Macroeconomic Effects of Bankruptcy & Foreclosure Policies*

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Abstract

I develop a general-equilibrium model of housing and default to jointly analyze the effects of bankruptcy and foreclosure policies. Heterogeneous households have access to mortgages and unsecured credit and can default separately on both types of debt. I show that the interaction between foreclosure and bankruptcy decisions is crucial for explaining the observed cross-state correlation between default policies and default rates. I use the model to argue that a major recent reform to bankruptcy has unintended consequences: it substantially increases bankruptcy rates, despite being intended to reduce them, and also increases foreclosure rates. Nevertheless, the reform yields large welfare gains.

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JEL codes: E21, G11, K35, R21

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In the United States, households hold two types of debt, secured and unsecured, and they hold large amounts of it, currently averaging more than 100 percent of disposable income. There are two channels for defaulting on this debt: bankruptcy for unsecured borrowing and foreclosure for secured mortgage borrowing. Households exercise these default options in substantial numbers - in 2010 more than 1.5 million households filed for bankruptcy and more than 1 million homes were foreclosed. In this paper, I use a calibrated structural model to argue that the two channels for default - bankruptcy and foreclosure - are fundamentally linked by household behavior. Understanding this link is critical for explaining the observed cross-state variation in bankruptcy and foreclosure rates and evaluating the consequences of reforms to bankruptcy and foreclosure policies.

Despite being separate legal processes, bankruptcy and foreclosure can be complements or substitutes: bankruptcy may prevent foreclosure by discharging a household's unsecured debt, thereby freeing up income for making mortgage payments. On the other hand, foreclosure could lead to bankruptcy if banks can sue households who default on their mortgages to recoup losses (in addition to seizing their homes). Further, households take into account the different channels for default when choosing the optimal composition of secured and unsecured debt in their portfolios. Thus, a change to bankruptcy laws, for example, may impact secured credit holdings and foreclosure rates if households respond by adjusting their debt portfolios.

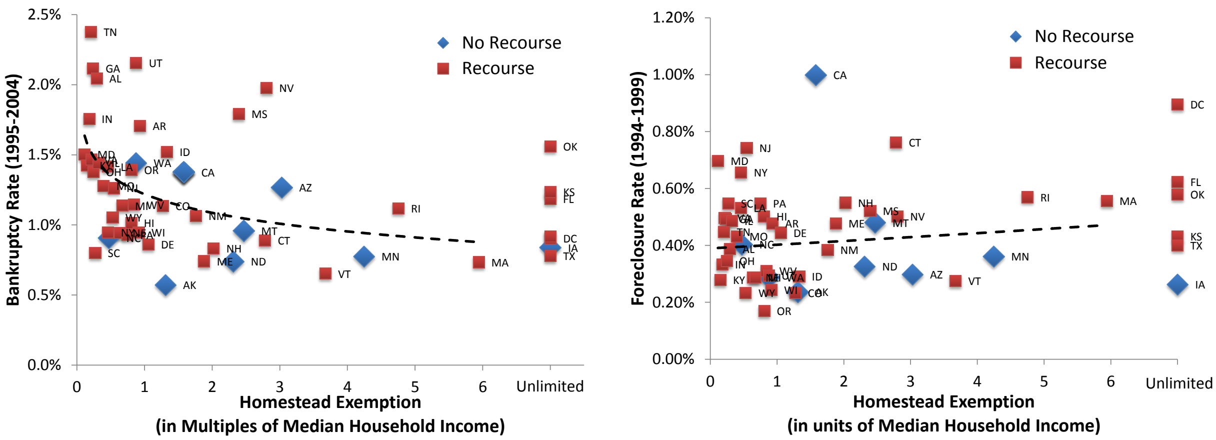
The fraction of households that choose to exercise the bankruptcy or foreclosure option varies greatly across U.S. states. In 2010, bankruptcy rates ranged from a low of 0.4 percent of households in Alaska to a high of 2.9 percent of households in Nevada. Similarly, foreclosure rates ranged from 0.4 percent of mortgages in North Dakota to 2.9 percent of mortgages in Nevada. A natural candidate to explain the cross-state variation in default rates is the variation in state bankruptcy and foreclosure laws.

States vary significantly in two pertinent dimensions of default law: the homestead exemption in bankruptcy and recourse in foreclosure. The homestead exemption specifies how much home equity the household can keep after the discharge of unsecured debt when a household files for Chapter 7 bankruptcy. In recourse states, after forfeiting their home, foreclosed households are still liable for the difference between the recovered value of the house and the face value of the mortgage, as opposed to no-recourse states where households can walk away from their mortgages with no additional liability. In Figures 1(a) and 1(b), I plot state bankruptcy and foreclosure rates as a function of the homestead exemption. The figures illustrate the significant variation in default rates and laws across states. In addition, Figure 1(a) illustrates a *negative correlation* between the generosity of the bankruptcy law and the bankruptcy rate. This relationship is striking: one might expect that more generous bankruptcy laws would make households more likely to go bankrupt. In fact, in an empirical study Scott Fay, Erik Hurst & Michelle J. White (2002) find that a household's chance of going bankrupt is increasing in the financial benefit from doing so. However, micro analysis is silent on whether portfolios of debt held by households are systematically different in states with different homestead exemptions. If more generous bankruptcy policies result in higher interest rates on unsecured debt, they may lead to lower unsecured debt holdings and therefore lower bankruptcy rates. This observed relationship between bankruptcy and the homestead exemption suggests that accounting for general equilibrium effects of policies might be important in reconciling micro and macro facts related to bankruptcy.

Motivated by these observations, I ask three questions in this paper: (1) What fraction of cross-state variation in default rates can be explained by differences in bankruptcy and foreclosure laws? (2) What are the effects of a major reform to bankruptcy, the 2005 Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA)? and (3) If the government could standardize exemption and recourse policy across states, what policy should it adopt?[1]

To address these questions, I analyze theoretically and quantitatively the effects of the homestead exemption and recourse on household portfolio and default choices, default

[1] The U.S. Congress has attempted and failed to standardize state exemption policy numerous times in the last 35 years amid intense debate over the optimal level of exemptions.



(a) State bankruptcy rates

(b) State foreclosure rates

Figure 1: Bankruptcy and Foreclosure Rates Across States. *Notes:* The homestead exemptions in terms of median income is calculated by state law for the homestead exemption in the year 2000 and median household income from the Census in 2000. Average state bankruptcy rates 1995-2004 are computed using bankruptcy filings from the American Bankruptcy Institute and the number of households in each state from the Census. Average state foreclosure rates 1994-1999 are computed from the Mortgage Banker Association's quarterly National Delinquency Survey from 1994-1999. The dashed lines are smoothed versions of the data.

rates and welfare. I construct a heterogeneous-agent general-equilibrium incomplete-markets model. The model has elements in common with the bankruptcy model of Satyajit Chatterjee, Dean Corbae, Makoto Nakajima & Jose-Victor Ríos-Rull (2007) and the foreclosure model of Karsten Jeske, Dirk Krueger & Kurt Mitman (2011). Households can finance purchases of a housing good with mortgages, and can save in bonds or borrow in unsecured debt. Households face idiosyncratic income and housing risk and 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 is stochastically 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 again for a period of time.

My main theoretical contribution is to characterize how the bankruptcy decision depends on the entire household portfolio. Unlike Chatterjee et al. (2007), I find that the net worth of a household is not a sufficient statistic for understanding a household's decision to go bankrupt. The bankruptcy decision depends jointly on the level of unsecured debt, home equity and non-exempt home equity. Given these three quantities, I prove that the set of income realizations that triggers bankruptcy is a closed interval. Further, I show that for a fixed level of net worth, a household with more home equity is more likely to declare bankruptcy since it stands to gain more from having its unsecured debt discharged. In addition, I show that the probability of going bankrupt is decreasing in the amount of non-exempt home equity, as the non-exempt portion is seized in bankruptcy.

My main quantitative result is that the model can account for 20 percent of the overall variation in state bankruptcy rates, and for 80 percent of the variation that cross-state regressions attribute to differences in laws. The model predicts, consistent with state level data, lower bankruptcy rates in states with higher homestead exemptions. More generous exemptions lessen the penalty from bankruptcy and therefore increase the probability of homeowners going bankrupt. This raises the equilibrium interest rate on unsecured borrowing. This higher interest rate, coupled with access to secured borrowing, causes households to substitute secured credit for unsecured by taking on more highly leveraged mortgages. Therefore, in states with higher exemptions, the household portfolio is more heavily weighted toward secured debt, resulting in lower bankruptcy rates, but higher foreclosure rates. Generating the negative correlation between bankruptcy rates and the homestead exemption depends crucially on the ability of households to endogenously substitute between the two types of credit. I show in a counter-factual analysis where secured borrowing and foreclosure are not allowed, that this version of the model does not reproduce the observed negative relationship between bankruptcy rates and the homestead exemption. This thought experiment highlights the importance of modeling secured and unsecured credit together.

Third, I use the calibrated model to evaluate the effects of a recent major reform to bankruptcy law: the 2005 Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA). The reform prohibited households earning above median income in their state from filing for bankruptcy. Analyzing the transition path induced by the reform, I find that bankruptcy rates initially drop, but then rise significantly for several years until converging to a rate roughly double the pre-reform level. The fraction of households with negative net worth and the total unsecured debt outstanding also increase significantly along the transition. Since income is highly persistent, households with above median income have a high probability of staying above median income (and being precluded from filing for bankruptcy) in subsequent periods, and thus their default risk is low. As a result, these households face much lower prices for unsecured debt, and optimally take on more of it than before the reform. If they remain above median income they repay or roll over the debt, but if they fall below the income threshold they optimally choose to go bankrupt. This simultaneously generates increased indebtedness and higher bankruptcy rates.

Even though the BAPCPA reform only changed bankruptcy law, I find that it has significant effects on foreclosure rates as well. Along the transition foreclosure rates increase for several years and then converge to a level 0.6 percentage points higher. My findings provide support for the hypotheses of Donald P. Morgan, Benjamin C. Iverson & Matthew Botsch (2009) and Wenli Li, Michelle J. White & Ning Zhu (2010) that BAPCPA contributed to the subsequent observed rise in foreclosure rates. As mentioned above, households become increasingly indebted causing a left-ward shift in the wealth distribution. Both before and after BAPCPA, households with low net worth take on more highly leveraged mortgages than high net worth households because they have fewer resources to finance housing purchases. Thus, increasing the mass of low net worth households increases the foreclosure rate. In addition, households with non-exempt home equity take on less unsecured debt (since it provides less insurance against housing risk), resulting in portfolios more heavily weighted toward mortgage debt.

