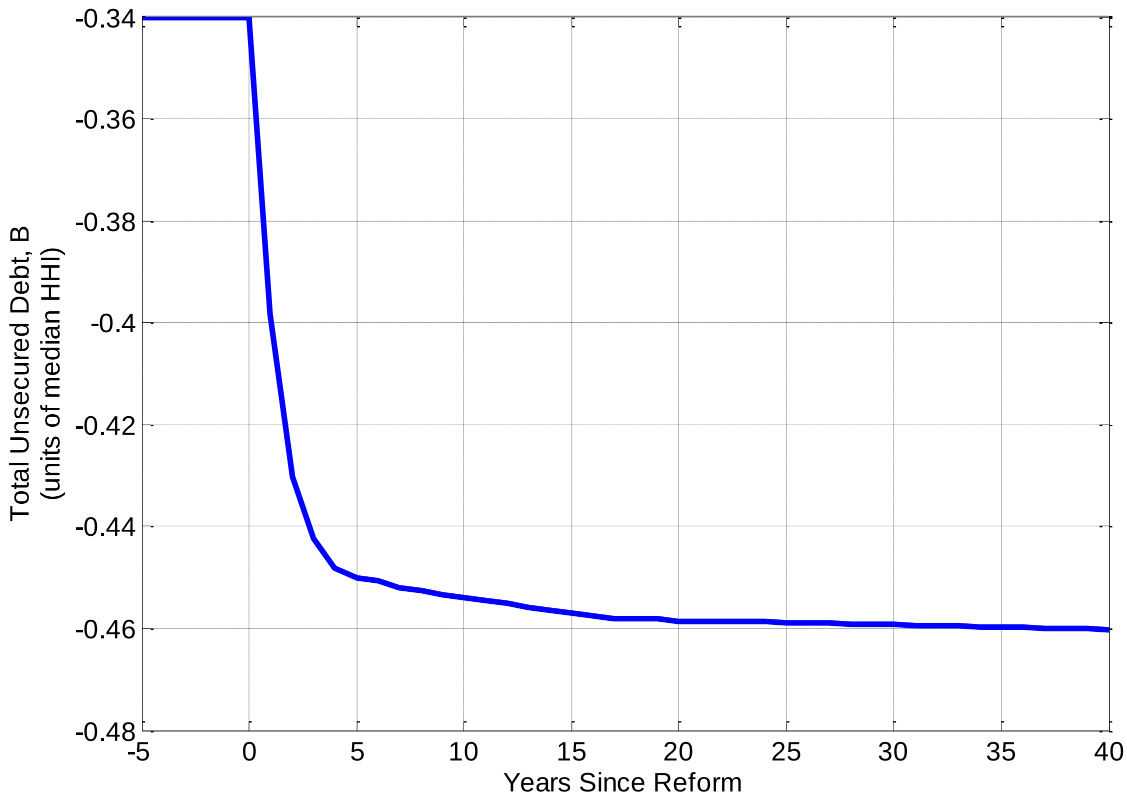

Figure 7: Total unsecured debt along the transition path after the BAPCPA is implemented at time 0.

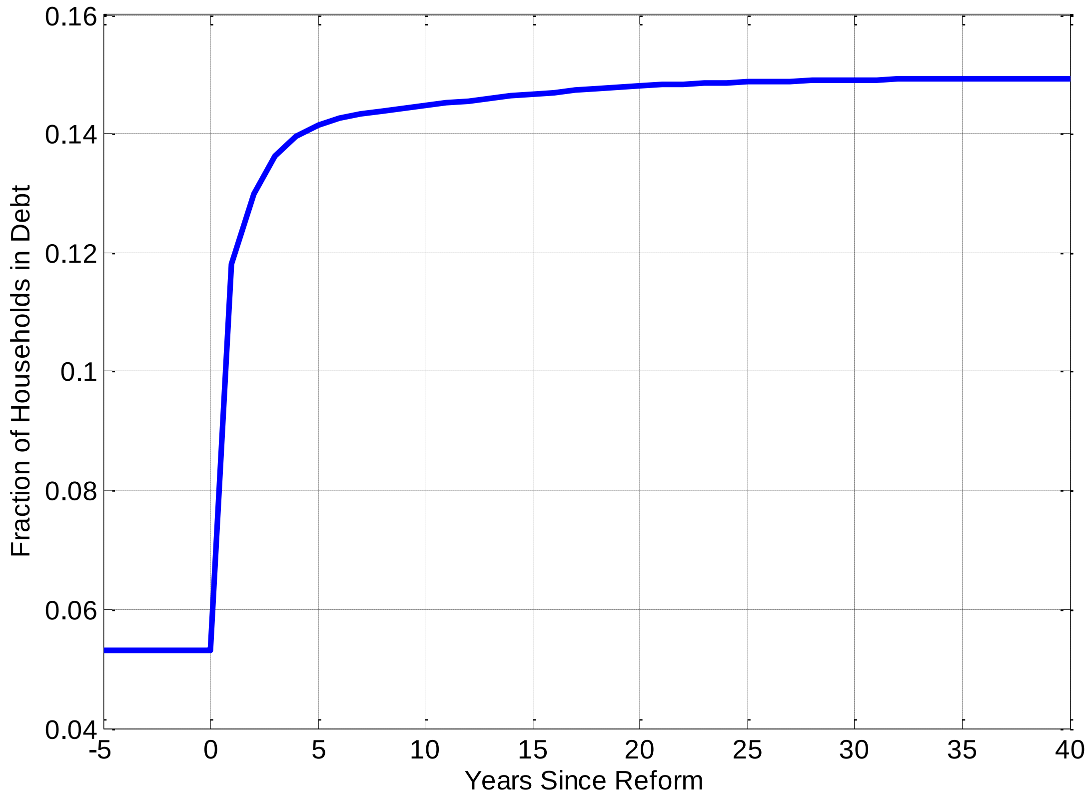

Figure 8: Fraction of households that have non-positive networh along the transition path after the BAPCPA is implemented at time 0.

