Consumer Bankruptcy and Mortgage Default*

Wenli Li (Philadelphia Fed.)
Costas Meghir (Yale, NBER and IFS)
Florian Oswald (SciencesPo Paris)

`Incomplete`

May 16, 2017

Abstract

We specify and estimate a rich model of consumption, housing demand and labor supply in an environment where individuals may file for bankruptcy or default on their mortgage. Uncertainty in the model is driven both by house price shocks and income shocks, while bankruptcy is governed by the basic institutional framework in the US as implied by chapter 7 and chapter 13. The model is estimated using micro data on credit reports and mortgages combined with individual level data from the American Community Survey. We perform several counterfactual experiments with the model which investigate welfare aspects of an important reform of the US consumer bankruptcy code implemented in 2006.

Keywords: Lifecycle, Bankruptcy, Mortgage Default, Labor Supply, Consumption

1 Introduction

A number of countries, inluding the US and the UK, have legislation that defines the way bankruptcy is to be treated. Such legislation is an attempt to balance the legitimate rights of

*Corresponding Author: florian.oswald@sciencespo.fr. This project is funded by a grant from the Sloan foundation. Florian Oswald is grateful for additional funding under ESRC transformative research grant, grant number ES/M000486/1. All errors and views expressed are our own and we individually have sole responsibility for them.

creditors with the need to offer some level of insurance for adverse events. Different legislation governs defaults on secured and unsecured debt and interestingly, such legislation varies widely across states in the US and across countries. For example the extent to which housing equity can be used to repay outstanding debts following default on unsecured debts varies widely across US states from 0% to nearly the entire level of housing equity. On the other hand, the extent to which non-housing assets can be used to repay debts following mortgage default is also regulated by legislation. Finally, the way debts are handled can also be means tested. For example, following a US reform in 2006, only lower income people can file for chapter 7, while individuals with above median earnings must file for chapter 13.

Such legislation can have important welfare effects for a number of reasons. First, and most obviously, it limits to varying degrees the impact of adverse shocks both because it offers some protection against the downside of severe income shocks by capping their impact on individual lifetime consumption. This will increase welfare. On the other side protection will cause adverse welfare effects because it will induce greater risk taking, it will lead individuals to file for bankruptcy when in principle they could repay debts (albeit at the cost of very low consumption for extended periods of time), and possibly reduce the incentive to work for accumulating assets; it will also tend to increase interest rates for both unsecured and to some extend secured debt as the interest will have to cover the expected losses by creditors. Finally the way that debts may be partially recovered can also have important welfare implications. For example wage garnishing following filing for chapter 13 can reduce the incentive to work.

In this paper we specify and estimate a microeconomic life-cycle model of non-durable consumption, housing and labor supply allowing for both bankruptcy and mortgage default so as to understand the effects of legislation governing such events. In our model individuals can choose to buy or rent a house, the amount of liquid assets they wish to accumulate, as well as their labor supply. At each point in time they can decide to either file for bankruptcy or default on their mortgage; this decision is made in view of the benefits that such action will have for them under the specific institutional context that they are facing. So as to capture the effects of bankruptcy on the pricing of credit we allow the interest rate on unsecured debt to depend on the probability of bankruptcy, which will depend on the state describing the individual circumstances and on the specific legislative framework.

Our model is estimated using US data from the period before 2006, which is when an important reform of the US bankruptcy code (BAPCPA) was enacted. The bankrutpcy reform in essence mandates that individuals with earnings above the state median are only eligible to file for bankruptcy chapter 13 of the bankruptcy code. Chapter 13 embodies in most cases a debt restructuring whereby debtors agree to make repayments to creditors according to a schedule drawn up by a bankruptcy judge. Often this takes the form of a wage garnishment, i.e. the debtor delivers part of monthly income to the creditor. In return, no other assets (most importanly: the debtor's house) will be liquidated. The alternative arrangement, chapter 7 bankruptcy, is characterized by total liquidation of all assets above a so-called *homestead exemption* level, and complete debt forgiveness. Access to chapter 7 is governed by an income means test, according to which only individuals with income below the state median level can file under that chapter. We are particularly interested in the effects of those incentives on labor supply decisions. What are the efficiency costs in terms of distorted hours choices introduced by the means test?

Our estimation approach relies on using house price processes bankruptcy and mortgage default rates at the local county level in the US based on microeconomic data recording all loan and mortgage activity as well as bankruptcies. Combining such data together with information from the census allows us to estimate a rich model of individual consumption and labor supply behavior allowing for differences across education groups.

The model can be used to assess the effects of policy reforms such as BAPCPA, as well as to address the tradeoffs involved in more or less consumer protection. For example we could answer the question of what would have happened over the course of the last couple of years had the reform not been enacted. To be able to do so, we rely on a representation of the economy that takes into account local variation in house prices and bankrutpcy and default rates. We provide empirical evidence that local economic conditions over and above state legal arrangements matter for the determination of bankruptcy and default rates.

There has been a lot of interest in homestead exemption levels and how they affect the rate of bankrutpcy. Convincing evidence is hard to come by, mainly because there is little variation in legal arrangements concerning bankrutpcy over time, and the rate itself is an equilibrium outcome. As in the most typical example of identifying demand and supply curves of **?**, it is difficult to identify a causal effect of homestead exemption on bankruptcy, because the supply of credit may be restricted in areas where the incentives to file are relatively large (i.e. high exemption), so that only good quality borrowers obtain credit, and therefore the higher incentives for bankruptcy are counterbalanced by a better quality pool of risks. An incomplete list of examples of this literature might include Pavan (2008), who investigates the effect of exemption levels on bankruptcy and durable purchases and finds that exactly this is happening, i.e. welfare gains from greater insurance are cancelled out by losses due to tighter credit constraints. Her conclusion is opposed to the one of Hintermaier and Königer (2009), who find that the stock of durables has little impact on the pricing of and thus access to unsecured borrowing in a calibrated model. In terms of empirical contributions, Gropp et al. (1997) find in SCF data that all else equal, borrowers in high exemption states are significantly more likely to have a loan application rejected. Fay et al. (2002) use PSID panel data to investigate the determinants of consumer bankruptcy, but they cannot examine exemption levels as they include a state fixed effect. Traczynski (2011) examines how different exemption levels may lead to different incentives for couples to divorce, relying on within state variation of exemption levels.

In terms of wider placement within the literature on consumer bankruptcy, this paper adds the housing and mortgage default dimension to the common framework of dynamic bankruptcy analysis. This framework relies on an extension of an Aiyagari (1994)-type economy which extends the way in which borrowing is possible. While in Aiyagari (1994) the assumption is that borrowing is allowed up to an amount the consumer can repay with probability one (typically this is the present discount value of lowest possible income for the rest of his life), thereby of course precluding non-repayment of debts, in this type of models non-repayment of debts is made possible by the bankruptcy law, which bounds the losses that a consumer can incur: the offered insurance then leads to moral hazard and it is this tradeoff that we eplore in this paper. The possibility of non-repayment leads banks to offer interest rates for unsecured borrowing which is based on an individual's probability of repayment of the loan. The theoretical foundation of this is laid out in Chatterjee et al. (2007), examples of applications to different aspects of risk-sharing and welfare implications are Athreya (2008), which examines the interaction of bankruptcy with social insurance, and Livshits et al. (2007), who calibrate a life-cycle model to investigate welfare differences of different bankruptcy schemes. This last contribution is close in spirit to the present paper, the difference being that here we augment the set of shocks the consumer is subject to assets they may hold. This set comprises income shocks, health shocks, and family shocks (divorce or children). See Sullivan et al. (1999) pp. 128 for another account for the importance of housing shocks as drivers of bankruptcy.

The closest paper to ours is the one by Mitman (2016) who also considers a model of consumption and housing with bankruptcy and default. However our model differs in a number of substantive ways. First, our model allows for labor supply; this is important both because by varying labor supply one can change the probability of bankruptcy and because it allows us to deal with post-bankruptcy wage garninshing when this is relevant; the anticipation of such an event can initself change behaviour limiting bankruptcy. The fact that we allow for endogenous labor supply enables us to consider the implications of the policy framework along this margin. Secondly, our model features a finite-horizon lifecycle setup, which allows us to consider a more realistic long-term mortgage contract. In our model, a mortgage is a contract with necessarily finite duration, that *deterministically* reduces the loan to value ratio of the borrower as time goes by. This is important, since mortgage vintage, which is highly correlated with borrower age, is a strong predictor of default and bankruptcy. Finally the housing market has more frictions in our model. In that dimension, our model is much closer to Attanasio et al. (2012)

In the next section we present some descriptive facts about bankruptcy, default and the institutional context. We then describe our model. We then discuss our data and the estimation approach. We then discus the estimation results and present the policy implications of our model.

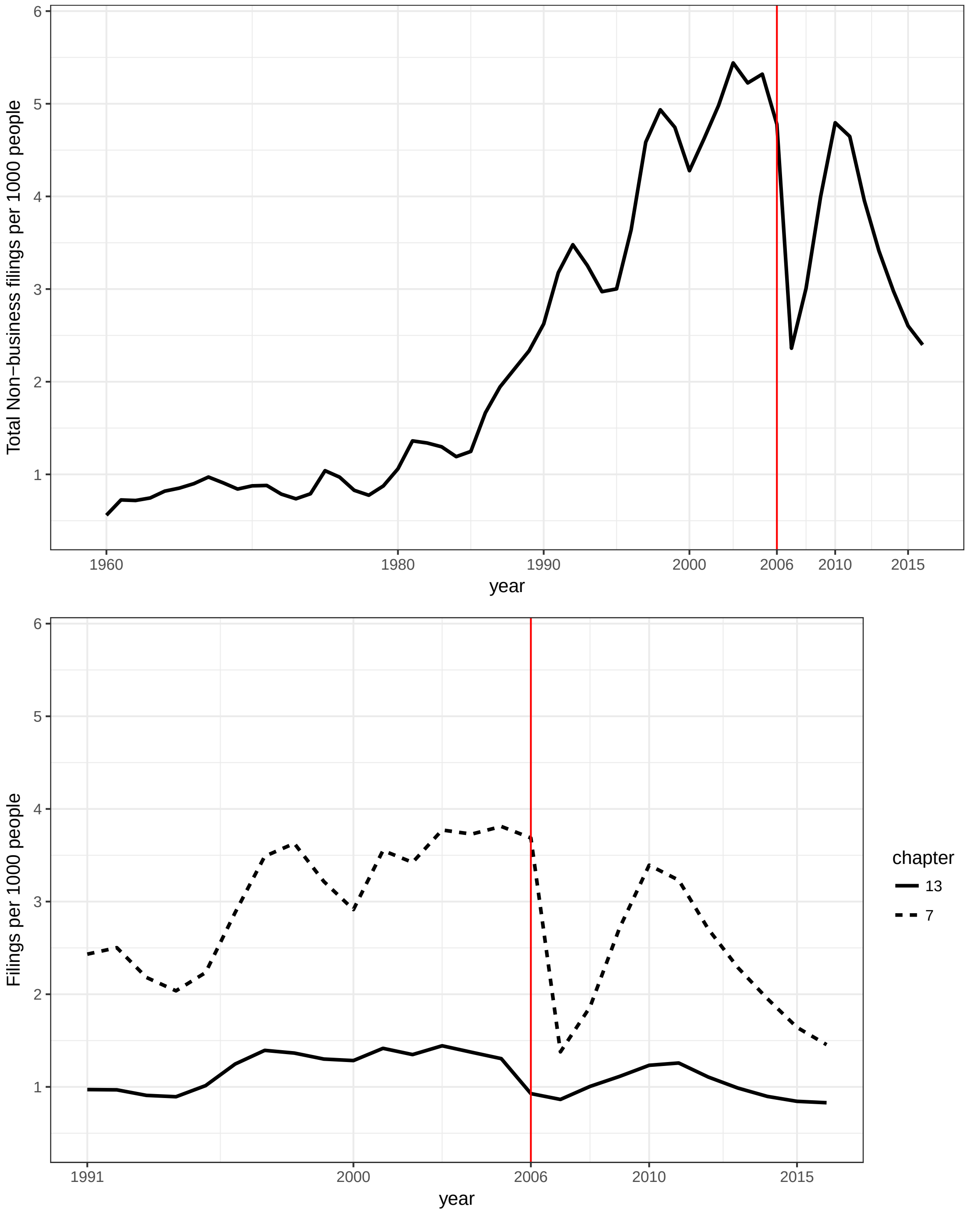


Figure 1: Trends in Bankruptcy Filings. The vertical red line indicates enactment of the BAPCPA reform in late 2005. The top panel shows aggregate non-business filings over time, the bottom panel splits this by chapter choice. This is data from the American Bankruptcy Institute. For a split by top/bottom 3 states in the distribution of filings, see figure 12 in the appendix.