Despite the increase in default rates, using a utilitarian welfare measure, households on average are willing to pay more than 1.4 percent of lifetime consumption to implement the policy. The mechanism behind the welfare gain is the increased state-contingency of unsecured debt after BAPCPA. Restricting bankruptcy only to households who earn below median income moves the unsecured debt contract closer to an insurance contract against low income realizations. Households can take on unsecured debt and exempt home equity at lower prices than before the reform. In the event of a low income realization, households can declare bankruptcy and keep the home equity. Thus, using a combination of home equity and unsecured credit, households can insure themselves against low income realizations.

Finally, I address the question of what level of exemption and recourse policy the federal government should enact were it to standardize default policies across states. I find that, under a utilitarian welfare function, the optimal joint policy is no-recourse foreclosure and a homestead exemption of roughly 25 percent of the state median income. The intuition for the result is as follows. Households in the economy face two types of risk: income risk and house price risk. 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.

The rest of the paper is organized as follows. In Section 1, I review the existing literature. 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. In Section 6, I discuss the results of policy experiments. Section 7 concludes.

1 Connections to Existing Literature

This paper is related to multiple areas of the literature on incomplete markets and household default. Chatterjee et al. (2007) and Igor Livshits, James MacGee & Michele Tertilt

(2007) study economies with savings and competitively priced unsecured debt, with prices depending on loan size and household characteristics.[2] In their models, these authors abstract from a household portfolio of exempt assets and liabilities and only consider the net household position since their focus is only on bankruptcy and unsecured credit. In my framework, I include an exempt housing asset and show that the net position is not sufficient to determine the default decision. Including assets and liabilities allows the model to be consistent with the large fraction of bankrupt households who have positive home equity. Further, the endogenous penalty of having non-exempt assets seized generates average credit spreads on unsecured credit that are consistent with what is observed in the data, which the existing literature has had trouble matching. Marina Pavan (2008) and Wenli Li & Pierre-Daniel Sarte (2006) incorporate durables into equilibrium default models to study the effects of homestead exemptions, but abstract from secured debt. Thomas Hintermaier & Winfried Koeniger (2009) analyze optimal debt portfolios in a life-cycle model of durable and non-durable consumption, but without the possibility of mortgage default.

Recent papers by Jeske, Krueger & Mitman (2011), Dean Corbae & Erwan Quintin (2011), Satyajit Chatterjee & Burcu Eyigungor (2011) and Carlos Garriga & Don Schlagenhauf (2009) build equilibrium models of housing, endogenous leverage choice, and foreclosure. Those papers abstract from unsecured debt and bankruptcy, and are primarily focused on understanding the effects of government housing market policy or the 2007 housing bust.[3] I see my paper as complementing those papers by providing insight on how BAPCPA may have contributed to the subsequent rise in foreclosures. To my knowledge, this is the first study to investigate the joint causes and consequences of foreclosure and bankruptcy in a structural, dynamic, general equilibrium model.[4]

[2] Kartik Athreya (2002) provides an early analysis of an incomplete markets model integrating a bankruptcy option. However, he assumes that all loans are pooled, so that loan pricing does not depend on household characteristics or loan sizes.

[3] There is also an important, empirically focused literature that investigates the causes and consequences of the recent housing bust, see e.g. Foote et al. (2009) or Atif Mian, Amir Sufi & Francesco Trebbi (2011).

[4] This work also complements a growing empirical literature that focuses on the interaction between foreclosure and bankruptcy (e.g., Sarah Carroll & Wenli Li (2008), Wenli Li & Michelle J. White (2009)).

Another strand of the literature has empirically investigated the effects of homestead exemptions and recourse. These papers provide an empirical benchmark to evaluate the predictions of the model. Reint Gropp, John Karl Scholz & Michelle J. White (1997) find that in states with higher homestead exemptions households with lower wealth are more likely to be denied auto loans. Karen M. Pence (2006) finds smaller mortgages are originated in states with borrower friendly foreclosure laws. Complementing that work, Andra C. Ghent & Marianna Kudlyak (2011) estimate that recourse laws significantly reduce the probability of foreclosure.

2 Model

I model each state in the US as an endowment economy, populated with a measure one continuum of households, a measure one continuum of banks and a measure one continuum of real estate construction companies. Time is modeled discretely and all agents are infinitely lived.

2.1 Households

Each period, households receive an idiosyncratic endowment of the consumption good y. The endowment is assumed to follow a stochastic process consisting of a persistent and a transitory component:

$$\log(y) = z + \varepsilon$$

where

$$z' = \rho z + \sqrt{(1-\rho^2)}\eta$$

where ε and η are independent normally distributed random variables with variances σ_ε^2 and σ_η^2.

Households derive period utility $U(c, s)$ from consumption and housing services s, which can be purchased at a price p_s relative to the consumption good. Households are expected utility maximizers and discount the future with parameter β.

Households can save or borrow 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 asset choices and is denoted $q_b(\cdot)$. The timing is such that for savings the household pays $b' \times q_b(b', \cdot)$ in the current period to receive b' in the subsequent period. For unsecured borrowing, the household receives $-b' \times q_b(b', \cdot)$ and has to repay $-b'$ in the subsequent period or has to go bankrupt.

Households can purchase perfectly divisible houses h' at a price p_h per unit of housing. Each unit of the housing good generates a unit flow of housing services, which can be rented out in the same period of purchase. I assume that houses are subject to *idiosyncratic* depreciation shocks, δ'.[5] The shocks are distributed according to CDF $F(\delta')$, with negative values of δ' corresponding to house appreciation. The realizations of δ' are assumed to be independent across time and households. A law of large numbers is assumed to hold such that $F(\cdot)$ represents the cross-sectional distribution of depreciation shocks.

Households can finance housing purchases with mortgages with face value denoted by m'. The mortgage is secured by the housing good owned by the household, and the price $q_m(\cdot)$ can be a function of all observable household characteristics as well as goods and asset choices. I assume that neither households nor financial intermediaries can commit to long term mortgage contracts.[6] A mortgage therefore is a one-period contract to receive

[5] The depreciation shock is intended to capture individual (as opposed to aggregate) changes in house values. In a steady state environment with constant aggregate house prices, this shock will generate households with negative home equity, which I later prove is a necessary condition for going into foreclosure. Alternatively, one could assume that the shocks are to the per unit price of the house, as opposed to the physical stock. That model is equivalent except for the case of sufficiently large shocks that would cause the price of the home to fall below the value of the services it generates. Given that the probability of such shocks is small, this modeling choice is inconsequential.

[6] On the household side, the assumption is innocuous given access to low cost mortgage refinance and home-equity lines of credit. On the bank side, long term contracts provide households insurance against inflation risk, real-interest rate risk and income risk. Since I am focused on steady-state equilibria, there is no aggregate inflation or interest rate risk that households need to insure against. In Section 3, I show that in no-recourse states households are also insured against income risk. A result of the assumption is

$m' \times q_m(m', \cdot)$ units of the consumption good in the current period and to repay m' in the subsequent period or to go into foreclosure.

2.2 Legal Environment

2.2.1 Foreclosure

Households have the option to default on mortgages after the realization of the housing depreciation and income shocks. 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,[7] i.e. the household receives $\max\{\gamma(1-\delta')p_h h' - m', 0\}$, where m', h' 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. If the housing collateral (after depreciation and foreclosure) is less than the face value of the mortgage, the difference is converted into unsecured debt via a stochastic deficiency judgment technology. Deficiency judgments $\mathcal{J} = 1$ occur with probability $\psi \in [0, 1]$, with probability $1 - \psi$, $\mathcal{J} = 0$.[8] The unsecured position of the households after foreclosure can be represented as:

$$b_F = b' + \mathcal{J}(\gamma(1-\delta')p_h h' - m')$$

where $\mathbb{E}[\mathcal{J}] = \psi$. A no-recourse state is a state where $\psi = 0$.[9]

that households face significant risk from housing shocks because they must refinance every period. This is most likely to affect results regarding how much negative home equity households are willing to tolerate before going into foreclosure. It is not clear that missing on that margin, however, significantly impacts the cross-state variation in defaults or evaluating reforms to bankruptcy laws, and is thus defendable for my analysis.

[7] This is consistent with foreclosure law. If the value of the collateral exceeds the outstanding debt, the bank must return the excess after liquidating the collateral and covering any associated foreclosure costs.

[8] The assumption of stochastic deficiency judgments is an abstraction to capture the decision of the bank to sue a household motivated by the fact that banks do not pursue deficiency judgments for all households who go into foreclosure even if it is legally allowed.

[9] Assuming that there is no additional penalty from foreclosure in no-recourse states yields a sharp characterization of the infinite-dimensional mortgage pricing function. In the US, a foreclosure would show up on the credit report of a household, potentially affecting the future ability to obtain a new mortgage. How-

2.2.2 Bankruptcy

Bankruptcy is modeled after the U.S. Chapter 7 bankruptcy law. Chapter 7 is by far the most commonly exercised bankruptcy option, accounting for more than 70 percent of all bankruptcies.[10] The amount of home equity that can be kept in bankruptcy - the state homestead exemption - is denoted by χ. The bankruptcy decision is made after the foreclosure decision and deficiency judgment realization. The timing convention is chosen to preclude the possibility of the household having an empty budget set after both default decisions. If a household declares bankruptcy, in the current period the following happens:

1. The household can keep home equity up to the exemption
2. Any non-exempt home equity is applied to unsecured debt
3. Unsecured debt is set to 0 and the household cannot accumulate bonds
4. The household cannot change its home equity balance
5. The household's credit history state changes to bad

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 with bad credit histories are excluded from unsecured borrowing and cannot declare bankruptcy, but they are not excluded from the mortgage market. Further,

ever, if households provide a sufficiently high down payment, the bad credit can be overcome. As such, it is reasonable to assume no additional penalty. In the model, just foreclosed households tend to have low wealth, and optimally choose not to purchase housing despite having access to credit, further mitigating the issue.

[10]The other option for households is Chapter 13 bankruptcy. Chapter 13 involves a repayment of debts over a 3-5 year period. Close to 50 percent of households who enter into Chapter 13 do not successfully complete the repayment plan, and a significant fraction end up converting to Chapter 7. It is important to note that the homestead exemption is still relevant for Chapter 13. Creditors must receive at least as much repayment as they would under the discharge of debt in Chapter 7.

households with bad credit histories face a proportional consumption penalty λ to represent, among other things, 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 $1-\alpha$.