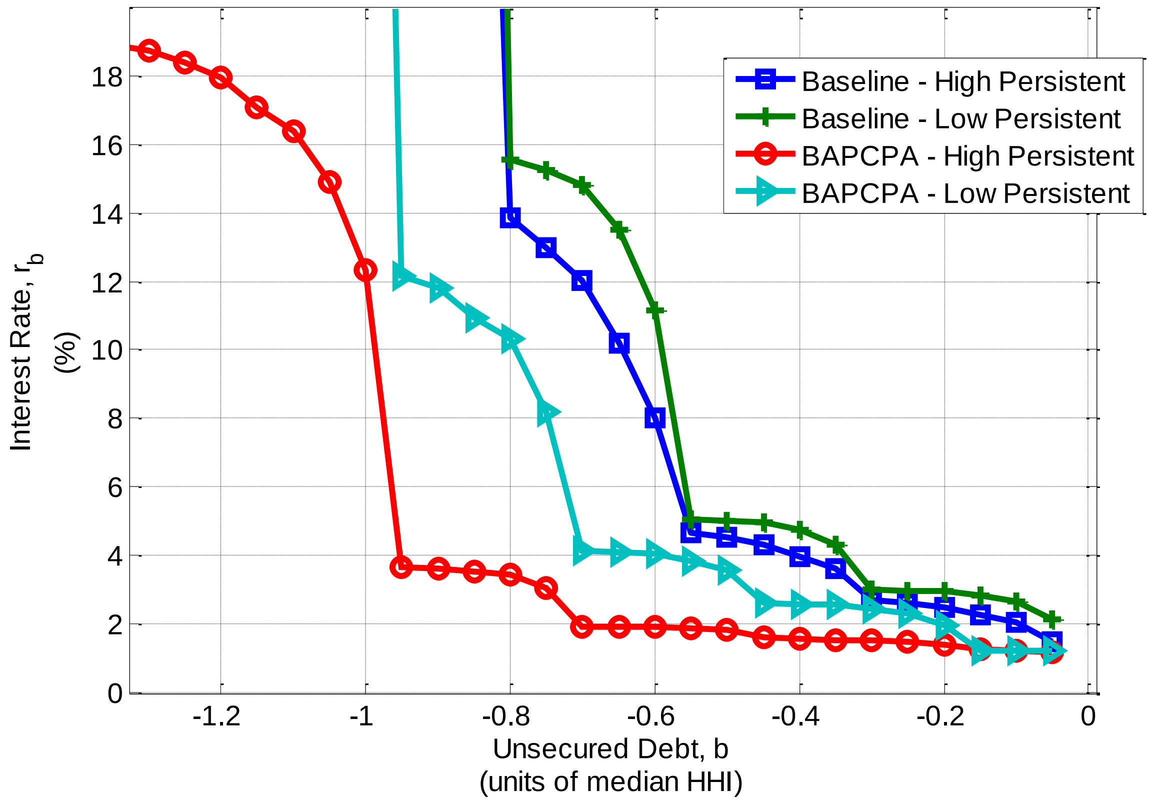

Figure 9: Interest rates on unsecured debt as a function of debt for a household with a house size equal to five times the median income and and 80% leveraged mortgage. The dashed lines represent the amount of non-exempt home equity (ξ) that the household has.

APPENDIX

A Proofs Related to the Household Problem

Assumption 1 *$U(c,h) : \mathbb{R}^2_+ \to \mathbb{R}$ is strictly increasing, concave and differentiable. Further, it is bounded above by $\overline{U}$, and given $P_h > 0$,*

$$u(\underline{y}^i/\lambda; P_h) - u(0; P_h) > \frac{\beta}{1-\beta}(\bar{U} - u(\underline{y}^i/\lambda; P_h)) \quad \forall\, i$$

In addition, I assume that there exist maximum levels of borrowing, both secured and unsecured:

Assumption 2 *There exists a maximum level of unsecured borrowing, $b_{\min}$, and a maximum mortgage size, $m_{\max}$.*

Proof of Lemma 16 Immediate from the definition of the foreclosure value functions and $\tilde{b}'$. ▮

Lemma 6 *$u(c; P_h)$ is continuous, strictly concave, strictly increasing.*

Proof Take $c_1, c_2 > 0$ and $c_\theta = \theta c_1 + (1-\theta)c_2$ for $\theta \in (0,1)$. $u(c_i; P_h) \equiv U(\tilde{c_i}, h_i)$ where $\tilde{c_i}$ and h_i are from the maximizers. From the strict concavity of U, we know that

$$\begin{aligned} \theta U(\tilde{c_1}, h_1) + (1-\theta)U(\tilde{c_2}, h_2) &< U(\theta\tilde{c_1} + (1-\theta)\tilde{c_2}, \theta h_1 + (1-\theta)h_2) \\ &\leq U(\tilde{c_\theta}, h_\theta) \end{aligned}$$

where the first inequality comes from the strict concavity of U and the second from the fact that $\theta\tilde{c_1} + (1-\theta)\tilde{c_2} + P_h(\theta h_1 + (1-\theta)h_2) = \theta c_1 + (1-\theta)c_2 = c_\theta$, thus it is a feasible choice for the maximization for $u(c_\theta; P_h)$, and by definition of a max. Continuity and strict monotonicity follow from the properties of U. ▮