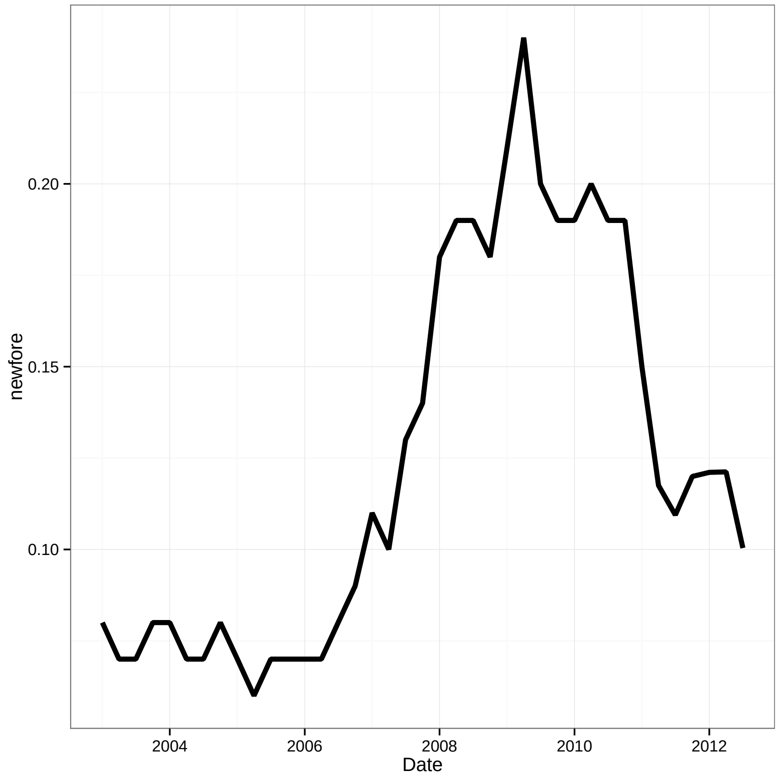


Figure 2: Trends in bankruptcy and default. This shows shows the percentage of total population with a new foreclosure by quarter, available at http://www.newyorkfed.org/householdcredit/.

2 Some Descriptive Facts

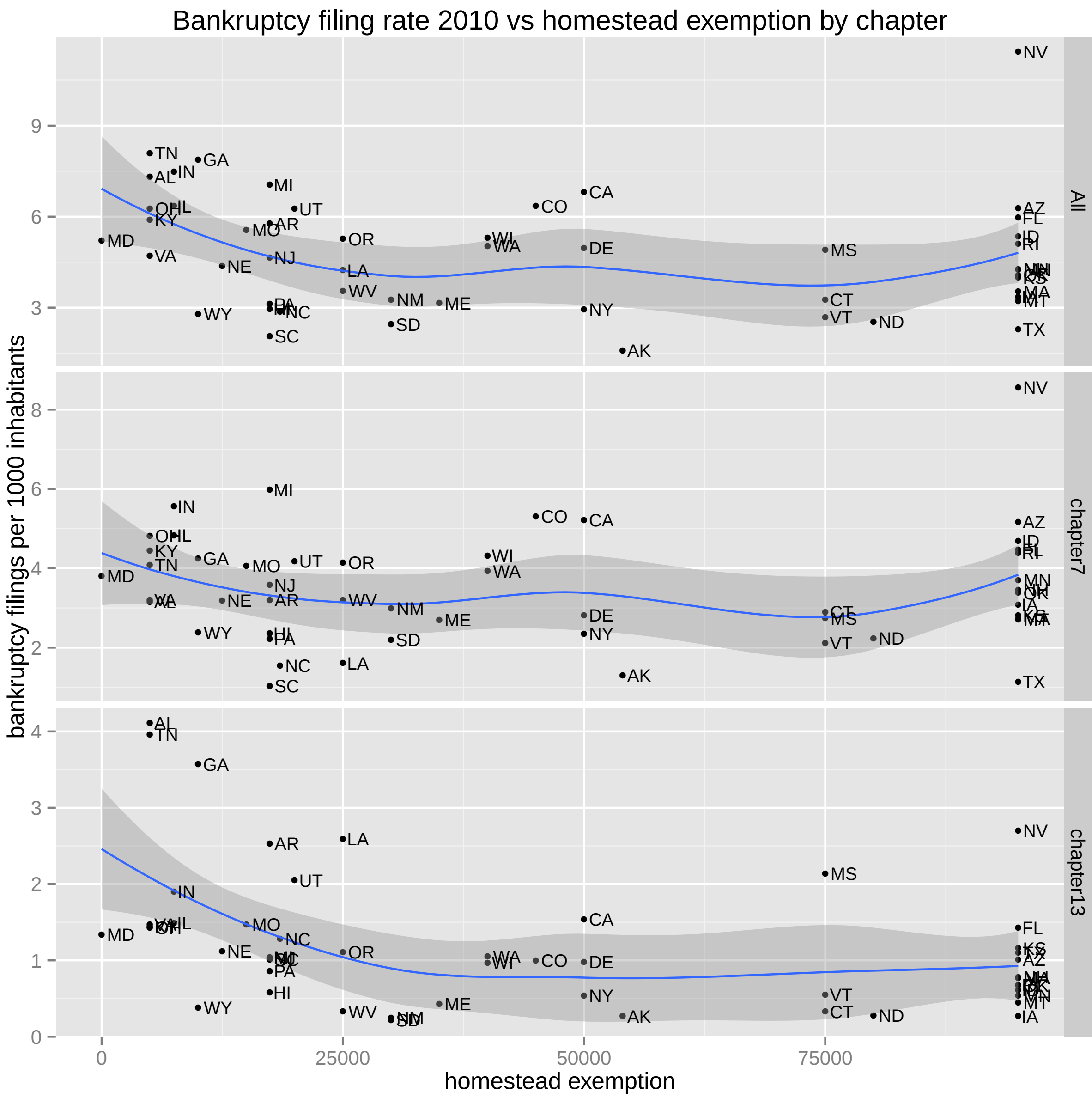


Figure 3: homestead exemption vs bankrutpcy rate. Homestead exemption values are top-coded at the 75% percentile ($91250). Blue line is a polynomial smoother with 95% confidence interval. Data: http://www.uscourts.gov/Statistics/BankruptcyStatistics/ and http://economics.sas.upenn.edu/~mitmanke/MitmanJMP.pdf

Trends in non-business bankrutpcy filings are shown in figure 1. Notice the spike in bankruptcies in 2005 which corresponds to the introduction of the "Bankruptcy Abuse Prevention and Consumer Protection Act" (BAPCPA), which led to a final rush before the rules changed. An overview of recent trends in mortgage default, on the other hand, is shown in figure 2.

We are interested the relationship between the level of homestead exemption and the amount of bankruptcy observed in a given state. One may think think that a more generous bankruptcy scheme, i.e. higher exemption levels, lead to more bankruptcy. However, this is not unambiguously true. A first look at the data is provided in figure 3, where we plot the bankruptcy rates by state versus their respective homestead exemption level, by chapter. Notice that the conclusions to be taken from that graph depend greatly on how one treates "unlimited exemption" (i.e. at which level this is fixed), but in general we can observe a negative correlation. There seems to be a credit rationing effect going on, whereby states with risker environments for lenders (bankruptcy is more generous), feature tighter credit access.

We explore this idea in a regression framework. Consider table 1, where we use data from the NYFed consumer credit report in conjunction with information on state ownership rates, the legal environment concering homestead exemption and recourse (recorded as to whether it is possible for the lender to obtain a deficiency judgment against delinquent borrowers), to correlate with the fraction of state j's population filing for a new bankruptcy in quarter t, measured in percent. We purposefully do not include a state fixed effect in order to be able to see the effects of characteristics of the legal environment.

From the above, we see that recourse legislation is positively related to new bankruptcies at the 10% significance level. Unlimited homestead exemption is significantly *negatively* associated with bankruptcy. All else equal, states with unlimited homestead exemption have 0.08% fewer consumers entering bankruptcy per quarter than states with a limit – if compared to the sample median of 0.17%, that is about half as much. This phenomenon could be explained by credit rationing and composition effects, whereby creditors in states with higher exemption are more selective, because incentives for bankruptcy are relatively strong. This has been shown for example in Gropp et al. (1997). However, these resuts show that relying on cross-sectional variation in institutional arrangements in itself does not provide a valid source of variation for estimating the model.

In terms of elasticities at the sample median for the regressors as shown in table 2, we see that a 1% decrease in the lagged house price index is associated with a 0.75% increase in

	New Bankruptcies$_{j,t}$
(Intercept)	0.3270^{***}
	(0.0793)
Unemployment$_{j,t}$	0.0077^{**}
	(0.0024)
HPI$_{j,t-1}$	-0.0004^{***}
	(0.0000)
New foreclosures$_{j,t-1}$	0.2392^{***}
	(0.0369)
Ownership rate$_j$	$-0.0016^{\cdot}$
	(0.0009)
Recourse$_j$	$0.0237^{\cdot}$
	(0.0130)
Homestead exemption$_j$	0.0000^{*}
	(0.0000)
Unlimited exemption$_j$	-0.0807^{***}
	(0.0134)
R^2	0.4951
Num. obs.	297

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\cdot}p < 0.1$

Table 1: Explaining the percentage of state population with new bankruptcies in quarter t with NYFed consumer credit report data, using quarterly data from 2003–2016 for Arizona, California, Florida, Illinois, Michigan, New Jersey, Nevada, New York, Ohio, Pennsylvania and Texas. *HPI* stands for house price index, *Recourse* is a dummy equal one if the state allows recourse to mortgage lenders, *Homestead exemption* is the dollar amount of homestead exemption granted to bankruptors, and *unlimited exemption* is a dummy equal to one if that level is unlimited.

the percentage of consumers with new bankruptcies. This is a sizeable effect, if compared to the elasticity associated with homestead exemption, which implies a 0.01% increase in new bankruptcies if exemptions are increased by 1% from the sample median. It appears that there are channels from house price risk to default on unsecured credit, i.e. bankruptcy. One could for example think that homeowners who are subject to a house price shock and at the same time are liquidity constrained could use the bankruptcy option to losen their budget constraint, so that they can keep current on their mortgage. Another possibility arises from the interaction between recourse law and bankruptcy. It could for example be that owners in foreclosure use bankruptcy to discharge any remaining debt which would be carried forward in case the lender had recourse. The elasticity of lagged foreclosures in table 2 indicates that increasing new foreclosures by 1% from it's median would result in a 0.17% increase of new bankruptcies in the following quarter.

variable	median	sd	elasticity
newbk	0.17	0.11	
unemp	6.23	1.91	0.28
Lhpi	367.86	126.27	-0.75
Lnewfore	0.12	0.16	0.17
own.rate	68.50	6.29	-0.62
hex	17425.00	154888.70	0.01
DeficiencyYes	0.82	0.39	0.11
ultdTRUE	0.18	0.39	-0.08

Table 2: Elasticites of estimates from the regression in table 1, calculated at the sample median of the respective variables.

3 Model

3.1 The individual lifecycle

Individuals maximize expected lifetime utility. As we focus on house purchases and since we need to economise in computations, the active life period starts at age 30 and lasts until age $T = 60$, which in the model is the age of retirement. Individuals differ by their completed level of schooling, but are identical in all other respects ex ante. There are two sources of uncertainty: house prices and earnings uncertainty.

3.2 Preferences

Households derive utility from consumption of a composite non-durable consumption good c, leisure l and from a housing good h.[1] Labor supply decisions are modelled as choices from an increasing set of values $L = \{l_1, l_2, \ldots, l_m\}$ corresponding to the fraction of disposable time supplied to the labor market with the convention that $l_1 = 0$ hours. Houses are characterized by their size, and we allow choice over a discrete grid $h \in \mathcal{H} = \{\underline{h}, h_1, \ldots, h_H\}$. Renters must live in the smallest house $\underline{h}$, which we choose to match the homeownership rate, and we define the ownership indicator $\mathbf{H} = \mathbf{1}[h > \underline{h}]$. The instantaneous utility function is

$$u(c, l, h) = \frac{(c \cdot \exp(\alpha(\text{educ})\, l))^{1-\gamma}}{1-\gamma} \exp(\mathbf{H}\theta h) + \mathbf{H}\mu(h) + \varepsilon(d) \tag{1}$$

where $(\alpha, \mu, \theta, \gamma)$ is a vector of parameters, and $\varepsilon(d)$ is a discrete choice-specific idiosyncratic utility shock. The set of discrete choices for owners is given by

$$d \in \{\text{stay,sell,default,file chapter 7,file chapter 13,file chpt. 7 and default}\}$$

and the one for renters is

$$d \in \{\text{rent,buy size } h \in \mathcal{H}, \text{file chapter 7,file chapter 13}\}.$$

This specification of utility in (1) is non-separable in consumption and labor as well as in consumption and housing.[2] We will restrict parameter values $\alpha < 0, \gamma > 1$, implying that utility is decreasing in labor, that individuals are risk averse and that the marginal utility of consumption is increasing in the amount of labor supplied. (see Low et al. (2010) for a similar specification.) The consumption and labor component is augmented by a multiplicative and additive term reflecting the effect of housing on utility for owner occupiers. The multiplicative term is a nonseparable scaling factor of utility, with the convention that scaling is relative to utility of renting. The additive term implies that we don't have a utility function which is homogeneous, thus preferences over consumption and housing are not homothetic. The sign of

[1] we use "individuals", "households" and "agents" interchangeably.

[2] Formally: Thinking of c, h, l as continuous, consumption and labour are weakly separable from housing but consumption and housing are not separable from leisure and neither are housing and leisure separable from consumption.

μ establishes whether housing is a necessity or a luxury. The setup is similar to Attanasio et al. (2012) but for the additional utility derived from leisure.