2.3 Household Decision Problem

Households can be in one of two credit history states, $\mathcal{H} = \{G, BC\}$, G represents a good credit history and BC represents having a bad credit history. The relevant state variables at the beginning of the period are the household portfolio, b, h, m, credit history, $\mathcal{H}$ and shocks δ, y, z. Let $X = (b, h, m, \delta, y, z)$, which summarizes the household state. Denote by a the cash-at-hand, or net resource household of a household after the foreclosure and bankruptcy decisions, and $\eta = \max\{p_h h(1-\delta) - m, 0\}$ the non-negative home equity of a household after the default decisions. 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:

$$V^G(b, h, m, \delta, y, z) = \max_{\mathcal{F}\in\{0,1\}} \mathbb{E}_{\mathcal{J}} \max\left\{W^B_{\mathcal{F}}(\eta_{\mathcal{F}}, y, z), W^{NB}_{\mathcal{F}}(a_{\mathcal{F}}, z)\right\} \tag{1}$$

where $\mathbb{E}_{\mathcal{J}}$ is the expectation over a deficiency judgment if the household goes in to foreclosure, and $W^{NB}_{\mathcal{F}}$ and $W^B_{\mathcal{F}}$ are the value of not going bankrupt and going bankrupt, respectively, conditional on the foreclosure choice. Conditional on choosing not to go bankrupt ($W^{NB}_{\mathcal{F}}$), the households solves:

$$W^{NB}_{\mathcal{F}}(a_{\mathcal{F}}, z) = \max_{c,s,m',h'\geq 0,b'} \left\{U(c, s) + \beta\mathbb{E}_{(\delta',y',z')|z} V^G(b', h', m', \delta', y', z')\right\}$$

$$\text{subj. to} \quad c + p_s s + [p_h - p_s]h' - m' q_m(b', h', m', z, G) + b' q_b(b', h', m', z) \leq a_{\mathcal{F}}$$

$$\text{where:} \quad \underbrace{a_{\mathcal{F}=0} = (1-\delta)p_h h - m + b + y}_{\text{No Foreclosure}} \quad \text{and} \quad \underbrace{a_{\mathcal{F}=1} = b_F + y}_{\text{Foreclosure}}$$

The household chooses contemporaneous consumption and new bond, housing and mortgage positions. A household who went bankrupt ($W^B_{\mathcal{F}}$), and conditional on the foreclosure choice, solves:

$$
\begin{aligned}
W^B_{\mathcal{F}}(\eta_{\mathcal{F}}, y, z) = \max_{c,h,m',h' \geq 0} & \left\{ U(c,s) + \beta \mathbb{E}_{(\delta',y',z')|z} V^{BC}(b',h',m',\delta',y',z') \right\} \\
\text{subj. to} \quad & c + p_s s = y \qquad b' = 0 \\
& [p_h - p_s]h' - m' q_m(b',h',m',z,BC) = \eta_{\mathcal{F}} \\
\text{where:} \quad & \eta_{\mathcal{F}=0} = \underbrace{\min\{(1-\delta)p_h h - m, \chi\}}_{\text{Exempt home equity}} \quad \text{and} \quad \eta_{\mathcal{F}=1} = 0
\end{aligned}
$$

where now the household consumes only out of the period's endowment, can't save or borrow in bonds and keeps the same amount of exempt home equity. V^{BC} is the value function of a household that starts the period with a bad credit history and is given by:

$$
\begin{aligned}
V^{BC}(b,h,m,\delta,y,z) = \max_{\mathcal{F} \in \{0,1\}} \mathbb{E}_{\psi} & \left\{ \max_{c,s,h',m',b' \geq 0} U(c,s) + \beta \mathbb{E}_{(\delta',y',z')|z} \begin{bmatrix} \alpha V^G(X') + \\ (1-\alpha) V^{BC}(X') \end{bmatrix} \right\} \\
\text{subj. to} \quad & \lambda(c + p_s s) + [p_h - p_s]h' - q_m m' + q_b b' \leq a_{\mathcal{F}} \\
\text{where:} \quad & a_{\mathcal{F}=0} = (1-\delta)p_h h - m + b + y \quad \text{and} \quad a_{\mathcal{F}=1} = b_F + y
\end{aligned}
$$

Notice that the timing is such that the housing services generated by the house h' can be traded in the same period as the purchase, which is why the effective per unit cost of buying a house is $p_h - p_s$. 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.[11]

[11]Note that the value functions for households with bad credit histories V^{BC} or that chose not to go bankrupt V^{NB}, may not be well defined as written. Since cash at hand can be negative, it is possible that there are no feasible choices (b', h', m') that result in non-negative consumption (c, s). In that case, households declare bankruptcy and receive no consumption for the period.

The solutions to these four coupled Bellman equations imply binary decision rules for foreclosure and bankruptcy, $f^*(X', \mathcal{H})$ and $B^*_{\mathcal{J}}(X')$, respectively, (where a value of 1 implies default) where recall $\mathcal{J}$ is an indicator representing whether the household received a deficiency judgment. In addition, the solutions also imply policy rules for housing, mortgage and bond choice.

2.4 Real Estate Construction Sector

The real estate sector is populated by a continuum of competitive firms who possess a linear, reversible technology to produce houses, $H = C_h$, where H is the output of houses and C_h is the input of consumption good (which could be negative if there is disinvestment in housing). The representative firm solves the following maximization problem:

$$\max_{H, C_h} \quad p_h H - C_h$$
$$\text{subj. to} \quad H = C_h$$

Therefore, the equilibrium house price is given by $p_h = 1$. In effect, the model has an exogenous house price, but an endogenous rental price p_s (which clears the market for housing services) and thus endogenous house-price to rent ratios.

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 proportional 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', h', m', persistent state z 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) for unsecured debt and Jeske, Krueger & Mitman (2011) for mortgages). 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 h' 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 h', the bank recovers the depreciated value of the house processed through the foreclosure technology,[12] $\gamma h'(1-\delta')$. In addition, with probability ψ the bank wins a deficiency judgment, $m' - \gamma h'$, but only recovers that value if the household does not file for bankruptcy. If a household goes bankrupt, the bank can recover any bonds held by the household.[13] Therefore, in general, the price of a mortgage will depend on all the observable characteristics of the household and the bond position b' in addition to m' and h'. The typical bank will only issue mortgage contracts with a non-positive expected net-return:

$$q_m(b', h', m', z, G)m' \geq \frac{1}{1+r_b+r_a} \times \mathbb{E}_{y',\delta',z'|z}\Bigg\{(1-f^*(X')m'+ \tag{2}$$

$$f^*(X')\Big[\psi\big((1-B_1^*(X'))m' + B_1^*(X')(\gamma(1-\delta')h') + \max\{b',0\}\big)\big) + (1-\psi)(\gamma(1-\delta')h')\big)\Big]\Bigg\}$$

where $B_1^*(X')$ is the bankrtupcy decision of a household after receiving a deficiency judgment. A household with a bad credit history cannot declare bankruptcy, and thus the mortgage price is characterized as above, but with $B^*(\cdot) = 0$. For a household with a bad credit history, the price also takes into account that the foreclosure decision is made after the realization of

[12]Since $p_h = 1$, I omit it from the remainder of the analysis.

[13]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.

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 Online Appendix.

2.5.2 Unsecured Credit Problem

When households are saving in bonds, $b' \geq 0$, q_b represents the price of buying a bond that pays b' units of consumption good tomorrow. There is no default risk on savings and thus:

$$q_b\left(b', g', m', z\right) \leq \frac{1}{1+r_b} \tag{3}$$

which from the zero profit condition immediately implies that the price only depends on the risk-free rate, $q_b = \frac{1}{1+r_b}$ when $b' \geq 0$.

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 the bank can recover a fraction of it. Let ξ' denote the non-exempt portion of a household's home equity, namely $\xi' = \max\{h'(1-\delta') - m' - \chi, 0\}$. 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 condition for the bank issuing unsecured debt of size b' to a household with characteristics X is therefore:

$$-b' q_b\left(b', h', m', z\right) \geq \frac{1}{1+r_b+r_a} \times \left\{\mathbb{E}_{\mathcal{J},y',\delta',z'|z}\left[-b'(1-B^*_{\mathcal{J}}(X')) + B^*_{\mathcal{J}}(X')\zeta\xi'\right]\right\} \tag{4}$$

2.6 Equilibrium Definition

The pair (ψ, χ) summarizes the legal environment for the state. Each state is treated as a small open economy for the purpose of the bond and mortgage market taking the risk-free rate r_b as given. The housing market is closed, reflecting the fact that housing services must be consumed in the same geographic location as the housing good. Let μ denote the cross sectional distribution of households over the credit history, cash at hand, income and home equity. I focus on a stationary recursive equilibrium.

Definition Given (ψ, χ) and r_b, a Stationary Recursive Competitive Equilibrium comprises:

- Value functions for the households,
  $\{V : \mathcal{H} \times \mathbb{R}^3 \times [\underline{\delta}, 1] \times Y \times Z \to \mathbb{R}\}$, $\{W : \{B, NB, BC\} \times \{0,1\} \times \mathbb{R} \times Y \times Z \to \mathbb{R}\}$
- Default decision rules and policy functions for the households:
  $\{f^* : \mathcal{H} \times \mathbb{R}^3 \times [\underline{\delta}, 1] \times Y \times Z \to \{0,1\}\}$, $\{B^* : \mathbb{R}^3 \times [\underline{\delta}, 1] \times Y \times Z \times \{0,1\} \to \{0,1\}\}$
  and $\{c, s, b', m', h' : \{B, NB, BC\} \times \mathbb{R} \times Y \times Z \to \mathbb{R}\}$
- Price p_s, pricing functions $\{q_m : \mathcal{H} \times \mathbb{R}^3 \times Z \to \mathbb{R}_+\}$ and $\{q_b : \mathbb{R}^3 \times Z \to \mathbb{R}_+\}$
- An invariant distribution: $\{\mu^* : \{B, NB, BC\} \times \mathbb{R} \times Y \times Z \to \mathbb{R}_+\}$

such that:

1. **Households Maximize:** Given prices and the pricing functions, the value functions solve (1), and c, s, b', h', m' are the associated policy functions, and B^*, f^* are the associated default rules.