Let $M \subset \mathbb{R}_+$ be the mortgage choice set, $B \subset \mathbb{R}$ be the bond/unsecured choice set, $G \subset \mathbb{R}_+$ be the housing choice set, $C \subset \mathbb{R}_+$ be the consumption expenditure choice set. The continuous state variable, cash-at-hand, $a \in A \subset \mathbb{R}_+$. There are two discrete state variables: the persistent income state is $i \in I$, where I is a finite set; and the credit history state $s \in \mathcal{S} = \{G, D, B\}$. For the household problem, I take the pricing functions $P_b : B \times G \times M \times I \times \mathcal{S} \to \mathbb{R}_+$ and $P_m : B \times G \times M \times I \times \mathcal{S} \to \mathbb{R}_+$ as given. To economize on notation, I will typically not make explicit the dependence of the prices on the choice parameters.

I define the budget correspondence for agents with a good credit history, $\Gamma^G : A \times I \to C \times B \times G \times M$ as:

$$\Gamma^G(a,i) = \{(c,b,g,m) \in C \times B \times G \times M : c + bP_b + g[P_h - P_l] - mP_m \leq a\} \tag{8}$$

For agents who declared bankruptcy at the end of the last perio,d I define the budget correspondence $\Gamma^D : A \times I \to \times G \times M$ as:

$$\Gamma^D(a,i) = \{(g,m) \in G \times M : g[P_h - P_l] - mP_m \leq a\} \tag{9}$$

Agents with bad credit histories face the budget correspondence $\Gamma^B : A \times I \to C \times B \times G \times M$ as:

$$\Gamma^B(a,i) = \{(c,b,g,m) \in C \times B \times G \times M : \lambda c + bP_b + g[P_h - P_l] - mP_m \leq a, b \geq 0\} \tag{10}$$

Now, I can define the value functions for agents who begin the period with credit histories G, D, B:

$$\begin{aligned}
v^G(a,i) &= \max_{x \in \Gamma^G(a,i)} \left\{ u(c;P_l) + \beta \sum_{i' \in M} \pi(i'|i) \iint W^G(b',g',m',y',\delta',i') dF(\delta') dP(y'|i') \right\} \\
v^D(a,y,i) &= u(y;P_l) + \max_{x \in \Gamma^D(a,i)} \left\{ \beta \sum_{i' \in M} \pi(i'|i) \iint W^D(0,g',m',y',\delta',i') dF(\delta') dP(y'|i') \right\} \\
v^B(a,i) &= \max_{x \in \Gamma^B(a,i)} \left\{ u(c;P_l) + \beta \sum_{i' \in M} \pi(i'|i) \iint \begin{bmatrix} \alpha W^B(b',g',m',y',\delta',i') + \\ (1-\alpha) W^D(b',g',m',y',\delta',i') \end{bmatrix} dF(\delta') dP(y'|i') \right\}
\end{aligned}$$

where

$$W^G = \max \left\{ \begin{array}{c} \max \left\{ \begin{array}{c} v^G(b' + 1g'(1-\delta') - m' + y', i'), \\ v^D(\min\{\max\{0, 1g'(1-\delta') - m'\}, \chi^s\}, y', i') \end{array} \right\}, \\ \left\{ \begin{array}{c} \psi \max \left\{ \begin{array}{c} v^G(b' + \gamma 1g'(1-\delta') - m' + y', i'), \\ v^D(\min\{\max\{0, \gamma 1g'(1-\delta') - m'\}, \chi^s\}, y', i') \end{array} \right\} + \\ (1-\psi) \max \left\{ \begin{array}{c} v^G(b' + \max\{\gamma 1g'(1-\delta') - m', 0\} + y', i'), \\ v^D(\min\{\max\{0, \gamma 1g'(1-\delta') - m'\}, \chi^s\}, y', i') \end{array} \right\} \end{array} \right\} \end{array} \right\} \tag{11}$$

$$W^D = \max \left\{ \begin{array}{c} v^B(b' + 1g'(1-\delta') - m' + y', i'), \\ \left\{ \begin{array}{c} \psi v^B(b' + \gamma 1g'(1-\delta') - m' + y', i') + \\ (1-\psi) v^B(b' + \max\{\gamma 1g'(1-\delta') - m', 0\} + y', i') \end{array} \right\} \end{array} \right\} \tag{12}$$

$$W^B = \max \left\{ \begin{array}{c} v^G(b' + 1g'(1-\delta') - m' + y', i'), \\ \left\{ \begin{array}{c} \psi v^G(b' + \gamma 1g'(1-\delta') - m' + y', i') + \\ (1-\psi) v^G(b' + \max\{\gamma 1g'(1-\delta') - m', 0\} + y', i') \end{array} \right\} \end{array} \right\} \tag{13}$$

Denote the cardinality of the number of credit states by $N_{\mathcal{S}}$. Let $\mathcal{W}$ be the set of all continuous (in b, g, m, y, δ), vector-valued functions $W : B \times G \times M \times Y \times \Delta \times I \to \mathbb{R}^{N_S}$ that are increasing in b, g, y and decreasing in m, δ that satisfy the following:

$$W^s(b, g, m, y, \delta, i) \in \left[\frac{u(0; P_l)}{1-\beta}, \frac{\bar{u}}{1-\beta}\right] \tag{14}$$

$$W^G(b, g, m, y, \delta, i) \geq W^B(b, g, m, y, \delta, i) \tag{15}$$

$$W^B(b, g, m, y, \delta, i) \geq W^D(b, g, m, y, \delta, i) \tag{16}$$

Lemma 7 *$\mathcal{W}$ is nonempty. With $\|W\| = \max_s\{\sup |W^s|\}$ as the norm, $(\mathcal{W}, \|\cdot\|)$ is a complete metric space.*