The aim of the household is to maximize lifetime utility

$$U = E_0 \sum_{t=1}^{T} \beta^{t-1} u(c_t, l_t, h_t) + \beta^T V_T(a, h, p, m, BK)$$

by means of choosing sequences $\{c_t, h_t, l_t, d_t\}_{t=1}^{T}$ of consumption, labor supply, housing and a set of discrete choices d relating to bankruptcy and default, which are detailed below. There is a standard discount factor $\beta < 1$ and a final period that takes into account the amount of home equity at the end of the active lifecycle and the start of retirement. The expectation is taken with respect to contingent paths of labor productivity and house prices. The final period value is a bequest function with a penalty for entering bequest in bankrutpcy state:

$$V_T(a, h, p, m, BK) = \frac{\theta_b (w + K)^{(1-\gamma)\pi}}{1-\gamma} - \theta_{BK}[BK = 1]$$

where w is net wealth $w = ph - m$, $K \geq 0$ allows for zero bequests and θ_{BK} is a penalty if one enters the last period in bankruptcy (BK) state.

3.3 House Prices

We specify idiosyncratic house price shocks, i.e. we are not interested in aggregate shocks here, but the individual decision to default or not. With this in mind, we specify that the price of each unit of housing is normalized to one at the time of purchase, and then this price is assumed to evolve in an autoregressive fashion like shown below:

$$\begin{aligned} p_{i0} &= 1 \\ p_{it} &= \rho_p p_{it-1} + \epsilon_{it-1} \\ \epsilon_{it} &\sim N(0, \sigma_p^2) \end{aligned} \tag{2}$$

In our empirical application we will estimate the standard deviation σ_p of this process to fit the default rate. This setup is similar to the one in Mitman (2016).

3.4 Labor productivity

We model the log of hourly wages for individual i at time s when they are of age t as

$$w_{ist} = d_s + f(\theta_i, t) + \eta_{ist} \tag{3}$$

where d_s is a time fixed effect, f is a polynomial in age and η_{ist} follows an age-dependent markov chain of order one, where – importantly – *both state space and transition matrix* of the markov chain depend on age. We take this representation of the wage process from De Nardi et al. (2016) and estimate it on PSID data following their procedure. We find it to be a particularly well-suited process because it captures well the changing shock structure in the lower part of the wage distribution, which is of first order when talking about bankruptcy.

3.5 Default Institutions

There are two distinct credit default institutions in the model: there is default on unsecured debt and default on secured housing debt. We will refer to the former as *bankruptcy* and to the latter as *default* for simplicity.

In 2005 the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) was introduced, making it more difficult for some consumers to file under chapter 7 of the bankruptcy act and instead forcing them to choose chapter 13 instead. In general terms, chapter 7 amounts to full discharge of debt while chapter 13 is a debt restructuring. The main aspect of eligibility for chapter 7 concerns a means test, whereby chapter 7 is not a choice if the individual's monthly income is above the state median. Under chapter 7, no debt repayments need be made (i.e. there is complete discharge of unsecured debts) but non-exempt assets are seized, while under chapter 13 the consumer must commit to a repayment plan that lasts on average for 5 years, but may otherwise keep their assets. One is tempted to expect that owners with important amounts of non-exempt home equity (maybe because they reside in states with low exemption level, or because they are rich in equity) would prefer to make debt repayments, if they are in a situation to do so, whereas owners in high exemption states may prefer the chapter 7 option, since this guarantees their home equity without the onerous debt repayment plan. The extent of the owner's preference for either option will depend on the amount of equity, their rank in the state income distribution, and the details of the repayment plan, i.e. what wage garnishments the bankrutpcy judge deems just.[3]

We model the distinction between both chapters. In particular, we incorporate the means test which requires consumers with greater than state median income to file for chapter 13. Given that homeowners are the ones predominantly affected by this restriction, it seems like an important feature of the budget set of the consumers in our data. We will perform a counterfactual policy experiment where we undo the reform and allow all consumers to file under chapter 7, regardless of their income.

With this distinction in mind, we model bankruptcy as follows. Depending on their position in the income distribution, a consumer ends up in either chapter 7 or 13.[4] In chapter 7 they are subject to the restrictions imposed through homestead exemption levels, i.e. they may only keep their homes if equity is less than the state exemption level, denoted ξ. In chapter 13, on the other hand, they may keep their house regardless of the exemption level since they sign up to a repayment plan, which stipulates debt repayments for as long as they are in *bankruptcy state*. Chapter 13 is only an option if the creditor can expect to recoup at least as much as under a chapter 7 liquidation. Associated with filing for bankruptcy we allow for certain costs: first the individual is excluded from financial markets for five years on average.[5] In addition bankruptcy involves psychic costs λ^{bk} associated with the stigma of a bad credit record.

The so–called homestead exemption is a legal clause which exempts a certain amount of home equity from liquidation, to different extents in different states. In practice, this means that if an owner finds themself with unsecured debt and at the same time has equity in the home below the exemption level, they could file for bankruptcy without risking to loose the home in a forced sale, since the unsecured lender is prevented from claiming the exempt equity. In the model, therefore, an owner with less than exempt equity stays in their house during bankruptcy (if it is optimal for them to do so). If an owner in excess of the exemption limit files, they lose the house, which is sold at market price, but they get to keep the exeption level from the proceeds of the sale.

The second institution concerns default on mortgage debt. It is important to distinguish the case where the individual no longer finds it optimal (or affordable) to continue repaying a

[3] Note that garnishments must not exceed 25% of disposable income under Federal Law.

[4] In future drafts we intend to relax this restriction allowing low income people with high levels of equity to file under chapter 13 if optimal for them.

[5] In the model, the length of exclusion is random and one exits exclusion at a constant probability. We adopt this strategy purely out of computational reasons. Having a counter variable would increase the state space five-fold, which is not an option.

mortgage on a house following say an income shock to the case where the house price has fallen placing them in negative equity. In the former case the house is sold and the mortgage repaid; the individual then moves either to a smaller house or rents. In the latter (negative equity case) there is an incentive to default. However, even then default may not occur in the model because of the costs involved. However, they may decide strategically to default if it is optimal to do so; alternatively they may also default if they are cash-flow constrained.[6]

In practice, default means that the owner becomes a renter, but is relieved of all outstanding mortgage debt. Credit scores of defaulters deteriorate by 200–300 points according to some observers, so we apply one period with no access to unsecured borrowing and psychic cost λ^{def} as a punishment. One issue that warrants a comment is so–called recourse legislation. According to a commonly used classification (see Ghent and Kudlyak (2009)), there are eleven US states in which a mortgage lender is practically prohibited to claim other assets of a home owner who defaults on a mortgage when the sale of the property does not cover the outstanding debt. Those states are classified as non-recourse states, whereas in the other states, a lender may lay claim to other assets to cover remaining outstanding debt after default. It is in those states and cases that remaining mortgage debt gets converted into unsecured debt, and which those defaulting then seek to discharge in an ensuing bankruptcy, should this be necessary. We use a factor $\psi \in [0, 1]$ to control what fraction of remaining debt gets carried over in certain legal systems.

3.6 Financial Market

There are two types of financial institutions in the model, one specializing in unsecured lending and one in mortgage lending. Both have access to international financial markets and take the interest rate r as given.

Mortgage Market

There is a unique mortgage contract for all types of individuals, characterized by a fixed interest rate r^m, a required downpayment fraction χ, and a mortgage term T_m. This setup implies that *years remaining* on the mortgage, $n \in \{0, \ldots, T_m\}$, is a state variable, with the convention that $n = 0$ denotes a fully paid off loan. Along the mortgage trajectory for initial borrowing

[6] see Bajari et al. (2008) and Guiso et al. (2009) for discussions of these issues

$p_{i0}h(1-\chi)$, the annual mortgage payment is a constant function κ, and the corresponding current mortgage balance is given by m:

$$\kappa(p_{i0}h, r_m, T_m) = p_{i0}h(1-\chi) \times \frac{r}{(1-(1+r)^{-T_m})} \tag{4}$$

$$m(p_{i0}h, r_m, T_m, t) = (1+r)\, p_{i0}h(1-\chi) - \kappa(p_{i0}h, r_m, T_m)\frac{(1+r_m)^t - 1}{r_m} \tag{5}$$

This is a fairly exact representation of an industry-standard fixed rate mortgage in the US. In line with that ideal, upon sale of the house, the mortgage needs to be repaid at once. We abstract from mortgage refinancing.

3.7 Unsecured debt market

Unsecured borrowing means that the liquid asset a can be made negative up to a certain endogenously determined amount $\bar{a} < 0$. The interest rates for saving and borrowing are denoted r and r^b, respectively. Borrowing and saving is assumed to take place in a one period discount bond fashion as in Chatterjee et al. (2007) or Athreya (2008) for example. In our model there is no asymmetric information so that bank can perfectly predict the probability of default. The interest rate it charges is accordingly adjusted at the individual level, assuming a competitive market where all financial intermediaries make zero profits.

When filing for bankrutpcy the individual may either file for chapter 7 (if low income), in which case no debt will be repaid, or can file for chapter 13 in which case a stream of payments will be deducted from earnings for a period of time, which lasts $T_{bk} = 5$ years on average (there is random exit from bankruptcy state). The repayment in chapter 13 depends on expected income of the invididual over the repayment period, whereby the lender assumes full-time work. [7] We denote with $\bar{y}$ the amount to be repaid in each period of chapter 13, and with $\bar{Y}$ expected income over the next T_{bk} years. Federal law imposes a maximum debt to income ratio $\hat{y} = 0.25$

[7] Once in a chapter 13 repayment plan, the individual is contraint to supply sufficient labor in order to be able to make the required payments.

that the repayment $\bar{y}$ must respect, hence we define

$$\bar{y} = \iota(a, \bar{Y}, \hat{y}) \frac{\bar{Y}}{T_{bk}}$$

$$\iota(a, \bar{Y}, \hat{y}) = \begin{cases} \frac{-a}{\bar{Y}} & \text{if } \frac{-a}{\bar{Y}} < \hat{y} \\ \hat{y} & \text{else.} \end{cases} \tag{6}$$

For example, if the individual enters bankruptcy with $a = -20,000$ in unsecured debt, and expects to earn $\bar{Y} = 120,000$ over the next 5 years, this implies that $\frac{-a}{\bar{Y}} = \frac{20}{120} < \frac{1}{4} = \hat{y}$ and hence the debt is fully repaid evenly spread out over the 5 years. In a different example with $\bar{Y} = 75,000$, this yields $\iota = \hat{y} = 0.25$, and there is only partial repayment of the debt.

If the individual is eligible to file under chapter 7 and does not own a house no further repayments will be made. On the other hand if she does own a house, any value over and above the homestead exemption (applicable in the state of residence) can be used to cover loan repayments: the housing equity effectively acts as security for the "unsecured" loan. We defined equity as $(1 - \phi)(p_{i0}h - m)$, with ϕ a proportional transaction cost when selling the house, thus the amount of *non-exempt* home equity is $\nu = \max(\mathbf{H}(1 - \phi)(p_{i0}h - m - \xi), 0)$. We allow additionally for some inefficiency in the bankruptcy technology of the lender $\zeta < 1$, such that the lender recovers only $\zeta\nu$ from a chapter 7 bankruptcy.

From the unsecured lender's perspective, expected repayment is thus composed of two possible events to occur in next period: no bankruptcy, or bankruptcy of either chapter 7 or 13. Under no bankruptcy, they get repaid in full, otherwise they get any non-exempt equity (if chapter 7) or the repayments over a chapter 13 plan. Under the assumption of free entry in the unsecured lending market and no pooling of contracts on behalf of the lenders, there is a zero expected profit condition that allows to price each individual unsecured loan a':

$$q(a'|X) = \left(1 - \pi^7(\cdot) - \pi^{13}(\cdot)\right) a' - \pi^7(\cdot)\nu - \pi^{13}(\cdot)\bar{y}T_{bk} \tag{7}$$

where $\pi^j(a'|X)$ denotes probability of bankruptcy chapter j next period, X is the relevant state space for the consumer, and the amount delivered to the consumer in the current period is $\frac{q(a'|X)}{1+r}$. The $\pi^j(\cdot)$ are computed by the lender using all observable information about the consumer who is applying for a loan.

3.8 Consumer choice

Consumers can either be owners or renters, and either type can be in a bankruptcy punishment state, or not. While in a punishment state, there is no borrowing possible, be it secured or unsecured (i.e. no new house purchase is possible), and a utility penalty is incurred. Exit from the punishment state occurs each period with exogenous probability δ. Whether an individual is in the punishment state or not is part of their state space. In addition the renter's state space is a compact subset of $\mathbb{R}^2 \times \{1, \ldots, T\}$ denoted $\mathcal{R}$ with typical element $R = (a, w, t)$, whereas the owner's space is defined as $\mathcal{S} \subset \mathbb{R}^3 \times \{0, \ldots, T_m\} \times \{\mathcal{H} \backslash \underline{h}\} \times \{1, \ldots, T\}$ with typical element $S = (a, w, p, n, h, t)$. The variables contained in S denote assets, wage, house price, mortgage vintage, house size and age. Notice that the renter's space does not contain mortgage vintage and house size. In each period $t < T - 1$, the renter's problem in the non-bankruptcy state is to choose the maximal value among three discrete choices "rent", "buy" and "file for bankruptcy chapter 7" and "file for bankruptcy chapter 13", although this last choice is subject to a means test. While in punishment state, they can only rent.