2. **Zero Profit Mortgages:** Given f^*, B^*, q_m solves (2) with equality for any contract traded in equilibrium

3. **Zero Profit Unsecured Debt:** Given B^*, q_b solves (4) with equality for any contract traded in equilibrium

4. **Zero Profit Bonds:** $q_b = \frac{1}{1+r_b}$ when $b' \geq 0$.

5. **Rental Market Clearing:** $\sum_{\mathcal{I} \in \{B,NB,BC\}} \int h'_{\mathcal{I}}(a, y, z) d\mu = \sum_{\mathcal{I} \in \{B,NB,BC\}} \int s_{\mathcal{I}}(a, y, z) d\mu$

6. **Invariant Distribution:** The distribution μ^* is invariant with respect to the Markov process induced by the exogenous Markov process z and the policy functions m', h', b', B^*, f^*

3 Theoretical Results

The purpose of this section is to provide theoretical results that characterize household default decisions and interest rates on debt that will guide the interpretation of the quantitative results. In addition, the theory will prove useful in the computation of equilibria. I characterize the bankruptcy and foreclosure decisions. Further, I analyze how housing, foreclosure, and the homestead exemption affect the household bankruptcy decision. I fully characterize mortgage interest rates for no-recourse states.

3.1 Existence and Characterization of the Household Problem

In order to prove the existence of a solution to the household problem, I need to make an assumption on preferences. I assume that utility is bounded above and that the utility of consuming zero is small enough that a household will always prefer to go bankrupt rather than having zero consumption in a given period.[14] Under this assumption, which is 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 $V^{\mathcal{H}}$ exist and are unique; (2) The value functions are bounded and increasing in a; (3) A bad credit score reduces utility, i.e. $V^G \geq V^{BC}$

The proof of the existence of a solution to the household problem follows from standard contraction mapping arguments (boundedness from below comes from the option to default). The details of all proofs can be found in the appendix.

Now that I have shown a solution to the household problem exists, I proceed to characterize the bankruptcy decision. Since the bankruptcy decision is made after the foreclosure

[14] In my quantitative analysis I will assume a constant relative risk aversion utility function with CRRA parameter greater than 1 which satisfies this condition.

decision, similar to Chatterjee et al. (2007), I can characterize the bankruptcy decision in terms of a *bankruptcy set* $\overline{\mathcal{B}}^*(b_F, \eta, \xi, z)$, where b_F 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 b_F. The bankruptcy set depends on those four variables alone because they capture the benefits of bankruptcy (the discharge of unsecured debt b_F and preservation of exempt equity $\eta - \xi$) as well as the costs (the loss of non-exempt equity ξ).

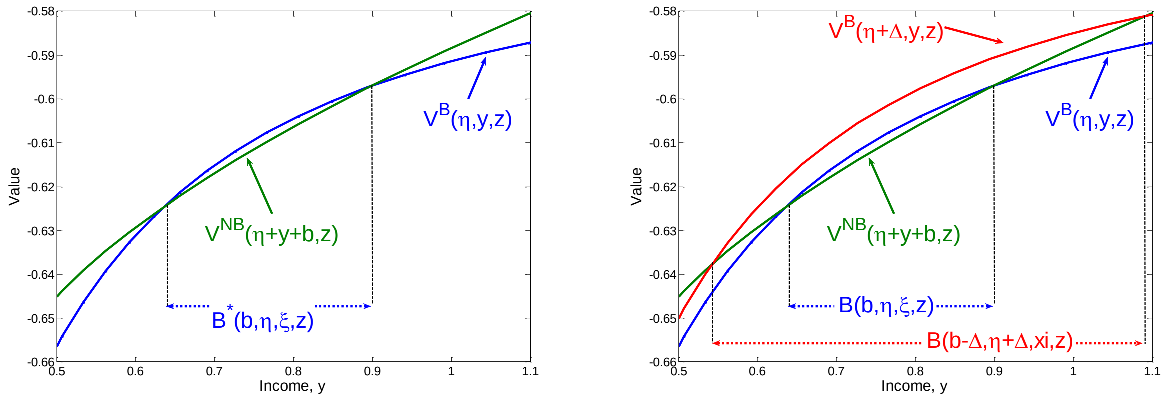
Proposition 2 Bankruptcy Characterization

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

(b) *The bankruptcy set expands with indebtedness b_F, i.e. $\overline{\mathcal{B}}^*(\hat{b_F}, \eta, \xi, z) \subseteq \overline{\mathcal{B}}^*(b_F, \eta, \xi, z)$ for $b_F < \hat{b_F}$.*

The proposition is illustrated graphically in Figure 2(a). The intuition for this result is that households with very low endowment realizations prefer to take on debt to increase contemporaneous consumption above the period endowment (consumption in bankruptcy). Whereas households with high endowments prefer to maintain access to credit, and thus repay, but may consume less than if they had declared bankruptcy.

Next, I characterize how the portfolio of the household affects the bankruptcy decision. Unlike Chatterjee et al. (2007), the bankruptcy decision depends on more than the net asset position of the household. Households with more non-exempt home equity are less likely to go bankrupt. Intuitively, as the household holds more non-exempt home equity the cost of going bankrupt increases (more housing wealth would be lost), but the benefit of going bankruptcy is constant. Thus, the set of endowment realizations for which the household



(a) The bankruptcy set.

(b) The bankruptcy set expands in home equity η.

Figure 2: Graphical illustration of Propositions 2 and 3.

goes bankrupt shrinks. Having a substantial amount of non-exempt home equity effectively increases the punishment of going bankrupt. This mechanism is important for understanding the equilibrium price effects generated in the quantitative analysis. Further, for a given net asset position a greater share in home equity increases the chance of bankruptcy. This result is illustrated graphically in Figure 2(b). Keeping the net asset position fixed but changing its composition does not affect the value of repaying,[15] but more home equity increases the value of going bankrupt. Therefore, the set of endowment values for which the household goes bankrupt expands. These results are formalized in Proposition 3:

Proposition 3 Home Equity, Exemptions and Bankruptcy

(a) The bankruptcy set contracts in non-exempt home equity ξ, i.e. $\overline{\mathcal{B}}^*(b_F, \eta, \xi_1, z) \subseteq \overline{\mathcal{B}}^*(b_F, \eta, \xi_2, z)$, for $\xi_2 < \xi_1$.

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

(c) When home equity exceeds the homestead exemption, the bankruptcy set is decreasing

[15]Since after repayment the relevant state variable for the household is the consolidated asset position.

in home equity, i.e. $\overline{\mathcal{B}}^*(b_F, \eta + x, \xi + x, z) \subseteq \overline{\mathcal{B}}^*(b_F, \eta, \xi, z)$ *for* $x > 0$.

(d) *When there is no homestead exemption, i.e.* $\chi = 0$*, the bankruptcy set only depends on the net asset position* $\eta + b_F$ *and the persistent income state* z.

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

Having characterized the bankruptcy decision, working backwards I now analyze the foreclosure decision. How foreclosure is related to bankruptcy depends crucially on the probability of a deficiency judgment, ψ. In order to understand how ψ controls the complementarity between foreclosure and bankruptcy, I first 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.

Proposition 4 *If the foreclosure technology is inefficient,* $\gamma < 1$*,* $f^*(X, \mathcal{H}) = 0$ *for all* b, z*, and* y *when* $h(1 - \delta) \geq m$.

For two special cases the foreclosure decision follows a cutoff rule in the depreciation shock δ'. If banks cannot obtain deficiency judgments (i.e., no-recourse, $\psi = 0$), households will choose to foreclose on their mortgages whenever they have negative home equity. Since households face no additional cost of foreclosure, it is always optimal to "walk away." Thus, under no-recourse Proposition 4 becomes an if-and-only-if statement - households only repay their mortgage when the value of the house exceeds the value of the mortgage (formalized in Proposition 5). In no-recourse states, therefore, the foreclosure decision is independent of the bond position or income of the household.

Proposition 5 *If there is no recourse,* $\psi = 0$*, the foreclosure decision follows a cutoff rule in* δ*, i.e. there exists* $\delta^*(h, m)$ *such that* $f^*(X, \mathcal{H}) = 1$ *for all* $\delta \geq \delta^*(h, m)$ *and 0 otherwise for all* b, y, z*. Further, the cutoff depends only on the leverage* $\kappa = \frac{m}{h}$*, and* $\delta^*(\kappa) = 1 - \kappa$.

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

Proposition 6 *If deficiency judgments always occur, $\psi = 1$, the foreclosure decision follows a cutoff rule in δ, which in general will depend on b, h, m, y, z. Further, any household with a good credit history that chooses foreclosure will subsequently go bankrupt. Households in bankruptcy or with bad credit history will optimally choose b', h', m' such that foreclosure is never optimal.*

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

Propositions 5 & 6 show that in the limiting cases of ψ the foreclosure decision follows a cutoff rule. In addition, these limiting cases suggest that ψ partially controls the complementarity between foreclosure and bankruptcy.[16] In my quantitative analysis I find that higher values of ψ lead to a higher probability of declaring bankruptcy conditional on choosing foreclosure.

3.2 Mortgage and Unsecured Interest Rates

Characterizing the intermediary pricing of mortgages and unsecured debt is limited by the partial characterization of the household foreclosure decision. However, when there is no recourse the sharp characterization of the foreclosure decision (Proposition 5), allows a full characterization of mortgage prices and a partial characterization of unsecured debt prices.

[16]When $\psi = 0$ the foreclosure decision is independent of the subsequent bankruptcy decision, but when $\psi = 1$ foreclosure always results in bankruptcy.

Proposition 7 *If there is no recourse, mortgages are priced exclusively based on leverage:*

$$q_m(h', m', b', z, \mathcal{H}; \psi = 0) = \frac{1}{1 + r_b + r_a} \left\{ F(\delta^*(\kappa')) + \frac{\gamma}{\kappa'} \int_{\delta^*(\kappa')}^{1} (1 - \delta') dF(\delta') \right\}$$
$$= q_m(\kappa'; \psi = 0)$$

where κ' and $\delta'^*(\kappa')$ are defined as in Proposition 5. This result is the same as that obtained in Jeske, Krueger & Mitman (2011). Note that $q_m(\kappa')$ 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.[17]

Proposition 8 *If there is no recourse:*

1. $b' \leq \hat{b}'$ *implies* $q_b(b', h', m', z) \leq q_b(\hat{b}', h', m', z)$.