Proof Any constant vector-valued function that satisfies (14) is clearly continuous and satisfies the monotonicity requirements. The set of all continuous vector-valued functions coupled with the same norm $(C, \|\cdot\|)$ is a complete metric space, thus to prove that $(\mathcal{W}, \|\cdot\|)$ is a complete metric space I need to show that $\mathcal{W} \subset C$ is closed under the defined norm. Take an arbitrary sequence of functions from $\mathcal{W}$, $\{W_n\}$ that is converging to a function W^*. If W^* violates any of the conditions (14)-(16) or the monotonicity properties, then there must exist some N, such that W_N also violates those conditions or properties, but that contradicts the assertion that $W_n \in \mathcal{W}\ \forall n$. Therefore, W^* must satisfy conditions (14)-(16) and the monotonicity properties. To prove the continuity of W^*, one can apply Theorem 3.1 in Stokey, Lucas and Prescott (1989), adapted to a vector-valued function. ∎

Lemma 8 *Γ^D is nonempty, monotone, compact-valued and continuous.*

Lemma 9 *Given $W \in \mathcal{W}$, $v^D(a, y, i; W)$ defined by (9) exists, is continuous in a and y, increasing in a and strictly increasing in y.*

Proof The existence and continuity of $v^D(a, y, i; W)$ are a direct consequence of the Theorem of the Maximum, since W is continuous and Γ^D is compact valued and continuous. The strict monotonicity in y comes from the strict monotonicity of $u(\cdot; P_h)$. The monotonicity in a comes from the fact that Γ^D is monotone in a and the monotonicity of W. ∎

In order to show the existence of v^G and v^B I first need to extend their definitions, because for some values of a the budget correspondence may be empty. First, I will denote by $c_s(a, i, x')$ the consumption of a household with i, s, a who makes the portfolio choice x'. Thus, $c_G(a, i, x') \equiv a - b'P_b - g'[P_h - P_l] + m'P_m$ and $c_B(a, i, x') \equiv (a - b'P_b - g'[P_h - P_l] + m'P_m)/\lambda$. Note that these consumptions can be negative. Using this notation, I can define lifetime utility from choosing portfolio x' as follows:

$$\omega_B(a, i, x'; W) \equiv u\left(\max\{c_B(a, i, x'), 0\}\right) + \tag{17}$$

$$\beta \sum_{i' \in M} \pi(i'|i) \iint \begin{bmatrix} \alpha W^B(x', y', \delta', i') + \\ (1-\alpha) W^D(x', y', \delta', i') \end{bmatrix} dF(\delta') dP(y'|i') \tag{18}$$

$$\omega_G(a, i, x'; W) \equiv u\left(\max\{c_G(a, i, x'), 0\}\right) + \tag{19}$$

$$\beta \sum_{i' \in M} \pi(i'|i) \iint W^G(x', y', \delta', i') dF(\delta') dP(y'|i') \tag{20}$$

Lemma 10 *$\omega_s(a,i,x';W)$ is continuous in a and x'. Further, for any i,x', ω^s is increasing in a, and strictly increasing if $c_s(a,i,x')>0$.*

Proof Note that $c_s(a,i,x')$ are continuous functions of a and x' and $u(\cdot;P_l)$ is continuous in its first argument. Further, since $W\in\mathcal{W}$ it is continuous in x' and integration preserves continuity. The monotonicity comes because of the strict monotonicity in $u(\cdot;P_h)$ and the fact that $c_s(a,i,x')$ is increasing in a and strictly increasing in a when $c_s(a,i,x')>0$ ∎

Thus, I redefine the extended value functions as:

$$v^s(a,i;W)=\max_{x'\in\bar{X}_s(a,i)}\omega_s(a,i,x';W) \tag{21}$$

where $\bar{X}_s(a,i)=\{(b,g,m)\in B\times G\times M: bP_b+g[P_h-P_l]-mP_m\leq a\}\cup\mathbf{0}$ is taken to be the budget correspondence (without c) when

Lemma 11 *$v^s(a,i;W)$ exists, is continuous in its first argument and is increasing in its first argument.*

Proof Immediate from the Theorem of the Maximum and the monotonicity of ω_s. ∎

Lemma 12 *A bad credit history lowers lifetime utility $v^B\leq v^G$*

Proof Since $W\in\mathcal{W}$, $\alpha W^B+(1-\alpha)W^D\leq W^G$. From the definition of $c_s(a,i,x')$, $\max\{c_B(a,i,x'),0\}\leq\max\{c_G(a,i,x'),0\}$. Thus, from the strict monotonicity of $u(\cdot;P_h)$, $\omega_B(a,i,x';W)\leq\omega_G(a,i,x';W)$. Hence, since $\bar{X}_B\subset\bar{X}_G$, $v^B\leq v^G$. ∎