The owner's problem in the non-bankruptcy state is to choose among "stay", "sell", "default", "file for bankruptcy chapter 7/13" and "file for bankruptcy chapter 7 and default", whereas during punishemt, this reduces to "stay", "sell" and "default".

In each of those cases, there are two intraperiod choices to make, i.e. how much to consume and how much labour to supply. In period $T - 1$ unsecured borrowing is not permitted, since final period assets must be non-negative.

3.9 The Choice of Renters

Denote the maximal expected lifetime utility for a renter of age t as W if not in a bankruptcy state. Otherwise it is denoted by $\tilde{W}_j$ for bankruptcy state $j = 7, 13$. Let s denote the end of period savings choice (i.e. $s = a'$). Defining labor income as

$$y(w, l) = \begin{cases} wl & \text{if } l > l_1 \\ b & \text{else,} \end{cases} \tag{8}$$

where $b > 0$ is an unemployment benefit and state median income as $\text{med}(y)$, we write the problem as follows:

$$W(a,w,t) = \begin{cases} \max\left(W^{\text{rent}}, W^{\text{buy}}, W^{\text{file.7}}, W^{\text{file.13}}\right) & \text{if } a < 0, y(w,l) < \text{med}(y) \\ \max\left(W^{\text{rent}}, W^{\text{buy}}, W^{\text{file.13}}\right) & \text{if } a < 0, y(w,l) \geq \text{med}(y) \\ \max\left(W^{\text{rent}}, W^{\text{buy}}\right) & \text{if } a \geq 0 \end{cases} \tag{9}$$

The restriction on the discrete choice set of the renter in (9) makes explicit the fact that one only can file for bankruptcy if there are effectively unsecured debts to discharge. In addition we implement the BAPCPA means test by preventing individuals with labor income above a threshold $\text{med}(y)$ to file for chapter 7. We define the conditional value functions next.

Value of Renting

The value of renting is given by

$$W^{\text{rent}}(R) = \max_{\substack{a' \in \mathbb{R} \\ l \in L}} u(c,l,\underline{h}) + \beta E_{w'|w}\left[W(R')\right] \tag{10}$$

subject to

$$c + \frac{q(a'|w)}{1+r} = y(w,l) + a > 0 \tag{11}$$

$$\pi^7(a'|w) = E_{w'|w}\left[\mathbf{1}\left[W^{\text{file.7}}(R') > W^{-\text{file.7}}(R')\right]\right] \tag{12}$$

$$\pi^{13}(a'|w) = E_{w'|w}\left[\mathbf{1}\left[W^{\text{file.13}}(R') > W^{-\text{file.13}}(R')\right]\right] \tag{13}$$

where R is the current state space and R' the state space as it evolves. Equation (11) is a standard budget constraint that requires expenditures (LHS: consumption c and saving/borrowing a') to be equal to cash-on-hand (labour income plus assets minus rent, which is normalized to zero). Equations (12) and (13) show how the probability of bankruptcy for each case is calculated by the lender in order to form q in equation (11).

Value of Buying

The value function for the buyer is

$$W^{\text{buy}}(R) = \max_{\substack{a' \in \mathbb{R} \\ h \in \mathcal{H} \\ l \in L}} u(c,l,h) + \beta E_{w'|w,p'|p}\left[V(S')\right] \tag{14}$$

subject to

$$c + \frac{q(a'|w,p,n,h)}{1+r} = y(w,l) + a \tag{15}$$

$$- \kappa(p_{i0}h, r_m, T_m) - \chi p_{i0}h > 0$$

$$\pi^{7}(a'|w,h) = E_{w'|w,p'|p}\left[\mathbf{1}\left[V^{\text{file.7}}(S') > V^{-\text{file.7}}(S')\right]\right] \tag{16}$$

$$\pi^{13}(a'|w,h) = E_{w'|w,p'|p}\left[\mathbf{1}\left[V^{\text{file.13}}(S') > V^{-\text{file.13}}(S')\right]\right] \tag{17}$$

Compared to the renter's problem, the budget constraint of the buyer (15) is augmented by two terms κ and $\chi p_{i0}h$, which stand for mortgage payment and downpayment, respectively. The function q now depends on the additional state variables mortgage debt and house size, (m,h). The respective probabilities of bankruptcy are computed similarly to before in (16) and (17). This case is representative of the owner's probabilities below, so will omitted there.

Renter Bankruptcy Chapter 7

The value of filing for bankruptcy under chapter 7 as a renter is similar to the value of staying a renter with the exception that current assets are set to $a = 0$ in the budget constraint since all assets are used against the debt. Moreover, the various penalties are applied (no borrowing and psychic cost of bankruptcy λ^{bk}). The future value in the bankruptcy state 7 is denoted by $\tilde{W}_7$.

$$W^{\text{file.7}}(R) = \max_{\substack{a' \in \mathbb{R}_+ \\ l \in L}} u(c,l,\underline{h}) + \beta E_{w'|w}\left[\tilde{W}_7(R')\right] - \lambda^{bk} \tag{18}$$

subject to

$$c + \frac{1}{1+r}a' = y(w,l)$$

As a result of filing for bankruptcy underchapter 7 all assets are used against the debt and the remaining amount is forgiven. However, the individual suffers the utility (stigma) cost λ^{bk} and cannot borrow until she exits this state. This happens with probability δ in each period. Thus the expected duration of this state is $\frac{1}{\delta}$. The value $\tilde{W}_7$ in the bankruptcy state is

$$\begin{aligned}
\tilde{W}_7\left(a, w, t\right) &= \max_{\substack{a' \in \mathbb{R}_+ \\ l \in L}} u(c, l, \underline{h}) \\
&+ \beta E_{w'|w}\left[\delta W(R') + (1-\delta)\tilde{W}_7(R')\right] - \lambda^{bk} \\
\text{subject to} & \\
c + \frac{1}{1+r} s &= y(w, l)
\end{aligned} \tag{19}$$

Renter Bankruptcy Chapter 13

Individuals may notbe elgible for Chapter 7, or indeed may choose Chapter 13. This problem is actually very similar to the previous one except that a wage garnishment tax τ is levied from labor income. Hence moving into the bankruptcy state we have

$$\begin{aligned}
W^{\text{file.13}}\left(R\right) &= \max_{\substack{a' \in \mathbb{R}_+ \\ l \in L}} u(c, l, \underline{h}) + \beta E_{w'|w}\left[\tilde{W}_{13}(R')\right] - \lambda^{bk} \\
\text{subject to} & \\
c + \frac{1}{1+r} s &= y(w, l) > 0,
\end{aligned} \tag{20}$$

The corresponding punishment state, following filing for chapter 13 is given by

$$\begin{aligned}
\tilde{W}_{13}\left(a, w, t\right) &= \max_{\substack{a' \in \mathbb{R}_+ \\ l \in L}} u(c, l, \underline{h}) \\
&+ \beta E_{w'|w}\left[\delta W(R') + (1-\delta)\tilde{W}_{13}(R')\right] - \lambda^{bk} \\
\text{subject to} & \\
c + \frac{1}{1+r} a' &= y(w, l) - \bar{y} + a > 0
\end{aligned} \tag{21}$$

3.10 The Problem of the Owner

The discrete choice problem of an owner not in a bankruptcy state is

$$V(a,w,p,n,h,t) = \begin{cases} \max\left(V^{\text{stay}}, V^{\text{sell}}\right) & \text{if } a \geq 0, hp_t - m_t \geq 0 \\ \max\left(V^{\text{stay}}, V^{\text{sell}}, V^{\text{def}}\right) & \text{if } a \geq 0, hp_t - m_t < 0 \\ \max\left(V^{\text{stay}}, V^{\text{sell}}, V^{\text{file.7}}, V^{\text{file.13}}\right) & \text{if } a < 0, hp_t - m_t \geq 0, y < \text{med}(y) \\ \max\left(V^{\text{stay}}, V^{\text{sell}}, V^{\text{file.13}}\right) & \text{if } a < 0, hp_t - m_t < 0, y \geq \text{med}(y) \\ \max\left(V^{\text{stay}}, V^{\text{sell}}, V^{\text{def}}, V^{\text{file.7}}, V^{\text{file.13}}, V^{\text{file.def}}\right) & \text{if } a < 0, hp_t - m_t < 0, y < \text{med}(y) \\ \max\left(V^{\text{stay}}, V^{\text{sell}}, V^{\text{def}}, V^{\text{file.13}}, V^{\text{file.def}}\right) & \text{if } a < 0, hp_t - m_t < 0, y \geq \text{med}(y) \end{cases} \tag{22}$$

where $a \geq 0$ denotes someone with positive financial assets and $hp_t - m_t$ is the net equity in the house. Again, not all discrete choices are available everywhere on the state space, as can be seen from the restrictions for each case. For example, filing for bankruptcy is only an option if there is in fact unsecured debt, i.e. on the region where $a < 0$. Additionally, the admissible chapter of bankruptcy depends on labor income lying below the threshold $\text{med}(y)$, as before. Similarly for the default choice, which is only an option if home equity is negative. Owners with home equity in excess of the exemption level face eviction should they file for bankruptcy under chapter 7. The level of homestead exemption determines whether an owner filing under chapter 7 stays on in the house or is evicted. We define the sub-problems in sequence below. Define the current state space as $S = (a,w,p,n,h,t)$.

Value of Staying as Owner

The value of staying in the current home is

$$\begin{aligned} V^{\text{stay}}(S) &= \max_{\substack{a' \in \mathbb{R} \\ l \in L}} u(c,l,h) + \beta E_{w'|w,p'|p}\left[V(S')\right] \qquad (23) \\ \text{subject to} & \\ c + \frac{q(a'|w,p,n,h,t)}{1+r} &= y(w,l) + a - \kappa(p_{i0}h, r_m, T_m) \end{aligned}$$

This problem is very similar to the buyer's above with the exception that there is no downpayment in the budget constraint as this is a one-off payment made at the time of purchase.

Value of Selling the Home

The value of selling depends on the renter's continuation value:

$$\begin{aligned} V^{\text{sell}}(S) &= \max_{\substack{s\in\mathbb{R}\\ l\in L}} u(c,l,\underline{h}) + \beta E_{w'|w,p'|p}\left[W(R')\right] \\ \text{subject to} & \\ c+\frac{q(a'|w,t)}{1+r} &= y(w,l)+a+((1-\phi)ph-m) \end{aligned} \tag{24}$$

In the above $(1-\phi)ph-m$ is the capital that can be recovered following the sale: ϕ is the proportion of capital lost by the process of selling due to administrative and marketing costs.

Value of Default

The default value, in turn, is similar to the value of selling with the exception that for a defaulter unsecured borrowing is impossible, and a one-time utility penalty is incured. Regarding recourse legislation, we include a factor $\psi\in[0,1]$ here that relates to the fraction of negative equity $((1-\phi)(ph-m))$ that is rolled over in post default life. For example $\psi=1$ would mean that the entire remaining mortgage debt is rolled over into post default life. Notice that the future value is that of a renter, but the asset state takes into account any remaining mortgage debt d brought forward.

$$\begin{aligned} V^{\text{def}}(S) &= \max_{\substack{a'>0\\ l\in L}} u(c,l,\underline{h}) + \beta E_{w'|w,p'|p}\left[W(d+a',w',p',t+1)\right] - \lambda^{\text{def}} \\ \text{subject to} & \\ c+\frac{1}{1+r}a' &= y(w,l)+a \\ d &= \psi((1-\phi)ph-m) \end{aligned} \tag{25}$$

Owner Bankruptcy chapter 7

The value of an owner who files for chapter 7 while staying in the home is given by

$$\begin{aligned} V^{\text{file.7}}(S) &= \max_{\substack{a'>0 \\ l\in L}} u(c,l,h) + \beta E_{w'|w,p'|p}\left[\tilde{V}_7(S')\right] - \lambda^{\text{bk}} \qquad (26) \\ \text{subject to} & \\ c + \frac{1}{1+r}a' &= y(w,l) - \kappa(p_{i0}h, r_m, T_m) > 0 \end{aligned}$$

This value is only defined if current assets are negative, $a < 0$. Crucially, the household may only stay in the house if net home equity lies below the homestead exemption level, i.e. iff $(1-\phi)(ph-m) < \xi$.

Value of Filing and Default The final value for the owner is defined by filing for bankruptcy and defaulting on the mortgage at the same time as follows:

$$\begin{aligned} V^{\text{file,def}}(S) &= \max_{\substack{a'>0 \\ l\in L}} u(c,l,\underline{h}) - \lambda^{\text{bk}} - \lambda^{\text{def}} \qquad (27) \\ &+ \beta E_{w'|w,p'|p}\left[\tilde{W}_7(R')\right] \\ c + \frac{1}{1+r}a' &= y(w,l) > 0 \end{aligned}$$

The assumption is that any remaining mortgage debt is discharged in the chapter 7 bankruptcy.