2. *If in addition the homestead exemption is zero,* $\chi = 0$*:*

   (a) $h' \leq \hat{h}'$ *implies* $q_b(b', h, m', z) \leq q_b(b', \hat{h}', m', z)$

   (b) $m' \geq \hat{m}'$ *implies* $q_b(b', h', m, z) \leq q_b(b', h', \hat{m}', z)$

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 q_b are equivalent to increasing implied interest rates.

[17] 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.

4 Calibration and Model Fit

The goal of the calibration is to assure 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 then aggregate state-level moments. I allow states to vary only in the homestead exemption χ, whether there is recourse ($\psi > 0$), and the level of median income,[18] keeping technology and preference parameters constant across states. The model needs to be solved for every combination of homestead exemption and recourse, χ 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 allocate each state in the US to one of the seven bins - three homestead exemption bins for no-recourse states and four homestead exemption bins for recourse states. For each bin I calculate the average homestead exemption and median income, weighting by state populations. The relative weight of the seven economies in calculating aggregate statistics is determined by the relative proportion of households from those states. For ease of exposition, I refer to the seven binned economies by the name of a representative state from the bin: Washington, California, Minnesota, Maryland, Michigan, Massachusetts and Florida .[19]

The values for the homestead exemption χ 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 Online Appendix for details). For each state, median income is normalized to 1, so χ 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 $\chi^{PA} \approx 0.75$.

Good data on deficiency judgments do not exist, so I take the value of ψ as a parameter

[18] The income process is the same across states modulo its median level.

[19] The state policy parameters are summarized in Table **??** in the Online Appendix.

to calibrate. Li & White (2009) analyze a sample of prime and sub-prime mortgages and find that 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.[20]

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 the model period is one 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 (Song Han & Geng Li 2011) 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 $0.24 \times 0.37 = 0.089$.[21] I aggregate unsecured debt and total debt across the seven economies (weighted by households and income) and compute the unsecured share.

4.1 Preferences and Technology

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

[20] Note that the discussion relating parameters to data targets is heuristic in the sense that all parameters determine all endogenous variables jointly in the model. In the discussion I relate parameters with the moments that they affect the most quantitatively.

[21] This number is nearly identical to the ratio of unsecured credit to unsecured credit plus mortgage debt measured in the 2004 Survey of Consumer Finances for prime age households.

Table 1: Externally Calibrated Parameters

Parameter	Value	Target
Income Process		
Persistence, ρ	0.98	
Std. of persistent shocks, σ_ν	0.3	Income process (Storesletten et al, 2004)
Std. of transitory shocks σ_ε	0.245	
Legal Technology		
Foreclosure technology, γ	0.78	Foreclosure Sale Loss
Bankruptcy technology, ζ	0.52	Distributions to Creditors
Clean credit history, α	0.167	File for Chapter 7 every 6 years
Interest Rates		
Risk-free rate, r_b	0.01	Risk-free rate
Cost of issuing debt, r_a	11 BP	Bank administration cost
Preferences		
Cobb-Douglas parameter, θ	0.8590	Housing share of consumption 14.1%

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

Notice that this implies the solution to the intra-temporal consumption optimization problem is $p_s h = \frac{1-\theta}{\theta} c$, 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. I restrict the analysis to households under age 50 because of strong life-cycle effects in housing and mortgage choice.[22]

I calibrate the time discount factor β to match the aggregate bankruptcy rate from 1995-2004. The American Bankruptcy Institute publish aggregate annual bankruptcy filings,

[22] Households in an infinite horizon model more closely correspond to prime age households in the data.

and I construct rates using data on the number of households from the Census. Sugato Chakravarty & Eun-Young Rhee (1999) report that 16.4% of respondents in the Panel Survey of Income Dynamics who filed for bankruptcy listed excessive health-care bills as the cause. Since I abstract from such expenditure shocks in the model, I target $100\% - 16.4\% = 83.6\%$ of the observed bankruptcy rate in the data.[23] Tables 1 and 2 summarize the model parameterization.

Endowment Process: Following Storesletten et al. (2004), I set persistence of the shock z, $\rho = 0.98$ and the variance to the innovations to $\sigma_\eta^2 = 0.09$. Estimates for the variance of log annual income range from 0.04 to 0.16 . I thus set $\sigma_\varepsilon^2 = 0.06$, 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.

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 revenue 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 Proposition 4). Campbell et al. (2011) estimate the discount due to bankruptcy in Massachussetts, and find it to be less than 5

[23]Himmelstein et al. (2009) attribute a much higher fraction of bankruptcies to health shocks because they include health related job loss and income changes. Since those shocks are captured in the calibration of the income process, I use the lower value.

percent. 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. The U.S. Department of Justice[24] reports of roughly \$10.5 billion collected in asset cases from 1994-2000, only 52 percent was dispersed creditors. Thus, I set the recovery parameter $\zeta = 0.52$. The remaining 48 percent is assumed to cover the unmodeled costs of administering bankruptcy.

The Depreciation Process: 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 percent annually, based on mean depreciation of residential housing reported by the Bureau of Economic Analysis. Using data on repeat home sales, the OFHEO estimates both aggregate and purely idiosyncratic components of house price risk.[25] Since there is only idiosyncratic risk in the model, I target the annual idiosyncratic house price volatility reported by the OFHEO of 10 percent.

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, σ_δ, and a cutoff parameter $\underline{\delta}$. The upper bound for the support is set to 1, so that complete depreciation is possible. The cumulative distribution function is: $F(\delta) = 1 - \left(1 + \frac{k(\delta - \underline{\delta})}{\sigma_\delta}\right)^{\left(-\frac{1}{k}-1\right)}$.

[24]"Preliminary Report on Chapter 7 Asset Cases 1994 to 2000."

[25]It models log house prices as a diffusion process consisting of a market price index and a house specific random walk. The technical details can be found in Charles A. Calhoun (1996).

Table 2: Internally Calibrated Parameters

Parameter	Value	Target	Data	Model
Preferences				
Risk aversion, σ	2.751	Bankruptcy rate	1.06%	1.06%
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 σ_δ	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	5.68×10^{-3}	Revolving share of debt	8.9%	8.9%

4.2 Model Fit

Aggregated statistics across the seven computed economies are listed in Table 3. The model performs well accounting for non-targeted moments in the data. The model slightly over-predicts average holdings of housing wealth. This result is not surprising since median net worth is targeted in the calibration, but housing and bonds are the only assets that households can hold in the model.[26] 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 does well in matching the fraction of households with zero or negative net-worth, the fraction of households who have unsecured debt, and the fraction of bankrupt households with positive home equity.

The presence of the housing asset allows the model to generate realistic interest rates. The mean interest rate paid on unsecured debt in the model is 11.2%, very close to the 12.3%

[26]In the data, the median households have mainly housing wealth and not too much financial wealth (which is highly concentrated among the rich).

Table 3: 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	Mortgage Debt, SCF 2004
Fraction of households with net worth ≤ 0	5.3%	6.7%	SCF 2004
Fraction of households with Unsecured Debt	38%	33%	SCF 2004
Fraction of bankrupt households with positive home equity	25%	33%	SCF 2004
Mean Interest Rate Paid on Unsecured Debt	11.2%	12.3%	SCF 2004
Mortgage Default Premium	24%	22%	MORTGAGE1US, GS1 from FRED

reported in the SCF. The model is also able to successfully replicate the default premium on mortgages. The mean mortgage interest rate in the model is 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%.

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 laws have on default rates. Thus, I can evaluate to what extent the cross-state variation in bankruptcy rates in the data is predicted by the model. Further, the exercise provides an important source of model validation before proceeding to the policy analysis. It is important to note that, in the model, the variation in policies is given exogenously. Richard M. Hynes, Anup Malani & Eric A.

Table 4: Decomposing Bankruptcy Rates
$bankrate_i = \beta_0 + \beta_L x_{L,i} + \beta_D x_{D,i} + \epsilon_i$

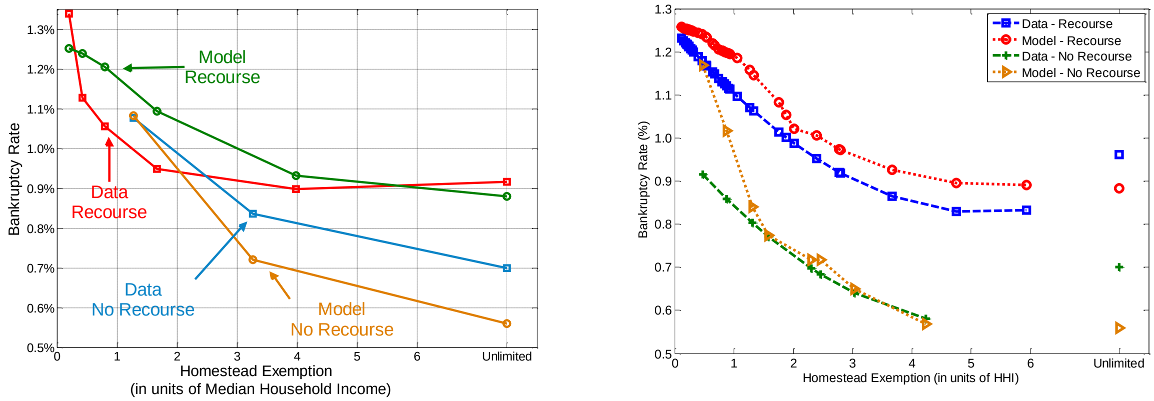
Variable	**Coefficient**	**(Std. Err.)**
Demographic		
log(Median household income)	-0.0047	(0.0027)
Average household size	0.0099*	(0.0028)
Weak garnishment law	-0.0033*	(0.0008)
Judicial Foreclosure	-0.0018*	(0.0008)
Bankruptcy & Foreclosure Law		
Recourse	0.0029*	(0.0010)
Homestead Exemption	-0.0019*	(0.0009)
Square of Homestead Exemption	0.0002	(0.0002)
Unlimited Exemption	-0.0028*	(0.0014)
Constant	0.0316	(0.0271)
R^2	0.58	

* indicates significance at 5% level

Posner (2004) provide a detailed historical account of the origins of property exemptions in bankruptcy. They find that historical exemption levels have more predictive power in explaining current exemption levels than contemporaneous economic and political factors, and that historical exemptions were mainly driven by economic forces of the 19th and early 20th century. Thus, to the extent that current economic conditions are independent of the economy a century ago, I view treating state exemption levels as exogenous as defendable.