I define the operator vector valued operator $TW(b,g,m,y,\delta)=\{TW^s(b,g,m,y,\delta):s\in\mathcal{S}\}$ by:

$$TW^G=\max\left\{\begin{array}{c}\max\left\{\begin{array}{c}v^G\left(b'+1g'(1-\delta')-m'+y',i';W\right),\\ v^D\left(\min\{\max\{0,1g'(1-\delta')-m'\},\chi^s\},y',i';W\right)\end{array}\right\},\\ \left\{\begin{array}{c}\psi\max\left\{\begin{array}{c}v^G\left(b'+\gamma 1g'(1-\delta')-m'+y',i';W\right),\\ v^D\left(\min\{\max\{0,\gamma 1g'(1-\delta')-m'\},\chi^s\},y',i';W\right)\end{array}\right\}+\\ (1-\psi)\max\left\{\begin{array}{c}v^G\left(b'+\max\{\gamma 1g'(1-\delta')-m',0\}+y',i';W\right),\\ v^D\left(\min\{\max\{0,\gamma 1g'(1-\delta')-m'\},\chi^s\},y',i';W\right)\end{array}\right\}\end{array}\right\}\end{array}\right\}$$

$$TW^D=\max\left\{\begin{array}{c}v^B\left(b'+1g'(1-\delta')-m'+y',i';W\right),\\ \left\{\begin{array}{c}\psi v^B\left(b'+\gamma 1g'(1-\delta')-m'+y',i';W\right)+\\ (1-\psi)v^B\left(b'+\max\{\gamma 1g'(1-\delta')-m',0\}+y',i';W\right)\end{array}\right\}\end{array}\right\}$$

$$TW^B=\max\left\{\begin{array}{c}v^G\left(b'+1g'(1-\delta')-m'+y',i';W\right),\\ \left\{\begin{array}{c}\psi v^G\left(b'+\gamma 1g'(1-\delta')-m'+y',i';W\right)+\\ (1-\psi)v^G\left(b'+\max\{\gamma 1g'(1-\delta')-m',0\}+y',i';W\right)\end{array}\right\}\end{array}\right\}$$

Lemma 13 *T is a contraction mapping with modulus β.*

Proof In order to prove that T is a contract mapping I appeal to Blackwell's sufficient conditions:

1. Self-map: $TW \subset \mathcal{W}$. In order to show this first note that v^G, v^D and v^B are all continuous in their first argument, the convex combination of two continuous functions is continuous and the maximum of two continuous functions is continuous. The boundedness property (14) is satisfied by the boundedness of v^s. That TW is increasing in b', g' and y' comes from the fact that all the v^s are increasing in their first argument and that v^D is strictly increasing in y. By the same argument, TW is decreasing in both δ' and m'. The monotonicity properties (15) and (16) are satisfied by virtue of $W^G \geq W^B$ since the payoff in W^B can always be achieved in W^G, and since $v^G \geq v^B \Rightarrow W^B \geq W^D$.

2. Monotonicity: $\hat{W} \geq W \rightarrow T\hat{W} \geq TW$. For each $s \in \mathcal{S}$ $v^s(\cdot; W)$ is increasing in W. Therefore, because the convex combination of two increasing functions is increasing and the maximum of two increasing functions is increasing $T\hat{W} \geq TW$.

3. Discounting: $T(W+k) = TW + \beta k$. Notice that for each $s \in \mathcal{S}$ $v^s(\cdot; W)$, $v^s(\cdot; W+k) = v^s(\cdot; W) + \beta k$, thus for each $s \in \mathcal{S}$, $T(W^s + k) = TW^s + \beta k$. ∎

Since I have extended the domain of v^G and v^D I must now verify that an agent will never make a choice such that he will have no feasible choices (i.e. for v^G he would choose to go bankrupt rather than repay, and for v^B that he would never pick a portfolio choice that could result in a negative asset position at the beginning of the next period). First I prove that an agent will choose to go bankrupt rather than not go bankrupt and have zero consumption.

Lemma 14 *Under Assumption 1, an agent with a good credit history will always choose to go bankrupt rather than not go bankruptcy and have zero consumption. Furthermore, an agent that chooses not to go bankrupt always consumes a strictly positive amount.*

Proof The utility from choosing not to go bankrupt when the budget set is empty is bounded by $u(0; P_h) + \beta\bar{u}/(1-\beta)$. By choosing bankruptcy the agent can guarantee lifetime utility of at least $u(y_{\min}/\lambda)/(1-\beta)$, which by Assumption 1 is strictly greater. To ensure that conditional on not going bankrupt agents consume a strictly positive amount, note that from the continuity of $u(\cdot; P_h)$, there exists some $\tilde{c} > 0$ such that $u(\tilde{c}; P_h) + \beta\bar{u}/(1-\beta) < u(y_{\min}/\lambda)/(1-\beta)$, which implies that conditional on not going bankrupt an agent will consume at least $\tilde{c}$. ∎

When an agent is in the bankruptcy or bad credit state, he does not have the option to declare bankruptcy, only foreclosure. Therefore, I must show that an agent will never make a portfolio or foreclosure choice that would result in zero consumption in the subsequent period.

First consider the case where there is no recourse after foreclosure, i.e. $\psi = 0$. From Lemma 2, when $\psi = 0$ an agent will choose foreclosure whenever $1(1-\delta')g' < m'$. Hence, an agent will always begin the subsequent period with a positive a since $y_{\min}$ is bounded away from zero.