Owner Bankruptcy Chapter 13

The main difference to chapter 7 bankruptcy is that the owner may keep the house (and all other assets) no matter how much equity there is after signing up to a chapter 13 repayment plan. Consequently we don't have to compute a value of eviction and we also rule out the possibility to file for chapter 13 and default on the mortgage at the same time.[8]

$$\begin{aligned} V^{\text{file.13}}(a,z,p,m,h,k,t) &= \max_{\substack{a'>0\\ l\in L}} u(c,l,h) + \beta E_{w'|w,p'|p}\left[\tilde{V}_{13}(S')\right] - \lambda^{\text{bk}} \qquad (28) \\ \text{subject to} & \\ c + \frac{1}{1+r}s &= y(w,l) - \kappa(p_{i0}h, r_m, T_m) > 0 \end{aligned}$$

Owner Bankruptcy punishment States

An owner in punishment state for either chapter has the discrete choice set "stay", "sell" and "default". Her savings s cannot be negative (she cannot borrow). As in the case of the renter, exit from the state is governed by the Bernoulli random variable $X \sim \text{Bernoulli}(\delta)$. Thus the value for this owner is

$$\tilde{V}_j(S) = \max\left(\tilde{V}_j^{\text{stay}}, \tilde{V}_j^{\text{sell}}, \tilde{V}_j^{\text{def}}\right), j = 7, 13$$

where the value for *stay* is given by

$$\begin{aligned} \tilde{V}_j^{\text{stay}}(S) &= \max_{\substack{a'>0\\ l\in L}} u(c,l,h) + \beta E_{w'|w,p'|p}\left[(1-\delta)\tilde{V}_j(S') + \delta V(S')\right] - \lambda^{\text{bk}} \qquad (29) \\ \text{subject to} & \\ c + \frac{1}{1+r}a' &= a + y(w,l) - \mathbf{1}[j=13]\,\bar{y} - \kappa(p_{i0}h, r_m, T_m) \\ j &= 7, 13 \end{aligned}$$

[8] Filing for chapter 13 and defaulting at the same time is a particularly unrealistic choice, since the consumer assumes the increased burden of chapter 13 (wage tax) without getting to enjoy the benefits (staying in the house).

the value for *sell* is given by

$$\begin{aligned}
\tilde{V}_j^{\text{sell}}(S) &= \max_{\substack{a' \geq 0 \\ l \in L}} u(c, l, \underline{h}) + \\
& \quad \beta E_{w'|w,p'|p}\left[(1-\delta)\tilde{W}_j(R') + \delta W(R')\right] - \lambda^{\text{bk}} \\
c + \frac{1}{1+r}a' &= y(w,l) - \mathbf{1}[j = 13]\,\bar{y} - \kappa(p_{i0}h, r_m, T_m) + a \\
&+ (1-\phi)ph - m > 0 \\
j &= 7, 13
\end{aligned} \tag{30}$$

and finally the value for *default* in the punishment state is given by

$$\begin{aligned}
\tilde{V}_j^{\text{def}}(S) &= \max_{\substack{a' \geq 0 \\ l \in L}} u(c, l, \underline{h}) - \lambda^{\text{bk}} - \lambda^{\text{def}} \\
&+ \beta E_{w'|w,p'|p}\left[(1-\delta)\tilde{W}_j(R') + \delta W(R')\right] \\
c + \frac{1}{1+r}a' &= y(w,l) - \mathbf{1}[j = 13]\,\bar{y} - \kappa(p_{i0}h, r_m, T_m) + a
\end{aligned} \tag{31}$$

The amount of assets that the person carries over into the next period depends both on the extent of recourse in the specific state and on the amount of mortgage debt. In any case a cannot be negative since the person has already filed for bankruptcy and cannot borrow. However it can be positive if the person started saving after filing. In a recourse state the existing financial assets will be used to pay off the mortgage (under chapter 7). We assume that any remaining mortgage debt is then forgiven and $a = 0$. This is not a particularly strong assumption because the individual could again file for bankruptcy, something we do not see that much of in the data.

4 Data

Our data is drawn from several sources. We use a confidential version of the Federal Reserve Bank of New York Consumer Credit Panel which we merge with LPS Mortgage Loan Level Data to compute bankruptcy and default rates at county level. We supplement this with county level house prices obtained from Zillow Research[9], as well as county level demographic and economic

[9] http://www.zillow.com/research/data/

characteristics from the American Community Survey (ACS).

The NY Fed Consumer Credit Panel is assembled mainly from quarterly credit bureau data, which the Federal Reserve Board, the New York Fed, and the Philadelphia Fed purchased from Equifax, one of the three major credit reporting agencies in the United States. The dataset contains a random subsample of credit users (a 5% random sample that is representative of all individuals in the US who have a credit history and whose credit file includes the individual's social security number). This is individual level data which includes comprehensive summaries of key characteristics of the different types of debt held by individual borrowers (e.g., total credit-card balances and limits). In addition, the dataset includes loan-level information on these borrowers' mortgage. More specifically, the data contain demographics (e.g. individual age, location by state, zipcode, and census tract, credit risk score), information on mortgages[10], information on other debts such as auto, student, department, installment loans etc (e.g. current balance, past-due indicators, credit limit, payments). A detailed description of the panel can be found at http://www.newyorkfed.org/research/staff_reports/sr479.pdf.

The second source is the LPS Mortgage Loan Level Data, formerly known as "McDash" data. We combine this with the consumer panel because the panel does not have very detailed information on mortgage terms. Merging with the LPS data gives us information on first liens (loan origination date, origination amount, lien status, and zipcode). This data have been used extensively over the past few years to study mortgage defaults. The LPS data set is divided into a "static" file, whose values generally do not change over time, and a "dynamic" file. The static data set contains information obtained at the time of underwriting, such as the loan amount, house price, (origination) FICO score, documentation status, source of the loan (e.g., whether it was broker-originated), property location (zip code), type of loan (fixed-rate, ARM, prime, subprime, etc.), the prepayment penalty period (if any), and the termination date and termination status if the loan has indeed terminated. The termination types include "paid off," foreclosure (and other negative termination events such as REO sale), and the transfer of the loan to another servicer. The dynamic file is updated monthly, and among other variables, it contains the status of the loan (current, 30 days delinquent, 60 days, etc.), the current interest rate (since this changes over time for ARMs), current balance, and investor type (private securitized, GNMA, FNMA, FHLMC, portfolio). LPS covers about 70% of the market after

[10]loan origination date, origination amount, current balance, requested payment amount or term of the loan, credit limit (on HELOCs), individual/joint account and payment status, whether GSE guaranteed, whether for a mobile home, whether second mortgage, and whether the account was closed in bankruptcy or foreclosure.

January 2005 and it oversamples prime mortgages.

We match the FRBNY Consumer Credit Panel with LPS based on mortgage loan origination date, origination amount, the zipcode of the property, purpose of the mortgage (purchase versus refinance), lien status (first lien versus second lien or home equity), type of mortgage (agency loans or not)) and occupancy type (primary residence, second homes or investment properties).

The final dataset we use is the American Community Survey (ACS) Public Use Microdata Sample. Merging ACS county level data onto the previous datasets results in a panel by county over time which contains information on average bankruptcy filing rates (for chapter 7 and 13 respectively), average default rates, on default and bankruptcy rates, average educational attainment, and average employment in a certain region over time. This information will allow us to relate education to bankruptcy and mortgage default rates, which introduces an element of heterogeneity in the model. Additional to that we use PSID data to estimate a life-cycle profile for the income process.

5 Model Implications

For illustrative purpose, we give some sample paths of individual histories in figure 4. The mechanism connecting interest rate and probability of bankrutpcy is illustrated for an arbitrary simulated individual in figure 5.

6 Estimation

A number of parameters are set based on earlier results from the literature. Table 3 lists the values of those. We rescale the house price so that it reflects the ratio of price to median income and set the initial log house price p_0 to 12, which roughly corresponds to the average value in our ACS dataset for 2006. We choose the values of α and γ in conjunction so as to pin down the amount of labour supplied, the value of the intertemporal elasticity of substitution, and the value of the Frisch labor supply elasticity. We set the weight of leisure in utility α so that on average individuals work 35% of their time. We want to target the intertemporal elasticity of substitution (IES) estimated by **?** of 0.75. The IES for consumption is given by $-\left[\alpha(1-\gamma)-1\right]^{-1}$, therefore we require $\gamma = 2, \alpha = 0.33$.

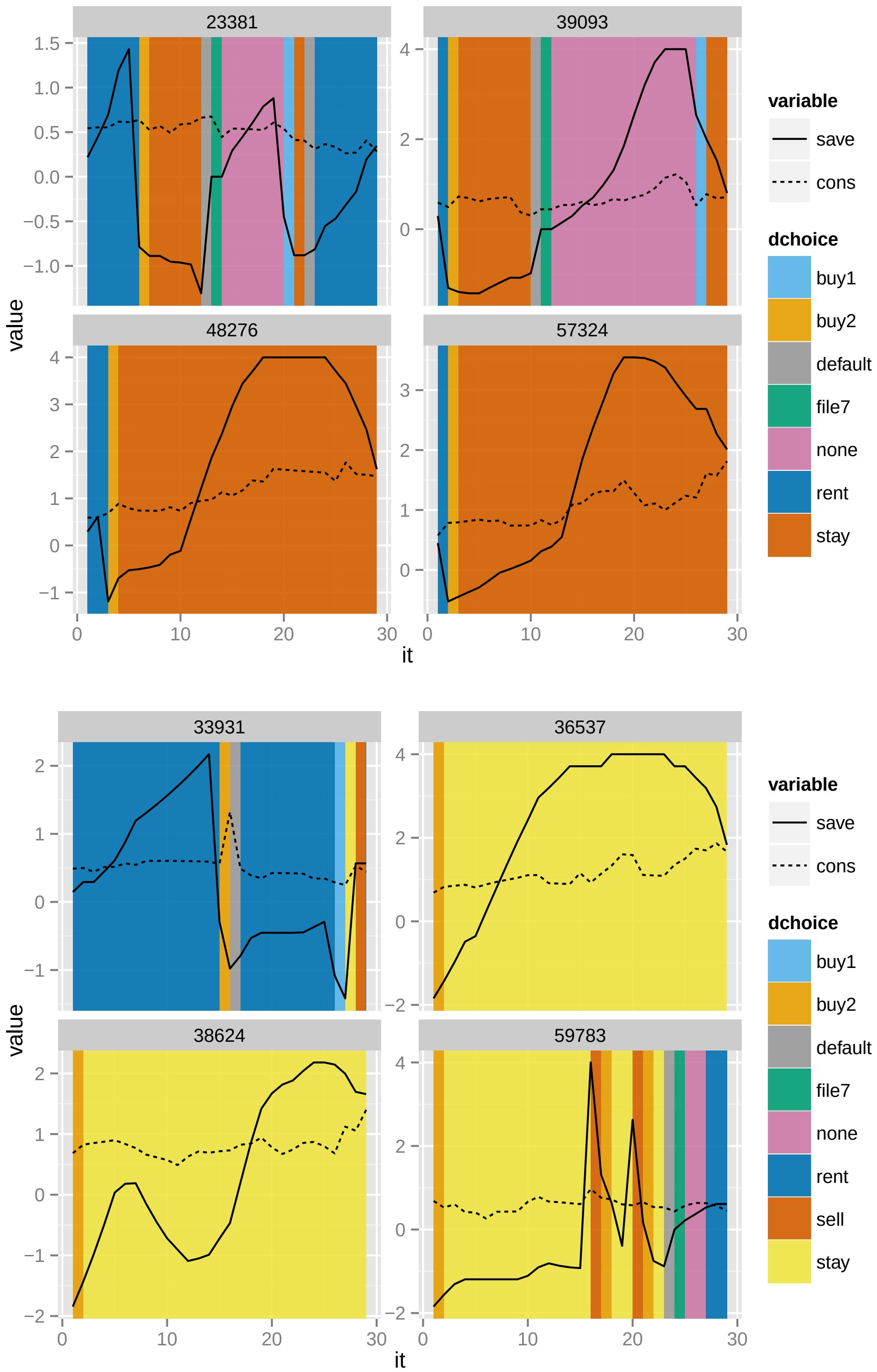


Figure 4: Inidivual simulation histories from the baseline model. Color codes illustrate the discrete choice taken at that age. Keep in mind that 2 important state variables (income and house price) are missing from this graphic to avoid clutter.