States vary in demographic and legal characteristics that are abstracted from in the model, but which may be relevant to state default rates. In order to partially control for that additional variation, in Figure 3(a), I plot mean model and data bankruptcy rates for states binned by exemption level and recourse policy. The model is able to capture the negative relationship between the homestead exemption and bankruptcy rates and the positive relationship between recourse laws and bankruptcy rates.

Figure 3(a) only presents conditional means. For a more careful accounting I control for additional observables and compute what fraction of the residual variation the model



(a) Bankruptcy rates in the data and model.

(b) Fitted data versus model generated data.

Figure 3: Accounting for the cross-state variation in bankruptcy rates.

explains. First, I regress the state level bankruptcy rate on log median household income, the average household size, a dummy indicating lenient garnishment law, a dummy for judicial foreclose, a dummy for recourse, the homestead exemption, the homestead exemption squared, a dummy for unlimited exemption, and a constant. 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 4. To compare my model to the predictions from the regression, I compute the R^2 between the fitted bankruptcy rate using only the legal variables $x_{L,i}\hat{\beta}_L$ and the model predictions m_i. I find that an R^2 of 0.82, indicating that the model can explain more than 80 percent of the variation attributable to variations in homestead exemptions and recourse law. The predicted bankruptcy rates from the regression and from the model are plotted in Figure 3(b). The model quantitatively matches the cross-state correlation between policies and default rates. I find that the model can explain roughly 20 percent of the overall variation in bankruptcy rates (without controlling for state level characteristics).

To illustrate the importance of studying foreclosure and bankruptcy together in order to capture the cross-state variation in bankruptcy rate, I conduct the following thought experiment: would a modified model without mortgages and foreclosure capture the cross-state

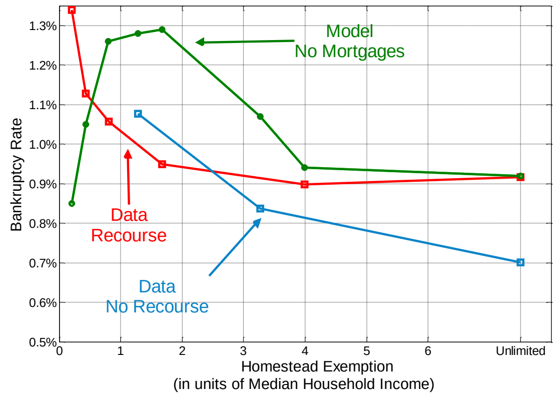


Figure 4: Data vs counterfactual model without mortgages and foreclosure.

variation? To answer this question, I re-calibrate the model without mortgages, dropping the targets related to mortgages and foreclosure. I plot the conditional means in Figure 5.1. This version of the model does not reproduce the observed negative relationship between bankruptcy rates and the homestead exemption. This counterfactual analysis highlights the importance of modeling secured and unsecured credit together.

5.2 The Household Default Decision

In order to understand how default policies lead to differences in default rates it is important to understand when households choose to default. In Figure 5 I consider a household in the Virginia economy (a recourse state with a $10,000 homestead exemption), who had purchased a $200,000 house, had an 80% leverage mortgage and took on $12,500 of unsecured debt. I plot the bankruptcy and foreclosure decisions as a function of the realized home equity (after the price shock) and income realization. The graph illustrates the complementarity and substitutability of the two types of default. In the upper right quadrant, the household has positive home equity and high income, so it repays its debt. However, if its income is lower and has only non-exempt home equity it chooses to go bankrupt to discharge its unsecured debt, while preserving its home equity. Households with low income and negative home equity default on both their mortgages and unsecured debt. Whereas high income

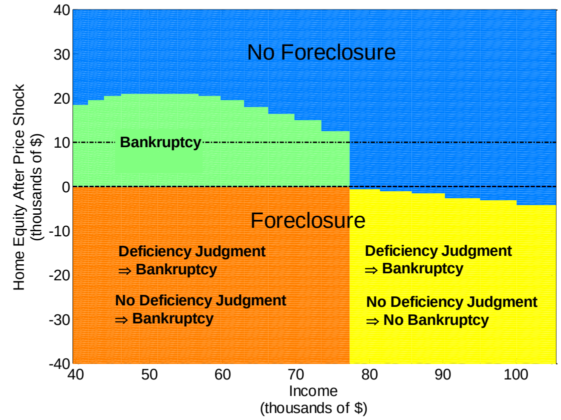


Figure 5: Household discrete choices with a house size equal to five times the median income and an 80% leveraged mortgage.

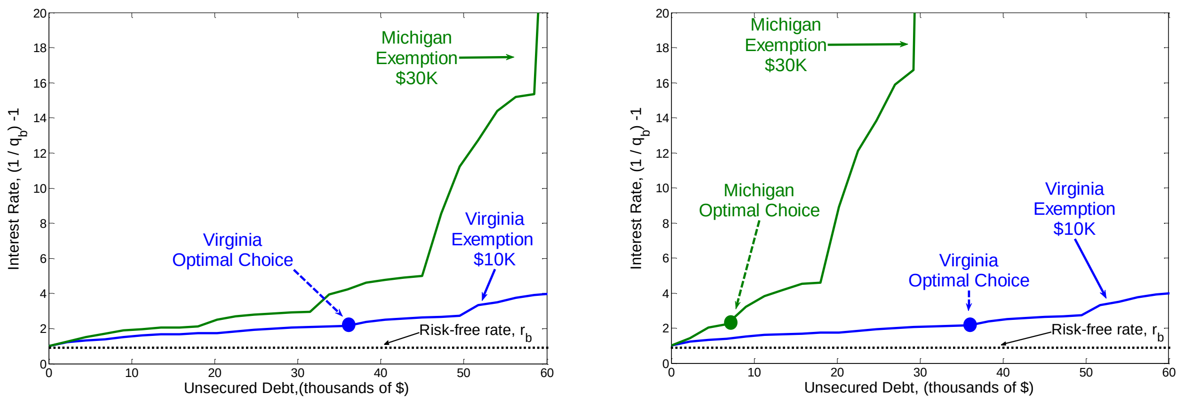
households with negative home equity only file for bankruptcy if they receive a deficiency judgment.

Examining the household default problem alone cannot explain why bankruptcy rates are lower when homestead exemptions are higher, since, from the household perspective, more generous exemptions should lead to larger sets of income realizations for which the household will go bankrupt. Therefore the key mechanism must be coming through an interest rate effect, which causes households to select into different debt portfolios across the different states.

5.3 Effects of the Homestead Exemption

In this section I explore the general-equilibrium interest rate effects that arise from different homestead exemptions. In the theoretical results, I proved that households with less non-exempt home equity are more likely to go bankrupt. 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, I choose two households, one in Virginia and one in Michigan



(a) Unsecured Interest Rates　　　(b) Unsecured Interest Rates

Figure 6: Interest rates on unsecured debt for households of identical net worth in Virginia and Michigan. The dots in both figures represent the optimal policy choices. *Notes:* The household in Virginia optimally chooses a \$265K house, \$180K mortgage and \$36K of unsecured debt. The Michigan line in (a) represents the price schedule that the household would face if it chose the same size house and mortgage as the Virginia household. The Michigan line in (b) represents the price schedule given its optimal choice of housing and mortgage: \$210K house, \$155K mortgage and \$6K of unsecured debt.

(both recourse states) that have roughly median net worth and the high persistent income realization. Virginia has a \$10K homestead exemption as compared to Michigan's \$30K. The household in Virginia optimally chooses a portfolio consisting of a \$265K house, a \$180K mortgage and \$36K in unsecured credit. In Figure 6(a), I plot the unsecured interest rate for other hypothetical amounts of unsecured borrowing for the Virginia household. In addition, I plot the unsecured interest rate as a function of unsecured debt for the household in Michigan, assuming the same choice of housing and mortgage (note that the risk-free interest rate is the same in both states). Notice that the interest rate in Michigan is significantly higher at the Virginia optimal choice of \$36K. This is due to the fact that in Michigan the household has more exempt home equity and less non-exempt home equity. Both households would have \$85K in home equity. However, in Michigan \$30K of that equity is exempt as compared to \$10K in Virginia. Imagine that the value of the home fell by 15%. Both households would be left with slightly more than \$45K in equity. If the household in Virginia went bankrupt, it would have \$36K in unsecured debt discharged, but would lose \$35K in non-exempt equity - for a financial benefit of \$1K. The Michigan household, however, would get the same discharge, but only forfeit \$15K, meaning a financial benefit of bankruptcy of \$21K. Thus, because of the difference in exemptions, the Michigan household is more likely to go bankrupt and would have to pay a higher interest rate on its unsecured debt.

At that interest rate, however, the Michigan household does not find it optimal to take on \$36K in debt. Since unsecured credit is more expensive, the overall cost of borrowing is higher for the Michigan household. As a result, it optimally takes on a lower level of debt. Since the household is borrowing less, it also optimally chooses a smaller sized house and mortgage. The Michigan household chooses a \$210K house and \$155K mortgage. In Figure 6(b), I plot the unsecured interest rates facing the Michigan household under the optimal housing and mortgage choice.[27] Since the household has only \$25K of non-exempt home equity, the interest rate rises rapidly as unsecured debt approaches that level. The household optimally chooses a much lower level of unsecured debt, about \$6K, but at a comparable interest rate to the Virginia household. Notice that in addition to the Michigan household taking on less overall debt (\$161K vs \$180K) the composition of the debt is also different. The Michigan household borrows almost exclusively in mortgage debt by taking on a more highly leveraged mortgage (74% vs 68%). By buying a smaller house, the Michigan household has less home equity, which further compounds the price effect of the higher homestead exemption. Thus, the household finds it optimal to increase its leverage, which only results in a small increase in the interest rate paid on the mortgage.[28]

The above discussion sheds light on why household portfolios are different across states with different homestead exemptions, but does not directly answer why these differences lead to different default rates. In all states, there are very low net worth households that only borrow in unsecured credit, and have no housing or mortgage debt. The debt portfolios and default rates of these households are, to first order, unaffected by the exemption,

[27]It should be understood that the household is making its choice of housing, mortgage and unsecured credit simultaneously. The discussion of the choices as separate or sequential is merely to help illustrate the intuition for the mechanism at hand.