When there is a positive probability of recourse, i.e. $\psi > 0$, even if an agent chooses foreclosure, he may still be responsible for the entire balance of the mortgage. Further, since the support of $F(\delta')$ includes 1, there is a positive probability that the depreciated value of the house $1(1-\delta')g'$ is arbitrarily close to zero. Thus, I need to rule out any *portfolio choices* (b', g', m'), that could result in cash-at-hand positions for which the budget set is empty in the subsequent period. However, the current assumption on $u(0; P_h)$ does not guarantee this. I strengthen the assumption on the utility function, and make an assumptions on the distributions of δ and y. Essentially, I need the tail distributions for y and δ not to go to zero too quickly as $y \to y_{\min}$ and $\delta \to 1$. Formally:

Assumption 3 *There exist* $\underline{c} > 0$, $\tilde{y} > y_{\min}$, $\bar{\delta} < 1$ *and* $\phi > 0$ *such that:*

1. $\bar{g}(1-\bar{\delta}) + \tilde{y} = \underline{c}$
2. $\phi = (1-\alpha)\psi\pi(i_{\min}|i_{\min})P(\tilde{y}|i_{\min})(1-F(\bar{\delta}))$
3. $\phi\left[u(\underline{c}; P_h) + \beta\bar{u}/(1-\beta)\right] + (1-\phi)\bar{u}/(1-\beta) < u(y_{\min}/\lambda)/(1-\beta)$

It is important to note that negative cash-at-hand positions need not imply that the budget set is empty when the household is excluded from unsecured borrowing. Since households who purchase houses pay the value of the house less the mortgage and the value of the housing services, it is possible that $g'[1-P_h] - m'P_m < 0$ (note that when $\psi = 0$ no-arbitrage precludes this). Thus, denote by $v = \min_{x' \in \bar{X}} \{P_b b' + g'[1-P_h] - m'P_m\}$, the maximal resources that can be obtained by an agent with a bad credit history.

Lemma 15 *If* $\psi > 0$*, under Assumption 3, an agent with a bad credit history,* $s = B$*, will always choose a mortgage* $m' + v \leq b' + y_{\min}$.

Proof The proof is by contradiction. Suppose not, i.e. an agent chooses a mortgage $m' + v > b' + y_{\min}$. For any such m' the probability that $a' \leq \underline{c}$ is greater than ϕ, which implies that the probability that consumption is less than $\underline{c}$ is greater than ϕ. Thus, the agent would be strictly better off consuming his endowment for every period (something which is always feasible), a contradiction. ∎

Proof of Proposition 1 The existence and uniqueness of the value functions is an immediate consequence of Lemma 13 and the Contraction Mapping Theorem. The monotonicity properties of the value functions and the effect of a bad credit score follow immediately from Lemmas 11 & 12. ∎

Lemma 16 *Conditional on the foreclosure choice and deficiency judgment realization, the bankruptcy decision* d^* *depends only on unsecured debt* $\tilde{b}'$*, positive home equity* η'*, non-exempt equity* ξ'*, endowment* y'*, and persistent state* i'.

The proof of Proposition 2 is an extension of Chatterjee et al. (2007). I first prove two lemmas.

Lemma 17 *Let* $\hat{y} \in Y \backslash \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$, $y > \hat{y}$. *If* $y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$, *then the optimal consumption with* $\hat{y}$, $c^*(\eta' + \tilde{b}' + \hat{y}) > \hat{y}$.

Proof Since $\hat{y} \in Y \backslash \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$, the agent strictly prefers not declaring bankruptcy, i.e.:

$$u(c^*(\eta' + \tilde{b}' + \hat{y}); P_l) + \beta \mathbb{E}[\max\{v^G, v^D\}] > u(\hat{y}; P_l) + \beta \mathbb{E} v^B(\eta') \tag{22}$$

Where $v^B(\eta')$ is an abuse of notation to denote the value function given a total savings in home equity. Let $\Delta = y - \hat{y}$. The choices: $\check{c} = c^*(\eta' + \tilde{b}' + \hat{y}) + \epsilon, \check{b}' = b'^*, \check{g}' = g'^*, \check{m}' = m'^*$ were feasible choices with resources $y + \eta' + \tilde{b}'$, but were not chosen since $y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$ (where the starred variables are the optimal choices under endowment $\hat{y}$), therefore:

$$u(\check{c}; P_l) + \beta \mathbb{E}[\max\{v^G, v^D\}] \leq u(y; P_l) + \beta \mathbb{E} v^B(\eta') \tag{23}$$

Subtracting equations (22) and (23) I obtain:

$$u(\hat{y} + \epsilon; P_l) - u(\hat{y}; P_l) > u(c^*(\eta' + \tilde{b}' + \hat{y}) + \epsilon; P_l) - u(c^*(\eta' + \tilde{b}' + \hat{y}); P_l) \tag{24}$$

which from the strict concavity of $u(\cdot; P_l)$ implies that $c^*(\eta' + \tilde{b}' + \hat{y}) > \hat{y}$. I have been a little loose with canceling the v^B's, but the portfolio choices should be identical given the identical savings levels. Further, I can always impose the same portfolio choice for equation (22) since it was clearly feasible, so the canceling is correct. ∎

Lemma 18 *Let* $\hat{y} \in Y \backslash \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$, $y < \hat{y}$. *If* $y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$, *then the optimal consumption with* $\hat{y}$, $c^*(\eta' + \tilde{b}' + \hat{y}) < \hat{y}$.