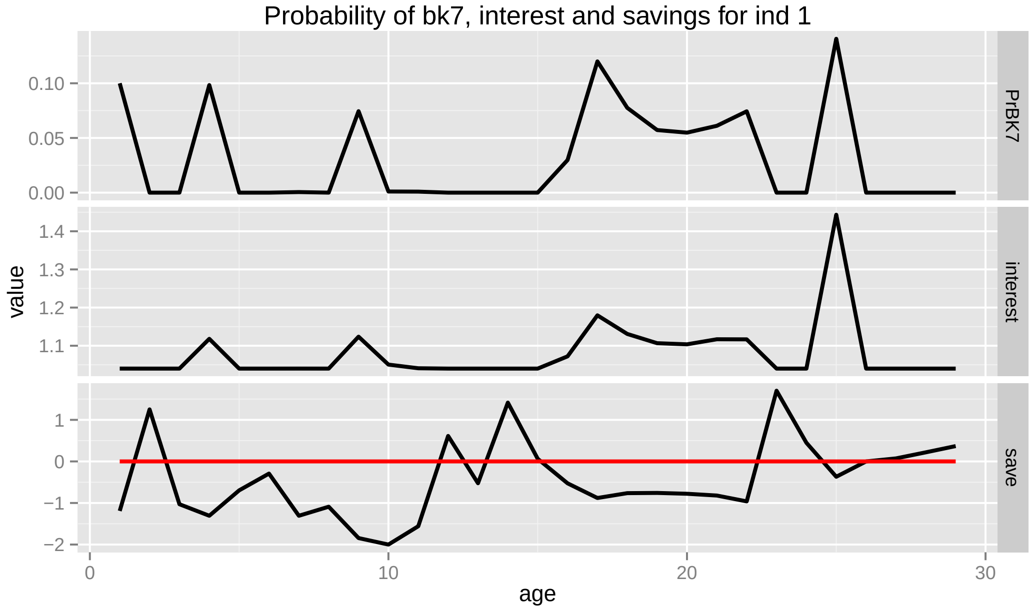


Figure 5: mechanism between probabilty of bankrutpcy, savings, and interest rate. Depending on the value of other (not shown) state variables, with negative savings, there is positive probability of bankruptcy (chapter 7 in this case), and an interest rate premium to pay.

	value	meaning
$1+r$	1.040	gross risk free interest rate
$\frac{1}{1+r}$	0.962	inverse of gross risk free interest rate
β	0.950	discount factor
χ	0.200	downpayment as proportion of house value
$(1+r^m)$	1.060	mortgage rate
p_0	13.000	median log house house price 2006
$p2y$	12.000	initial price to income ratio in simulation
ϕ	0.940	proportional fixed cost of selling
ρ_z	0.950	AR1 coefficient on wage AR1 component
ρ_p	0.900	AR1 coefficient on price AR1 component
δ	0.200	prob of exiting bk state
η	0.000	rental rate as a fraction of house price
κ	0.600	flat price as a fraction of house price
ψ	0.100	fraction of mortgage debt rolled-over under Recourse
τ_{bk}	0.100	prop of wage garnished in chapter 13 bankruptcy
$\overline{w}$	1.000	chapt. 7 income meanstest as a fraction of med income
$\overline{e}$	0.500	homestead exemption as a fraction of med. income
α	-0.333	disutility from labour
γ	2.000	CRRA
b	0.250	unemployment benefit
a_L	-2.000	minimal assets (times med. income)
a_H	4.000	maximal assets (times med. income)
p_L	0.300	minimal price (times p0)
p_H	1.100	maximal price (times p0)
HS	0.130	proportion of individuals less than HS

Table 3: fixed parameters

Beyond this set of parameters the rest are estimated using the data described earlier and within the context of our model. The estimation approach we use combines simulation with the MCMC approach developed by Chernozhukov and Hong (2003). The criterion we minimize is a distance criterion between data moments and simulated moments from the model. One of the key advantages of this approach is that it can cope with criteria that are not differentiable, which is often the case when dealing with simulated moments. [11]

6.1 Empirical Moments

To estimate the model we combine a basic set of moments, as listed in Table 4 together with indirect inference. Indirect inference involves matching the coefficients of auxiliary regressions obtained from the actual data to those obtained when the same regressions are fit to simulated data. In particular we wish to allow for ex ante heterogeneity in the model by specifying preferences as well as wages to be functions of education. Other sources of heterogeneity (ex-post) are the wage shocks and of course the house prices.

In estimating the model we need to define the source of variation that identifies it. Unfortunately, the variation in the institutional framework cannot be used for identification of the model. This is because the institutions themselves may be endogenous, in the sense that they are designed to fit the local context. Moreover, the composition of people borrowing and hence defaulting will vary as a result of different equilibria in each market. Changes in institutions may have been informative but on the one hand these are very rate and secondly we would need more than one discrete item of variation. As a result we decided to estimate the model based on a single institutional context. We then use the model to simulate the impacts of alternative institutions. For this purpose we group states into 5 distinct groups according to

[11] Our function is evaluated on a set of N parallel Markov chains, which differ in their respective "tempering". Intuitively, chains with higher index n are subject to larger shocks to the current parameter vector, therefore they perform exploration of the parameter space over a wider area. Additionally, chains can communicate with one another according to some rule. This mechanism allows chains to make large jumps over the parameter space, moving away from areas where the objective function has a relatively large value and towards regions with better, smaller values. For a technical description see Baragatti et al. (2013).

moment	data
Bankruptcy rate %	0.5
bankruptcy ch. 13 (prop)	0.2
bankruptcy ch. 7 (prop)	0.3
default rate (prop)	0.030
default rate age 30-40 (prop)	0.033
default rate age 41-50 (prop)	0.030
default rate age 51-60 (prop)	0.025
duration	8.000
flats (prop of total)	0.105
ownership rate (prop)	0.716
ownership rate age 30-40 (prop)	0.613
ownership rate age 41-50 (prop)	0.740
ownership rate age 51-60 (prop)	0.804
unemployment rate (prop)	0.068

Table 4: List of empirical moments. (prop) means that the number is given as a proportion of the total population, i.e. for bk=0.004, the observed number of bankruptcies would be population * bk. These are computed from our baseline set of states. Refer to Section A, group 5.

bankrupcty–relevant legislation (amount of homestead exemption and whether or not deficiency judgements are allowed). Our reference group is the largest one, labelled group 5 in table **??**, which we observe annually from 2006 to 2012.

We use two sources of variation: time variation from housing prices (which we take as exogenous. This relies on local county level shocks to generate variabilty in the bankruptcy rates. We also need a source of information to identify the way that ex-ante heterogeneity, which we associate with education, affects decisions. For this we use cross sectional variation The difficulty is that the data on defaults and bankruptcy does not include information on education. However we can exploit variation acoss counties in the level od education to identify the model. This requires us to contro l for factors that affect bankruptcies and are correlated with education but are not accounted for in the model. To achieve this we first contrsuct a county level data set by matching into ACS county level data information on bankruptcy and mortgage default. We then regress these on the proportion of indivuals with a college degree that live in the county, as well as other confounding characteristics that are not included in the model and whose impact needs to be accounted for. The idea is to generate a "synthetic" county level data that nets out heterogeneity between counties, resulting in an environment that is closely comparable to the one in our model.

A plot of percentage of low-educated vs log bankruptcy rate is in figure 6.

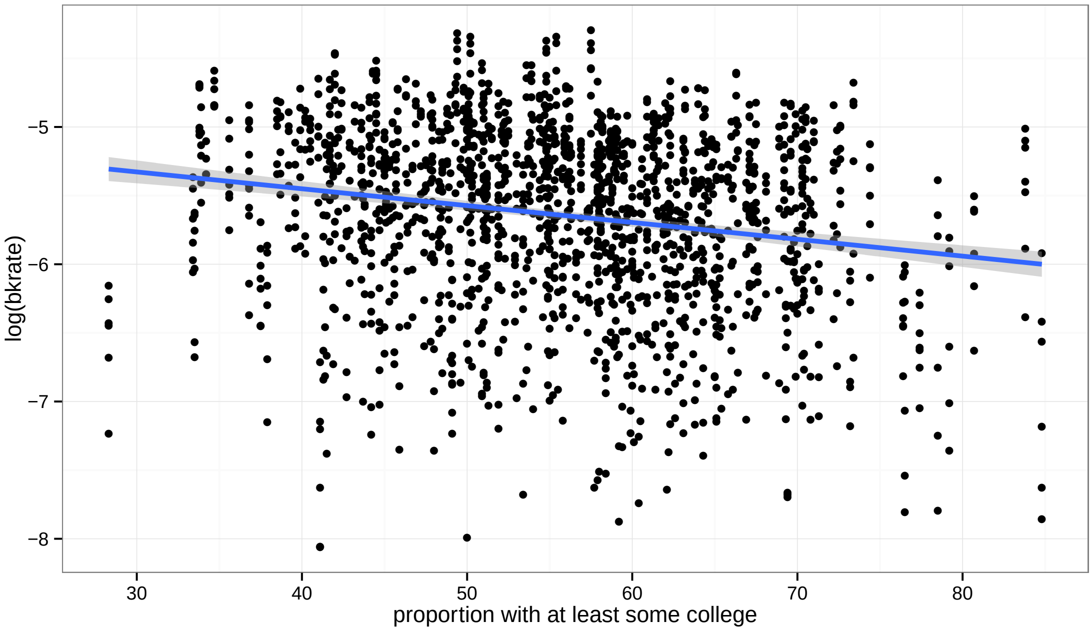


Figure 6: bankruptcy vs fraction of low-educated

To generate the auxilary coefficients used in estimation we run regressions of the per capita mortgage default rate, the bankruptcy rate, the rate of filing for chapter 7 and 13 respectively and the proportion in small homes (flats), i.e. those with less than three rooms. In each auxiliary regression also we include the proportion with less than college degree, house prices divided by median income and the proportion of males and females who are divorced. Summary statistics from the dataset we are using are given in table 5. Thenumbers represent meansand standard deviations across counties.

The result of the auxiliary regressions are summarised in table 6. We are particularly interested in the coefficient on house prices and on the proportion of low educated people, which we match with our model. Our assumption is that the associations of these variables with the various outcome variables can be replicated by our model once we condition on the remaining variables, which absorb cross county heterogeneity. The coefficient on education is a function of both the process of income associated with education and possibly of preferences. According

	mean	Standard Deviation
Bankruptcy Rate	0.006	0.002
Mean House Value / Median Income	2.522	0.768
Percentage less than HS	14.530	5.481
Percentage of HS.grad	32.335	6.278
Percentage of HS.grad+	53.139	9.736
Percentage of Graduate	8.658	3.927
Percentage of divorced females	12.242	1.734
Percentage of divorced males	10.178	1.860
Ownership Rate	71.769	8.598
Default Rate	0.015	0.010
Bankruptcy Rate Chapter 7	0.003	0.002
Bankruptcy Rate Chapter 13	0.002	0.002
Percentage Flat owners	8.037	3.454
Median Earnings	47006.016	8344.394
Homestead Exemption	8153.907	1773.698
Homestead Exemption / Median Income	0.179	0.053

Table 5: summary statistics ACS-NYFed data

to these coefficients increased house prices (relative to median income) reduce the probability of bakruptcy and particularly under chapter 7; this is because under Chapter 7 you loose your assets and consequently if you have a valuable house you are less likely to file under that system. House prices are not associated with increased filings under chapter 13, which is consistent with the fact that under that chapter you keep your assets. Furthermore, increased house prices reduce default rates and they decrease the probability of owning at all, while increasing the probability of owning a smaller house (flat). Lower levels of education are associated with higher levels of bankruptcy and indeed higher rate of filing under chapter 13. This seems unexpected since chapter 7 allows you to write off all debts against any assets you may have, while under chapter 13 you keep your assets and a repayment plan is agreed based on withholding of wages. However, low educated people have low wages and lower labour market attachment and as a result are likely to pay much less under Chapter 13, while still being able to hold on to their houses or other assets. Of course higher earning individuals are compelled to file under 13, but as the bankruptcy rate declines rapidly with education this effect does not dominate. We also included divorce rates, which may reflect the extent of hardship particularly for females. Finally, we also condition on the state level of homestead exemption and on county level median income. These coefficients are not used in the estimation of the model, which is based on a group of states with a homogeneous set of institutions.

	bk.rate	bk.rate7	bk.rate13	def.rate	Pr(own)	Pr(flat|own)
Intercept	-0.0021	-0.0011	-0.0010	0.0048	93.5402^{***}	-0.8768
	(0.0013)	(0.0010)	(0.0010)	(0.0035)	(2.8428)	(1.2045)
House Price	-0.0005^{***}	-0.0005^{***}	-0.0000	-0.0021^{***}	-1.8661^{***}	1.1329^{***}
	(0.0001)	(0.0001)	(0.0001)	(0.0005)	(0.4422)	(0.1894)
Prop Less than College	0.0094^{***}	0.0036^{*}	0.0058^{***}	0.0158	-16.3043^{*}	1.0075
	(0.0021)	(0.0016)	(0.0016)	(0.0087)	(7.0597)	(2.9948)
Divorced Females	0.0004^{***}	0.0001^{*}	0.0003^{***}	0.0006^{*}	-2.0070^{***}	0.5623^{***}
	(0.0001)	(0.0000)	(0.0000)	(0.0003)	(0.2364)	(0.1004)
Divorced Males	-0.0002^{***}	-0.0000	-0.0002^{***}	-0.0003	0.6831^{**}	0.1349
	(0.0001)	(0.0001)	(0.0001)	(0.0003)	(0.2584)	(0.1094)
Mortgage Default	0.0675^{***}	0.0333^{***}	0.0341^{***}			-9.0432
	(0.0076)	(0.0060)	(0.0060)			(13.7826)
Homestead Exemption	0.0000^{***}	0.0000^{***}	0.0000^{***}			
	(0.0000)	(0.0000)	(0.0000)			
Median Earnings	0.0000	0.0000^{***}	-0.0000^{**}			
	(0.0000)	(0.0000)	(0.0000)			
Bankr.Rate (Chpt. 7)				1.6216^{***}	-454.2885^{*}	-598.5466^{***}
				(0.2404)	(195.0143)	(85.4790)
Bankr. Rate (Chpt. 13)				1.6160^{***}	1257.2595^{***}	-228.2523^{**}
				(0.2405)	(195.1241)	(85.5037)
R^2	0.3581	0.1809	0.3124	0.2184	0.2550	0.1750
Adj. R^2	0.3508	0.1716	0.3046	0.2109	0.2477	0.1657
Num. obs.	627	627	627	627	627	627
RMSE	0.0018	0.0015	0.0015	0.0092	7.4570	3.1549

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 6: Auxiliary Regressions. Notice that *p* and *low* have been rescaled for readibility by multiplying both data series with a factor of 0.01.