[28]See Figure **??** in the Online Appendix for the mortgage interest rate schedule faced by the Michigan household conditional on its housing and unsecured debt choice

Table 5: Unsecured Interest Rates

	Data (CEX)	Model
Low Exemption	23.49%	7.93%
	(1.13%)	(0.56%)
High Exemption	27.64%	13.07%
	(3.49%)	(2.50%)

Notes: Data constructed by diving interest and finance charges by total debt and computing the mean across households. The model means are the averages of 100 simulations of a sample of size $N = 10,760$. Standard errors are reported across simulations

since they hold no housing. The equilibrium price effects of the homestead exemption do, however, affect the fraction of households with housing that choose to take on unsecured debt. Households with non-exempt home equity are the ones that take advantage of cheap unsecured borrowing. As the homestead exemption rises, the fraction of households that have non-exempt home equity falls. As a result, some households stop borrowing unsecured and only take on mortgage debt. Thus, the fraction of households who borrow unsecured, and therefore *are at risk of going bankrupt* is smaller in high exemption states. This leads to lower bankruptcy rates.[29] The extensive margin choice of whether to take on unsecured debt drives the majority of the variation in bankruptcy rates. Further, differences in the extensive margin explain why states with higher interest rates also have lower default rates (even though interest rates reflect default probabilities). In states with high exemptions, *conditional on borrowing unsecured* households have a higher propensity to default, but since fewer households are borrowing, the state bankruptcy rate is lower. Foreclosure rates are higher in high exemption states because mortgage leverage is higher and the probability of foreclosure is increasing with leverage. These effects can be seen in the state level aggregates in Tables **??** and **??** in the Online Appendix.

5.3.1 Empirical Evidence for Unsecured Interest Rate Variation Across States

In the model, households in low exemption states pay on average lower interest rates on unsecured debt than households in high exemption states. To compare the prediction of the model to the data, I construct a measure of interest rate paid using the Consumer Expenditure Survey (CEX) from 1994-2003. For households that reported having unsecured debt, I compute the effective interest rate by dividing the expenditure on interest and finance charges by the amount of unsecured debt. While a crude measure, to my knowledge the CEX is the only publicly available data source that provides information on unsecured debt, interest and state of residence. There are a total of 10,760 observations in my sample, so I simulate 100 samples of the same size from the model. I report the means and standard errors across the simulations from the model generated data. Because the CEX is not designed to be representative at the state level, I divide states into high and low exemption states and then compare the mean interest rates in Table 5. The interest rates are significantly higher in the CEX (and are high relative to the 12.3 percent average interest rate reported in the SCF), most likely due to the simplified measure being used and because the CEX also includes finance charges. However, the direction and magnitude of the difference in interest rates in the model is consistent with the data, providing additional evidence for the mechanism.

5.3.2 Empirical Evidence for Mortgage Leverage Variation Across States

As examined in the previous section, homestead exemptions change the price of unsecured debt. As a result households take on different portfolios of debt. The model predicts that households in high exemption states take on more highly leveraged mortgages than in low exemption states. To compare this prediction to the data, I construct household mortgage leverage from the 2000 Residential Finance Survey (RFS). I compute the leverage by sum-

[29] In recourse states even households that hold no unsecured debt but hold mortgages are at risk of bankruptcy because of the deficiency judgments in foreclosure. However, quantitatively, these households account for less than 1% of bankrupt households in recourse states.

Table 6: Mortgage Leverage

	Data (RFS)	Model
Low Exemption	67.03%	68.27%
	(0.82%)	(0.66%)
High Exemption	74.50%	74.10%
	(5.23%)	(0.52%)

Notes: Data constructed by dividing mortgage balances by current house value and computing the mean across households. The model means are the averages of 100 simulations of a sample of size $N = 4,315$. Standard errors are reported across simulations

ming across the balance on all mortgages outstanding and diving by the current value of the home for all prime-aged households. Since the RFS only includes state identifying information for twelve states (note that those twelve states include 65 percent of all households in the US[30]) again I partition the states between high and low exemption states. The mean leverage of households with a mortgage and standard errors are reported in Table 6. I simulate households from the model of the same sample size ($N = 4,315$) and same states as the RFS 100 times and report the mean leverage and standard deviation across simulated means also in Table 6. The model does remarkably well in matching the level of leverage and its difference between high and low exemption states.

5.4 Effects of Recourse

Recourse has surprisingly little effect on foreclosure and mortgage interest rates. Recourse and no recourse states with the same homestead exemption have nearly identical foreclosure rates. This is because recourse only has significant effects on two groups of mortgage holders. The first are those with mortgages with very high leverage (>90 percent). Those households have a large probability of being slightly underwater in the next period, and households are more likely to repay slightly underwater mortgages in recourse states (as shown in Figure 5). However, very few households take on mortgages with leverage over 90 percent (median

[30]The twelve states are: California, Florida, Illinois, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, Texas, Virginia, Washington.

leverage in the data and model are both less than 70 percent), so in the aggregate this effect is marginal.

The other group of households affected by recourse are those with substantial savings in bonds. Those households are less likely to foreclose because they have the resources to repay an underwater mortgage and want to avoid a deficiency judgment.[31] However, households that have substantial savings in bonds take on mortgages with low leverages and thus have low probabilities of going into foreclosure. Further, only a small fraction of households hold significant amounts of savings in bonds. Thus, the marginal change in their interest rate and foreclosure probability is negligible when aggregated at the state level.

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. In addition, in recourse states 10-20 percent more households go bankrupt conditional on foreclosure compared to no-recourse states. That number directly reflects the effect of the parameter ψ, the probability of a deficiency judgment. These results are consistent with recent research by Li & White (2009) (see their Table 5) that suggests that households are more likely to file for bankruptcy after foreclosure in recourse states than no-recourse states.

Having shown that the model is an appropriate laboratory for studying bankruptcy and foreclosure in the U.S., I proceed with policy analysis.

6 Policy Experiments

I now use the 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 first major reform to bankruptcy in almost 30 years. The reform made it more difficult for households earning more than the median income in their state from filing for Chapter 7 bankruptcy. The analysis enables me to evaluate the hy-

[31] This is consistent with the interpretation of the effects of recourse found in Ghent & Kudlyak (2011).

pothesis of Morgan, Iverson & Botsch (2009) and Li, White & Zhu (2010) that BAPCPA contributed to the subsequent observed rise in foreclosure rates. The second experiment is motivated by the ongoing debate in the U.S. Congress whether to standardize homestead exemption policy. To inform this policy debate, I use my calibrated model to quantitatively determine the optimal joint homestead exemption and recourse policy from a utilitarian welfare perspective.

6.1 BAPCPA

To simulate the effects of BAPCPA, in the model households above median income cannot file for bankruptcy, unless as a result they have non-positive consumption. I compute the transition from the original steady state to the new steady state equilibrium. I find that it takes several years for default, housing and debt to reach their new steady state levels. Taking into account the transitional dynamics 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 substantial, both in terms of default rates and total borrowing in the economy, as shown in Table 7. Unsecured debt increases 30 percent over approximately 10 years. The increase in unsecured debt is small, however, relative to the increased 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 percent. The percentage of households that file for bankruptcy initially drops, and then rises rapidly and converges to a rate of 2.45 percent.[32] Qualitatively, the initial drop and subsequent rise are consistent with bankruptcy rates post-BAPCPA, however the model predicts a much faster increase in bankruptcy rates than observed. Foreclosure also more than doubles going from 0.55 percent to 1.15 percent of mortgages per year. How can

[32] The transitional dynamics are illustrated in Figure ??-?? in the Online Appendix.

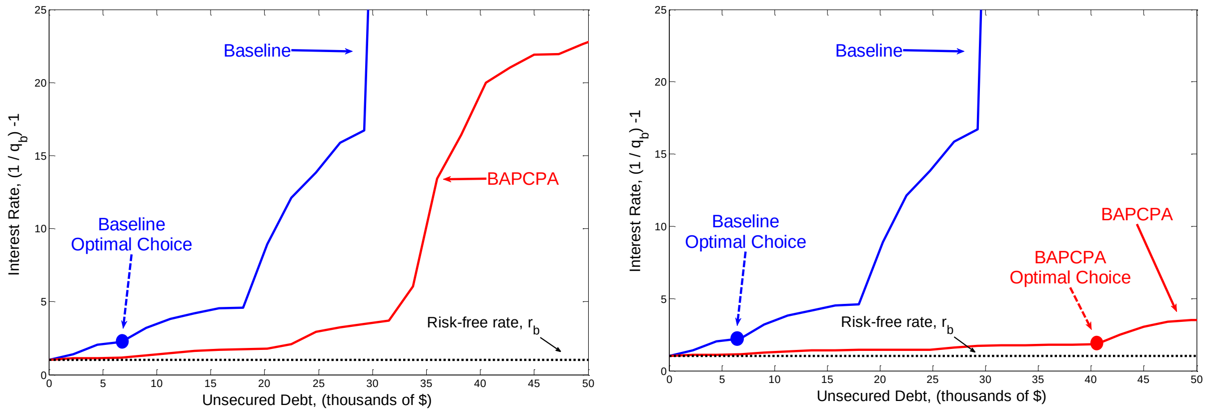
Table 7: Aggregate Effects of BAPCPA

	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	1.06%	2.45%
Foreclosure Rate	0.55%	1.16%

a policy that is intended to make it more difficult for households to go bankrupt result in *higher* bankruptcy rates?

The reform significantly reduces the cost of unsecured borrowing. In Figure 7(a), I plot the unsecured interest rates for the same household in Michigan as in the previous section, one with roughly median net worth and high persistent income. The household optimally chooses a portfolio consisting of $210K house, a $155K mortgage and $6K of unsecured credit. Also in the figure, I plot the unsecured interest rates that household would face if it chose the same size house and mortgage after the BAPCPA reform. The interest rate schedule shifts significantly to the right, meaning that the household faces lower interest rates. In addition, the interest rate schedule remains low even when the total amount of debt borrowed exceeds non-exempt home equity (the point at which the ex-ante financial gain from going bankrupt is positive). This is as a result of the fact that if the household earns above median income in the subsequent period it cannot go bankrupt even though there is a financial gain from doing so. Households are also less likely to go bankrupt in order to maintaining access to credit. Since interest rates are lower, access to credit is more valuable post-reform, implying that a greater direct financial benefit is required for a household to choose to go bankrupt.