Proof Omitted. The proof is essentially identical to the previous. ∎

Proof of Proposition 2

(a) If $\overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$ is non-empty let $\underline{y}^B = \inf \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$ and $\bar{y}^B = \sup \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$. These both exist from the Completeness Property of $\mathbb{R}$ since $\overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i') \subseteq Y \subset \mathbb{R}$. If they're equal, I'm done, therefore suppose $\underline{y}^B < \bar{y}^B$. Take $\hat{y} \in (\underline{y}^B, \bar{y}^B)$. Suppose by way of contradiction that $\hat{y} \notin \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$. Now, there exists a $y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$ such that $y > \hat{y}$ (if not $\bar{y}^B = \hat{y}$, contradicting that $\hat{y} \in (\underline{y}^B, \bar{y}^B)$). Thus, from Lemma 1, $c^*(\eta' + \tilde{b}' + \hat{y}) > \hat{y}$. By the same argument there exists a $y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$ such that $y < \hat{y}$, but from Lemma 2 this implies $c^*(\eta' + \tilde{b}' + \hat{y}) < \hat{y}$, a contradiction. The closedness comes from the continuity of v^G and $u(\cdot; P_h)$. ∎

(b) Suppose $y \in \overline{\mathcal{B}}^*(\tilde{b}'_1, \eta', \xi', i')$. Take $\tilde{b}'_2 < \tilde{b}'_1$. Since v^G is increasing in the first argument, $v^G(\tilde{b}'_2 + \eta' + y, i') \leq v^G(\tilde{b}'_1 + \eta' + y, i')$. However, since $y \in \overline{\mathcal{B}}^*(\tilde{b}'_1, \eta', \xi', i')$ this implies that $v^G(\tilde{b}'_1 + \eta' + y, i') \leq v^D(\eta' - \xi', y, i') \Rightarrow v^G(\tilde{b}'_2 + \eta' + y, i') \leq v^D(\eta' - \xi', y, i') \Rightarrow y \in \overline{\mathcal{B}}^*(\tilde{b}'_2, \eta', \xi', i')$, which implies $\overline{\mathcal{B}}^*(\tilde{b}'_1, \eta', \xi', i') \subseteq \overline{\mathcal{B}}^*(\tilde{b}'_2, \eta', \xi', i')$. ∎

Proof of Proposition 3

(a) Suppose $y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi_1', i')$. Take $\xi_2' < \xi_1'$. Since v^D is increasing in the first argument $v^D(\eta' - \xi_1', y, i') \leq v^D(\eta' - \xi_2', y, i')$. However, since $y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi_1', i')$ this implies that $v^G(\tilde{b}' + \eta' + y, i') \leq v^D(\eta' - \xi_1', y, i')$, which implies that $y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi_2', i')$. $\blacksquare$

(b) Suppose $y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$. Take $x > 0$. Since v^D is increasing in its first argument, $v^D(\eta' + x - \xi', y, i') \geq v^D(\eta' - \xi', y, i')$. However, since $y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$ this implies that $v^G(\eta' + y + \tilde{b}', i') \leq v^D(\eta' - \xi', y, i')$, and $v^G(\eta' + y + \tilde{b}', i') = v^G((\eta' + x) + y + (\tilde{b}' - x), i')$, therefore $y \in \overline{\mathcal{B}}^*(\tilde{b}' - x, \eta' + x, \xi', i')$. $\blacksquare$

(c) When there is no homestead exemption the value of defaulting only depends on the endowment y and state i'. Today's budget set only depends on the net asset position, therefore the bankruptcy set only depends on $\eta' + \tilde{b}'$ and i'. $\blacksquare$

(d) This comes directly from Proposition 1 and that $v^G(a, i) \geq v^B(a, i)$. Let $\varepsilon = \tilde{b}' + \eta' - \chi^s > 0$. Suppose not, i.e. $\exists y \in \overline{\mathcal{B}}^*(\tilde{b}', \eta', \xi', i')$. This implies that $u(y; P_l) + \beta \mathbb{E} v^B(\chi^s, i') \geq u(c^*(\eta' + \tilde{b}' + y); P_l) + \beta \mathbb{E} v^G(s^*(\eta' + \tilde{b}' + y), i')$. However, consuming $y + \varepsilon$ and saving χ^s was a feasible choice, which implies that: $u(c^*(\eta' + \tilde{b}' + y); P_l) + \beta \mathbb{E} v^G(s^*(\eta' + \tilde{b}' + y), i') \geq u(y + \varepsilon; P_l) + \beta \mathbb{E} v^B(\chi^s, i') > u(y; P_l) + \beta \mathbb{E} v^B(\chi^s, i')$ from the strict monotonicity of u, which arrives at the desired contraction. $\blacksquare$

Proof of Lemma 1 When $\gamma < 1$ and $1g'(1 - \delta') > m'$ implies $1g'(1 - \delta') - m' > \gamma 1 g'(1 - \delta') - m'$ (the deficiency judgment value) and $\mathbf{1}g'(1 - \delta') - m' > \max\{\gamma \mathbf{1} g'(1 - \delta') - m', 0\}$ (the no deficiency judgment value). Thus, the household can guarantee itself strictly more resources tomorrow if it does not declare bankruptcy (if it has a good credit history), then from since the value functions are increasing in their first argument, we are done. In case of bankruptcy and $\chi^s > 0$ the same argument holds. If $\chi^s = 0$ the assumption that when a household has positive home equity and is indifferent between foreclosuring and not it chooses to repay completes the proof. $\blacksquare$

Proof of Lemma 2 The proof is immediate from Lemma 1 and the definition of foreclosure when $\psi = 0$. When $\delta' \geq 1 - \kappa' \Rightarrow 1g'(1 - \delta') \leq m'$, thus the household will always have more resources if it chooses foreclosure. $\blacksquare$

B Proofs Related to the Intermediaries Problem

Proof of Lemma 4 The proof is a direct consequence of Propositions 2-3 and Lemma 2. $\blacksquare$

Proof of Lemma 5 This is essentially the same as Jeske, Krueger, and Mitman (2010) Proposition 7. The result for P_m carries through. To complete the proof note that when χ^0 the price of unsecured credit is decreasing in m. Thus, for a fixed g', b', picking an m' such that $m'/g' > \kappa^*$ reduces mortgage and unsecured receipts. $\blacksquare$

C Computational Details

In order to calibrate the model I employ a nested fixed point algorithm to match relevant moments from the model with the data. I discretize the state space and the choice parameters and fix a level of consumption $\underline{c}$ consistent with Assumption 3.