7 Estimation Results

Table (7) shows the current values of the parameters being estimated, which are used in our current simulations. It is hard to interpret these in isolation. However there are some interesting

	value	meaning
θ	0.10	partial deriv of cons w.r.t housing in utility
ϕ	0.50	utility weight of flat relative to house
μ	3.00	ownership premium
$\lambda^{bk,H}$	1.10	cost of bankruptcy High Educ
$\lambda^{bk,L}$	1.00	cost of bankruptcy Low Educ
$\lambda^{def,H}$	0.70	cost of default High Educ
$\lambda^{def,L}$	1.00	cost of default Low Educ
$\lambda^{bk,def,H}$	50.00	cost of default and bankruptcy High Educ
$\lambda^{bk,def,L}$	50.00	cost of default and bankruptcy Low Educ
F	0.10	Fixed cost of work

Table 7: current value of paramters (to be estimated)

features. First, there is a strong ownerhip premium (μ), which ensures that even low wealth individuals will much prefer to own than to rent. Secondly, increasing the size of the house reduces the marginal utility of consumption making housing and housing substitutes ($\theta < 1$). Finally a flat is worth about half a larger house.

The cost of bankruptcy is higher for high educated individuals, while the cost of default is higher for the low educated, which is driven by the fact that many low educated individuals file under chapter 13. The cost of doing both at the same time is effectively infinite and this just reflects the fact that these events are almost never seen to occur simultaneously.

8 Policy Experiments

Bankruptcy law is a form of insurance against the worst kind of shocks. In effect it puts a floor on consumption when events occur that prevent individuals from repaying debts. This of course allows individuals to borrow amounts that they may not be able to repay, contrary to the standard Ayagari model where the amount borrowed is bounded by the amount individuals can repay with certainty. Like most insurance systems it comes with its share of moral hazard, which depends on the institutional framework providing this insurance. For example if there is unlimited homested exemption there is an incentive to store all assets in housing and then default on ones debt. It is this kind of behaviour that the BAPCA tried to eliminate by requiing individuals with higher incomes to file under Chapter 13. But then again, income can be manipulated through changes in labour supply, which is one of the moral hazard issues with chapter 13. Our model includes all these elements and now we proceed to understand the effects on behavior and the welfare value of alternative arrangements for managing bankruptcy and mortgage default taking into account the effects on the cost of credit and of course the changes in the behaviour of individuals.

The key policy parameters we consider are the amount of homestead exemption and whether non-housing equity can be used to repay mortgage loans following default. In addition, given the recent reforms on who can file under chapter 7 vis a vis 13 an interesting question is how should this be regulated and what is the effect on behaviour of wage garnishings. We consider these issues based on our model simulations.

In this section we report results from policy experiments where we change three parameters: firstly, the extent to which lenders have recourse (controlled by a parameter ϕ, which is the proportion of debt that is rolled over); secondly we vary the level of means testing that is applied before an individual is allowed to file for chapter 7; and finally we will be looking at the effects of changing the level of homestead exemption.

8.1 Varying the level of the homestead exemption level

In the first experiment we set homestead exemption to a value close to zero. Remember that in the model, this makes chapter 7 bankruptcy an illegal choice for homeowners who have any positive equity in their homes. See tables 8 and an illustration in figure 7. All remaining lifecycle profiles are in a file called current/experiments/hex.pdf.

This is the opposite experiment: what would happen if we increase the level of homestead exemption to 5 times median income of baseline group 5. Statistics and graph are in table 9 and figure 8.

8.2 Changing the level of recourse to full recourse

Here we increase the level of recourse to the lender from 10% of remaining mortgage debt to 99%, basically implying that the consumer is liable for everything. This is the experiment with the largest implications. Please have a look at all the profiles in current/experiments/rollover.pdf. Have a look at table 10 and figure 9.

Variable	baseline: hex=0.5	policy: hex=0.1
Labor supply	0.98	0.98
Consumption	0.63	0.63
Savings	0.28	0.24
Mortgage Debt	2.67	2.72
Equity	2.15	2.12
Realised Utility	3.98	3.85
Prob BK7 (%)	0.32	0.18
Prob BK13 (%)	0.32	0.36
Gross Interest Rate	1.14	1.14
Consumption Tax (%)	100.00	99.47
Expected Utility	-3.65	-3.65

Table 8: Statistics for setting hex=0.

variable	regime	mean
L	base: hex=0.5	0.96148
L	new: hex=5	0.96209
cons	base: hex=0.5	0.74094
cons	new: hex=5	0.73951
save	base: hex=0.5	0.73689
save	new: hex=5	0.77616
m	base: hex=0.5	2.99426
m	new: hex=5	2.97505
eq	base: hex=0.5	2.46444
eq	new: hex=5	2.43397
val	base: hex=0.5	10.03838
val	new: hex=5	9.98075
PrBK7	base: hex=0.5	0.00301
PrBK7	new: hex=5	0.00230
PrBK13	base: hex=0.5	0.00148
PrBK13	new: hex=5	0.00125
interest	base: hex=0.5	1.14831
interest	new: hex=5	1.00930
	Consumption Tax	1.00351

Table 9: Statistics for setting hex=5.

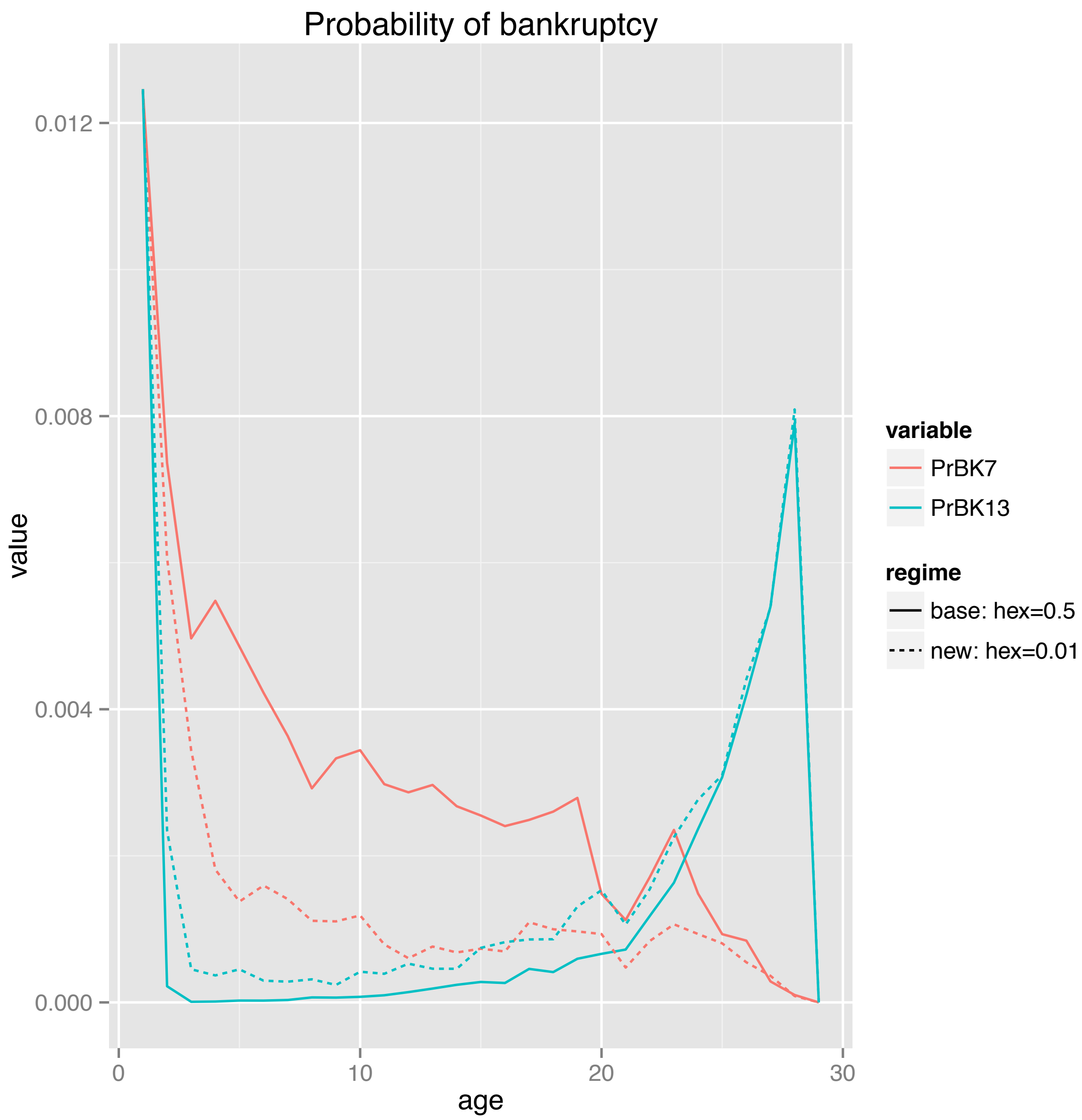


Figure 7: reducing homestead exemption to zero forces homeowners to file for 13 or not at all. We see a marked decrease in the probability of chapter 7 and an increase in the one for 13. Keep in mind that the probability of bankruptcy is a solution outcome, NOT a simulation outcome (i.e. it is not directly related to simulated histories). A high probability of bankruptcy arises from a large number of reachable future states where bankrutpcy is optimal. This, in turn, feeds into the pricing of loans. If the probability of bankrutpcy is high, the implicit interest rate on the loan is higher (making it less attractive), and therefore in the simulation we may not see a comensurate increase in observed bankrutpcies.

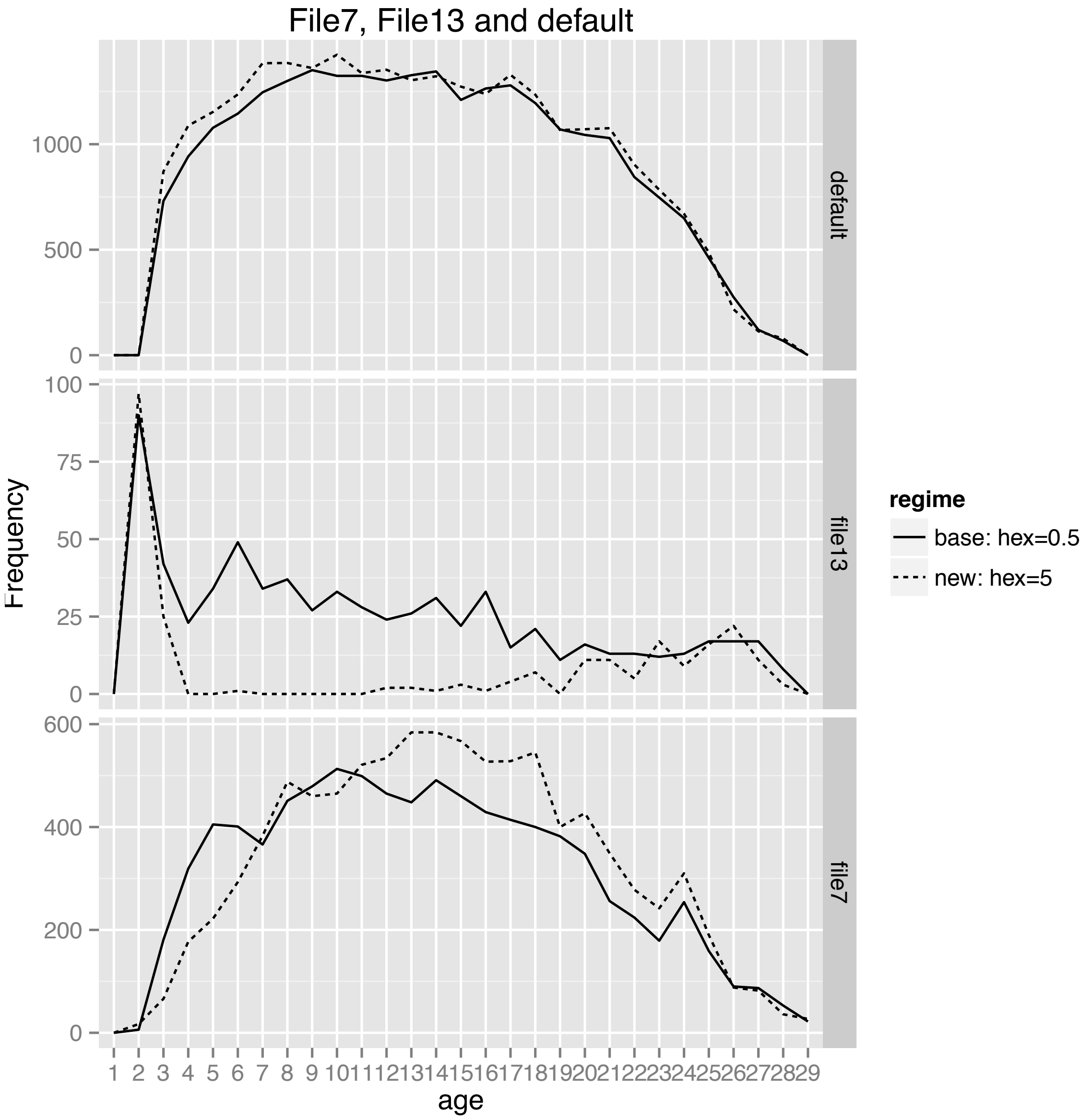


Figure 8: Setting hex=5.