Facing the lower cost of borrowing, the household in Michigan no longer finds it optimal to take on $6K of unsecured credit. After the reform, the household takes on a bigger house and mortgage, $280K and $190K respectively. Based on those choices, the unsecured interest rates that the household faces are plotted in Figure 7(b). With the increased amount of home equity and the BAPCPA restrictions, the household faces significantly lower borrowing costs



(a) Unsecured Interest Rates (b) Unsecured Interest Rates

Figure 7: Interest rates on unsecured debt for a household in Michigan before and after the BAPCPA reform. The dots represent the optimal policy choices of the household. *Notes:* Before the reform, the household optimally chooses a \$210K house, \$155K mortgage and \$6K of unsecured debt. The BAPCPA line in (a) represents the price schedule that the household would face if it chose the same size house and mortgage as before the reform. The BAPCPA line in (b) represents the price schedule given the household's optimal choice of housing and mortgage after the reform: \$280K house, \$190K mortgage and \$41K of unsecured debt.

and optimally chooses \$41K of unsecured credit. This type of change in behavior can explain the large increases in unsecured debt taken on by households after the reform.

Increases in debt and lower interest rates alone do not fully account for the increase in bankruptcies. The composition of who is taking on unsecured debt changes as well. Before the reform, there were primarily two groups of households that took on unsecured debt: those with very low net worth and those with substantial non-exempt home equity. Households with only exempt home equity took on only small amounts unsecured debt or none at all. After the reform that distribution changes. The low net worth households continue to borrow only in unsecured debt. However, households with high income and only exempt home equity take on more unsecured credit than before the reform. The persistence of income makes interest rates on unsecured debt low, even though the financial benefit of going bankrupt is high. If the household stays above median income, it simply repays or rolls over the debt. However, if the household falls below median income, it files for bankruptcy because the financial gain from doing so is large (since it keeps all of its home equity and discharges substantial unsecured debt). Unsecured borrowing coupled with exempt home equity essentially serves as insurance against below-median income realizations in the subsequent period. These results contrast with those of Chatterjee et al. (2007) who find a slight decline in the bankruptcy rate after imposing the income restriction for filing. The difference highlights the importance of considering exempt assets (mainly houses) as well as liabilities in any analysis of the effects of bankruptcy policy.

6.1.2 Effect of Homestead Exemption under BAPCPA

Before the reform, higher homestead exemptions lead to lower bankruptcy rates. After BAPCPA, the relationship is reversed - higher levels of the homestead exemption lead to higher levels of bankruptcy.[33]

The income restriction imposed under BAPCPA significantly mitigates the price effect of higher exemptions because 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 and exempt home equity can mimic an insurance contract against low income realizations. The level of insurance provided is limited by the level of the exemption (the maximum amount households can keep after bankruptcy). Therefore, households in high exemption states take on unsecured debt and increase home equity, leading to increased bankruptcy rates.

6.1.3 Welfare Consequences of the Reform

Despite higher levels of bankruptcy and foreclosure, households on average are made strictly better off from the reform. Taking into account transitional dynamics, the average consumption equivalent welfare gain across households from adopting the policy is 1.4 percent of lifetime consumption (this is a utilitarian welfare measure). The reason why households benefit from the reform is that they are excluded from going bankrupt in states of the world

[33] The state by state default rates are presented in Table ?? the Online Appendix.

where the gain is relatively small, but allowed to go bankrupt when the gain is large. Furthermore, with the exempt asset they are able to do better than just not having to repay the debt - they can also essentially transfer resources to the bankruptcy state through exempt housing. Since income is persistent, the cost of this "insurance" is fairly low for households above median income, so more households use it and end up going bankrupt more often, but are better off by doing so.

6.2 Optimal Homestead Exemption and Recourse Policy

In my second policy experiment, I ask how the government should optimally set the homestead exemption and recourse policy to maximize utilitarian welfare, taking into account the transitional effects of switching to a new policy. In the real world the federal government has the power to adopt a 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 and recourse 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. However, households in this economy face two types of uncorrelated risk: house price risk and income risk. Having no recourse mortgages allows 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 can provide insurance against a drop in income. The trade-off between price and insurance is lower after BAPCPA, however, since default is costly, it is optimal to keep the exemption relatively low, yielding lower bankruptcy and foreclosure rates. In addition, the lower exemption disproportionately benefits households with low wealth, since their assets are mostly exempt. Since I have adopted a utilitarian welfare function, setting the exemption to benefit mostly low net worth households may represent a trade-off 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 percent 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. The welfare gains are also heterogeneous across households. For example, high net worth households benefit most from adopting no-recourse mortgages, and lower income households with unsecured debt and home equity benefit from the lower exemption.

7 Conclusions

The option to default provides an important channel for insurance for households in an incomplete markets world. In the wake of the 2005 reform and the financial crisis of 2008 there has been fierce debate over how the government should regulate consumer credit markets. In this paper, I have shown that household behavior fundamentally links secured and unsecured credit, and foreclosure and bankruptcy. From the perspective of these findings, researchers and policy makers, therefore, ought to take into account both channels of default when analyzing consumer credit; otherwise they risk misstating the overall effect on household behavior and welfare. I illustrated this by showing that the model can capture the cross state variation in bankruptcy rates *only* when foreclosure is incorporated. Moreover, the evaluation of the 2005 BAPCPA reform showed that it had the unintended consequence of raising both bankruptcy and foreclosure rates.

The framework I developed opens up exciting avenues for future research. First, aggregate house price risk could be incorporated into the model. The model with aggregate risk could be used to evaluate mortgage modification policies intended to mitigate the effects of large house price drops. In particular, the model provides the necessary framework to evaluate proposed reforms to bankruptcy that would allow bankruptcy judges to modify the principal balances on mortgages (commonly referred to as "cramdowns"). Second, one could use the model to explain aggregate house price changes. Moving from an endowment economy to a production economy with aggregate risk and frictions on housing would generate endogenous movements in house prices. I defer this to future work.

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APPENDIX

In this appendix I present the proofs for Propositions 3-5. All remaining proofs can be found in the Online Appendix.

Proof of Proposition 3

(a) Suppose $y \in \overline{\mathcal{B}}^*(b_F, \eta, \xi_1, z)$. Take $\xi_2 < \xi_1$. Since $W^B_{\mathcal{F}}$ is increasing in the first argument $W^B_{\mathcal{F}}(\eta - \xi_1, y, z) \leq W^B_{\mathcal{F}}(\eta - \xi_2, y, z)$. However, since $y \in \overline{\mathcal{B}}^*(b_F, \eta, \xi_1, z)$ this implies that $W^{NB}_{\mathcal{F}}(b_F + \eta + y, z) \leq W^B_{\mathcal{F}}(\eta - \xi_1', y, z)$, which implies that $y \in \overline{\mathcal{B}}^*(b_F, \eta, \xi_2, z)$. ∎

(b) Suppose $y \in \overline{\mathcal{B}}^*(b_F, \eta, \xi, z)$. Take $x > 0$. Since $W^B_{\mathcal{F}}$ is increasing in its first argument, $W^B_{\mathcal{F}}(\eta + x - \xi, y, z) \geq W^B_{\mathcal{F}}(\eta - \xi, y, z)$. However, since $y \in \overline{\mathcal{B}}^*(b_F, \eta, \xi, z)$ this implies that $W^{NB}_{\mathcal{F}}(\eta + y + b_F, z) \leq W^B_{\mathcal{F}}(\eta - \xi, y, z)$, and $W^{NB}_{\mathcal{F}}(\eta + y + b_F, z) = W^{NB}_{\mathcal{F}}((\eta + x) + y + (b_F - x), z)$, therefore $y \in \overline{\mathcal{B}}^*(b_F - x, \eta + x, \xi, z)$. ∎

(c) Suppose $y \notin \overline{\mathcal{B}}^*(b_F, \eta, \xi, z)$, where $\xi > 0$. Take $x > 0$. Since $W^{NB}_{\mathcal{F}}$ is increasing in the first argument, $W^{NB}_{\mathcal{F}}(b_F + \eta + x + y, z) \geq W^{NB}_{\mathcal{F}}(b_F + \eta + y, z)$. Note that since $\xi > 0$, the additional home equity is forefeited in bankruptcy, $W^B_{\mathcal{F}}((\eta + x) - (\xi + x), y, z) = W^B_{\mathcal{F}}(\eta - \xi, y, z)$. Thus, since $y \notin \overline{\mathcal{B}}^*(b_F, \eta, \xi, z)$ this implies that $W^{NB}_{\mathcal{F}}(b_F + \eta + x + y, z) \geq W^{NB}_{\mathcal{F}}(b_F + \eta + y, z) \geq W^B_{\mathcal{F}}(\eta - \xi_1', y, z)$, which implies that $y \notin \overline{\mathcal{B}}^*(b_F, \eta + x, \xi + x, z)$. ∎

(d) When there is no homestead exemption the value of defaulting only depends on the endowment y and state z. Today's budget set only depends on the net asset position, therefore the bankruptcy set only depends on $\eta + b_F$ and z. ∎

(e) This comes directly from Proposition 1 and that $W^{NB}_{\mathcal{F}}(a, i) \geq W^{BC}_{\mathcal{F}}(a, i)$. Let $\varepsilon = b_F + \eta - \chi^s > 0$. Suppose not, i.e. $\exists y \in \overline{\mathcal{B}}^*(b_F, \eta, \xi, z)$. This implies that $u(y; p_s) + \beta \mathbb{E} V^{BC} \geq u(c^*(\eta + b_F + y); p_s) + \beta \mathbb{E} V^G$. However, consuming $y + \varepsilon$ and saving χ was a feasible choice, which implies that: $u(c^*(\eta + b_F + y); p_s) + \beta \mathbb{E} V^G \geq u(y + \varepsilon; p_s) + \beta \mathbb{E} V^{BC} > u(y; p_s) + \beta \mathbb{E} V^{BC}$ from the strict monotonicity of u, which arrives at the desired contraction. ∎

Proof of Proposition 4 When $\gamma < 1$ and $h(1-\delta) > m$ implies $h(1-\delta) - m > \gamma h(1-\delta) - m$ (the deficiency judgment value) and $h(1-\delta) - m > \max\{\gamma h(1-\delta) - m, 0\}$ (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 $\chi > 0$ the same argument holds. If $\chi = 0$ the assumption that when a household has positive home equity and is indifferent between foreclosing and not it chooses to repay completes the proof. ∎

Proof of Proposition 5 The proof is immediate from Proposition 4 and the definition of foreclosure when $\psi = 0$. When $\delta \geq 1 - \kappa \Rightarrow h(1-\delta) \leq m$, thus the household will always have more resources if it chooses foreclosure. ∎