The outline of the algorithm is as follows:

1. **Loop 1** - Guess a vector of the structural parameters Θ^0
   (a) **Loop 2** - Make an initial guess for the price of housing services P_h^0
      i. **Loop 3** - Make an initial guess for the price schedules P_b^0 and P_m^0
      ii. Compute the policy choice $(\breve{b}', \breve{g}', \breve{m}')$ that yields the maximal resources in the current period, and denote it by $\breve{a}$.
         A. **Loop 4** - Make an initial guess for v^0 on the domain $[\breve{a} - \underline{c}, \bar{a}]$, and define v^0 for $a < \breve{a} - \underline{c}$ as $u(\underline{c}) + \beta\bar{u}/(1-\beta)$, consistent with the extended definition from Appendix A.
         B. Compute $\mathbb{E}_{\delta',y',i'} W(b', g', m', y', \delta', i')$ for each choice of b', g', m', and the implied default decisions $d(b', g', m', y', \delta', i')$ and $f(b', g', m', y', \delta', i')$.
         C. Compute the new value functions, v^1, by maximization given $\mathbb{E}_{\delta',y',i'} W(b', g', m', y', \delta', y')$
         D. Compute the foreclosure, bankruptcy and portfolio policy functions
         E. If $\|v^1 - v^0\| < \epsilon_v$ end **Loop 4**, otherwise set $v^0 = v^1$ and go to B.
      iii. Given the default decisions $d(b', g', m', y', \delta', y')$ and $f(b', g', m', y', \delta', y')$, use Equations 5 & 4 to compute the new implied price schedules P_b^0 and P_m^0.
      iv. If $\|P^1 - P^0\| < \epsilon_P$ end **Loop 3**, otherwise set $P^0 = \nu P^0 + (1-\nu)P^1$ and go to (ii).
   (b) Compute the invariant distribution μ over $A \times I \times \mathcal{S}$.
   (c) Compute the housing services supplied H^S and demanded H^D from the policy functions and invariant distribution.
   (d) If $\|H^D - H^S\| < \epsilon_H$ end **Loop 2**.
   (e) If $H^D < H^S$, pick $P_h^1 < P_h^0$ and repeat **Loop 3**
   (f) Repeat until $H^D > H^S$, then use a bisection until $\|H^D - H^S\| < \epsilon_H$ end **Loop 2**.
2. Compute model moments $\mathcal{M}^{\text{MODEL}}$.
3. If $\sum w_i(\mathcal{M}_i^{\text{MODEL}} - \mathcal{M}_i^{\text{DATA}})^2 < \epsilon_{\mathcal{M}}$ end **Loop 1**. Otherwise, return to 1.

D Foreclosure and Bankruptcy Information by State

Table 11: Foreclosure Deficiency and Homestead Bankruptcy Exemption by State

State	Foreclosure Deficiency	Max Homestead Exemption	Federal Allowed
Alabama	Yes	5,000*	No
Alaska	No	54,000	No
Arizona	No	150,000	No
Arkansas	Yes	17,425*	Yes
California	No	50,000†	No
Colorado	Yes	45,000	No
Connecticut	Yes	75,000	Yes
Delaware	Yes	50,000	No
D.C.	Yes	17,425*	Yes
Florida	Yes	∞	No
Georgia	Yes	10,000*	No
Hawaii	Yes	17,425*	Yes
Idaho	Yes	104,471	No
Illinois	Yes	7,500*	No
Indiana	Yes	7,500	No
Iowa	No	∞	No
Kansas	Yes	∞	No
Kentucky	Yes	5,000	No
Louisiana	Yes	25,000	No
Maine	Yes	35,000	No
Maryland	Yes	0	No
Massachusetts	Yes	100,000	Yes
Michigan	Yes	17,425*	Yes
Minnesota	No	200,000	Yes
Mississippi	Yes	75,000	No
Missouri	Yes	15,000	No
Montana	No	100,000	No
Nebraska	Yes	12,500	No
Nevada	Yes	550,000	No
New Hampshire	Yes	100,000	No
New Jersey	Yes	17,425*	Yes
New Mexico	Yes	30,000*	Yes
New York	Yes	50,000	No
North Carolina	No	18,500	No
North Dakota	No	80,000	No
Ohio	Yes	5,000	No

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Table 11 – Continued

State	Foreclosure Deficiency	Max Homestead Exemption	Federal Allowed
Oklahoma	Yes	∞	No
Oregon	Yes	25,000‡	No
Pennsylvania	Yes	17,425*	Yes
Rhode Island	Yes	200,000	Yes
South Carolina	Yes	17,425*	Yes
South Dakota	Yes	30,000	No
Tennessee	Yes	5,000†	No
Texas	Yes	∞	Yes
Utah	Yes	20,000*	No
Vermont	Yes	75,000	Yes
Virginia	Yes	5,000*	No
Washington	No	40,000	Yes
West Virginia	Yes	25,000	No
Wisconsin	Yes	40,000*	Yes
Wyoming	Yes	10,000*	No

*Can be doubled for couples
†Can be multiplied by 1.5 for couples
‡33,000 for couples