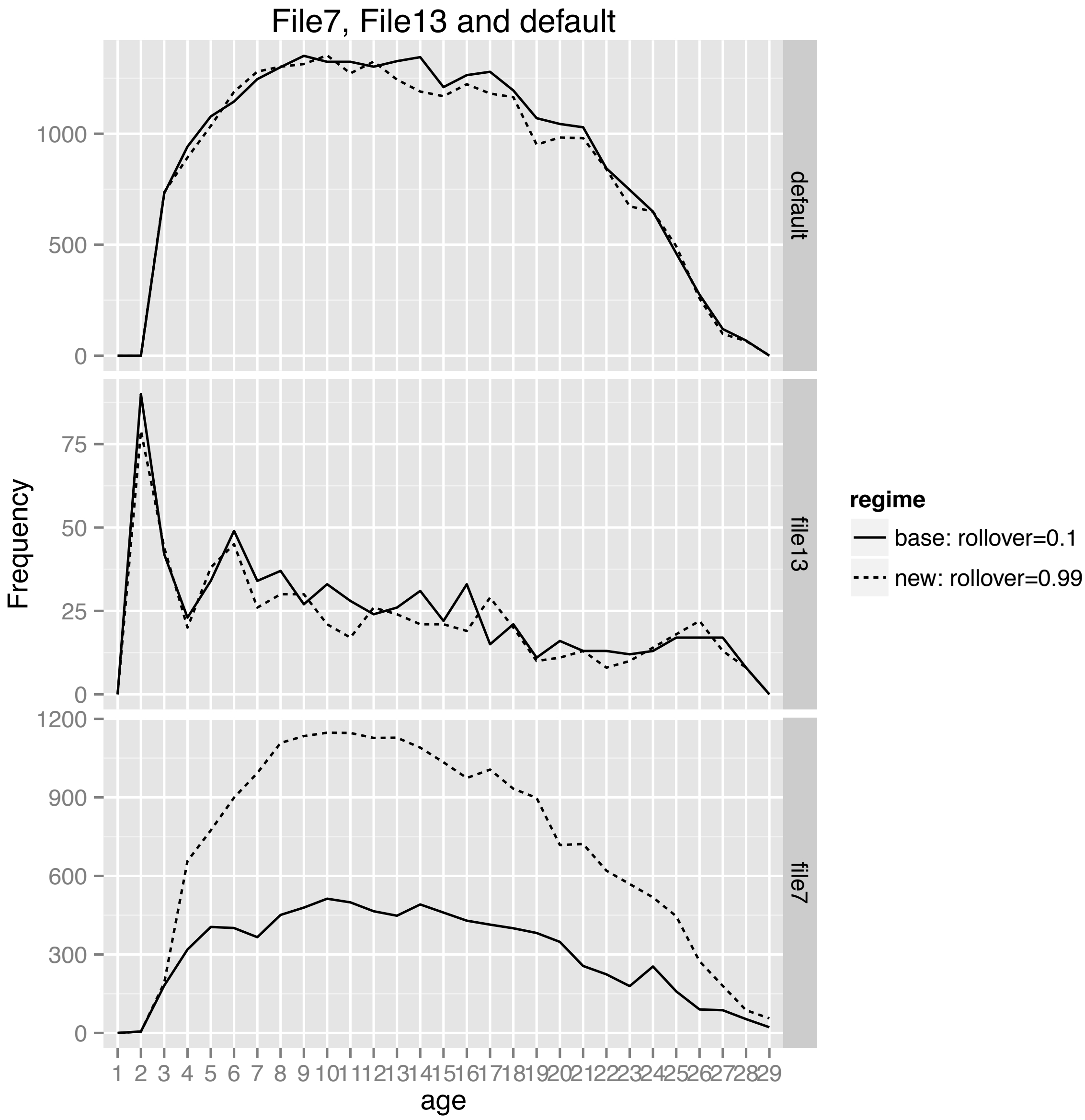


Figure 9: Bankruptcy over the lifecycle under full recourse. Given that default is unavoidable in certain circumstances, we find a large increase in chapter 7 bankruptcies. These are consumers who must carry forward their remaining negative equity and find it optimal to file for bankruptcy in the following period.

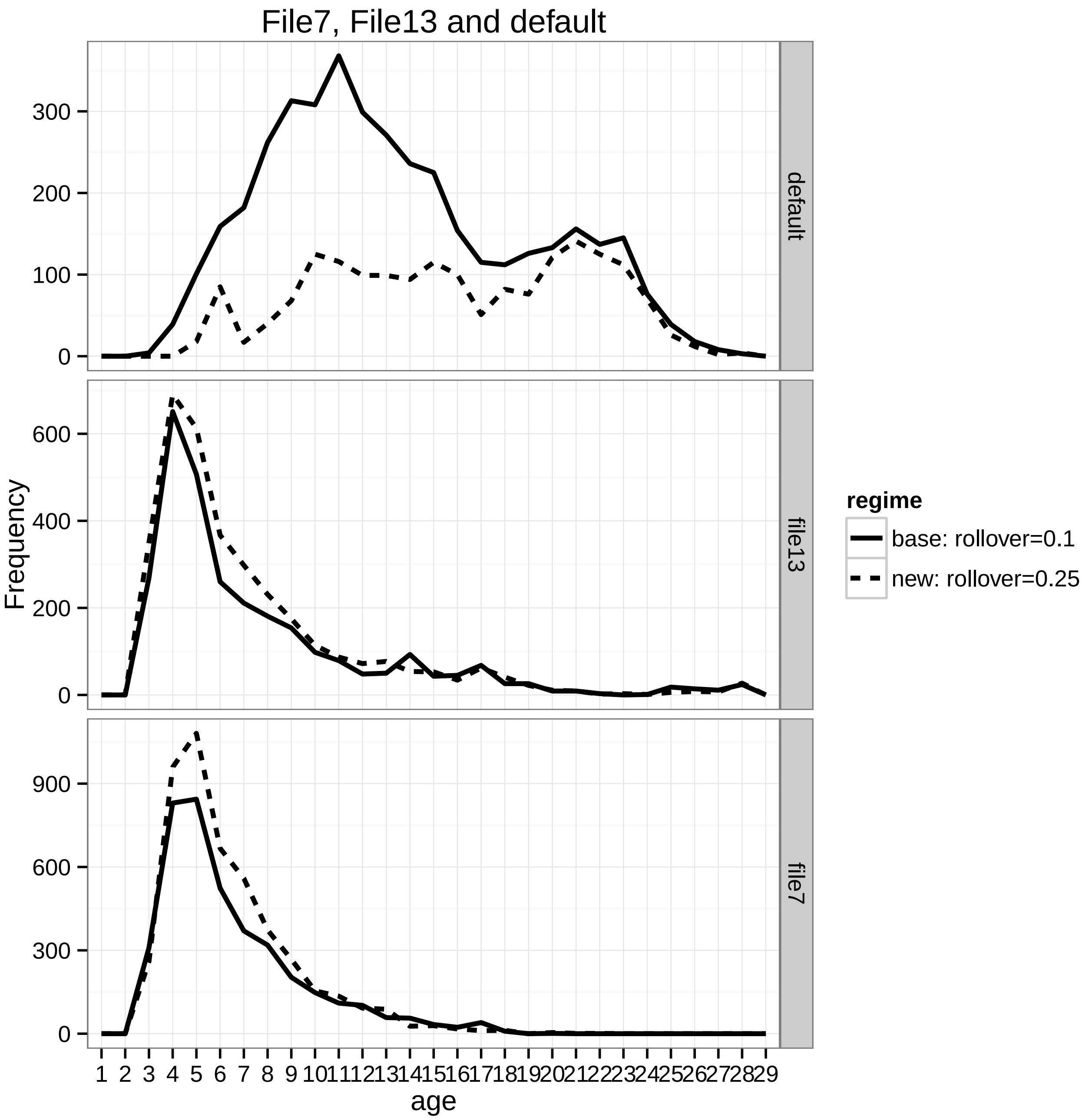


Figure 10: new figure for rollover

Variable	baseline: rollover=0.1	policy: rollover=0.25
Prob BK7 (%)	1.75	2.01
Prob BK13 (%)	0.74	0.87
Interest Rate (%)	6.03	6.48
Labor supply	0.99	0.99
Consumption	0.60	0.60
Mortgage Debt	2.28	2.24
Equity	3.19	3.21
Willingness to pay(%)	-	-0.61%

Table 10: Statistics for setting rollover=0.99.

Variable	baseline: meanstest=1	policy: meanstest=0
Labor supply	0.98	0.97
Consumption	0.63	0.63
Savings	0.28	0.15
Mortgage Debt	2.68	2.74
Equity	2.16	2.03
Realised Utility	4.11	3.21
Prob BK7 (%)	0.33	0.11
Prob BK13 (%)	0.32	1.18
Gross Interest Rate	1.14	1.01
Consumption Tax (%)	100.00	98.15
Expected Utility	-3.65	-3.65

Table 11: statistics reducing BAPCPA meanstest

8.3 Decreasing the BAPCPA meanstest

The BAPCPA meanstest states that anyone with income above state median income is barred from filing for chapter 7. In this experiment we lower the meanstest, thus allowing more people to file for chapter 7. We see that the probability of chapter 7 goes up dramatically. Notice that this is not the same as observed chapter 7 bankruptcies - the former is an implication from the solution, the latter from the simulation. It basically means that higher probability of bankruptcy translates into worse terms on loans, such that less people want to borrow, such that in equilibrium we do not observe many more chapter 7 bankruptcies. Statistics in table 11, figure is 11.

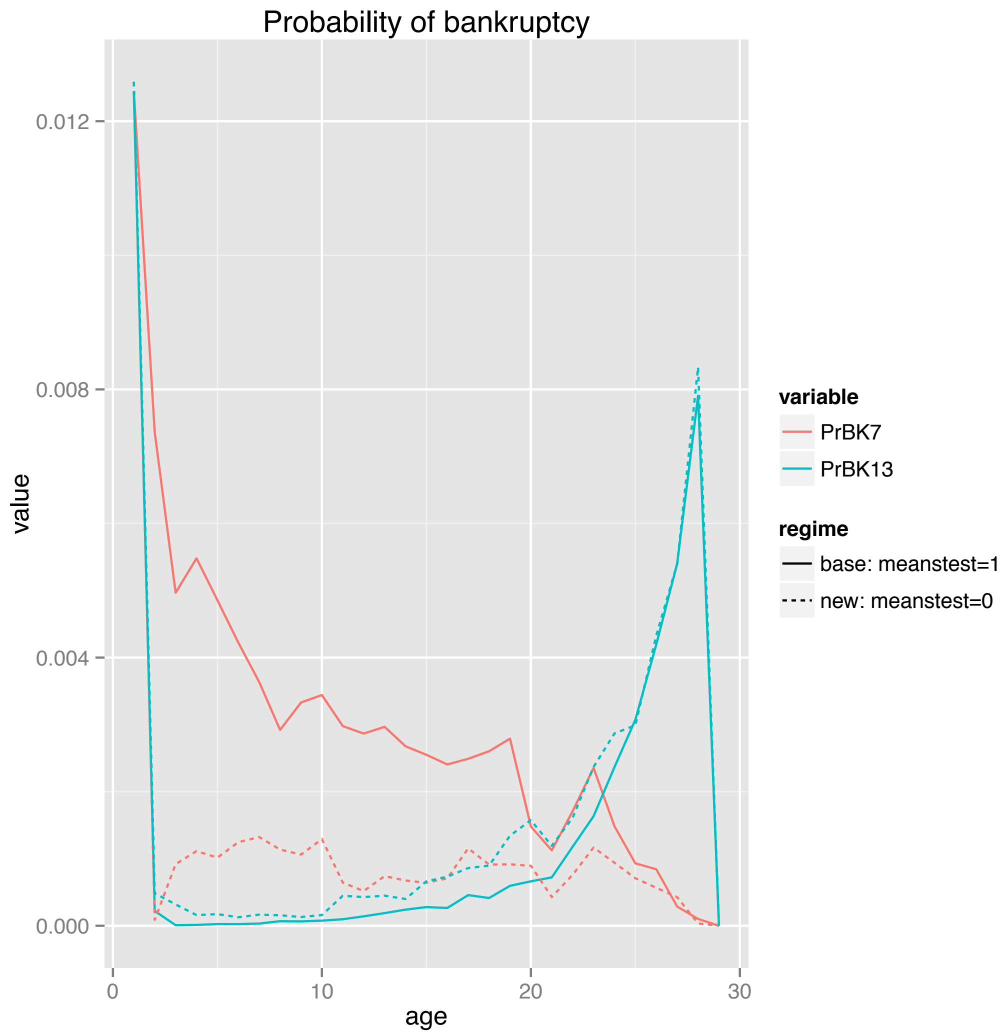


Figure 11: prob of bankruptcy when decreasing the BAPCPA meanstest.

variable	regime	mean
L	base: meanstest=1	0.96148
L	new: meanstest=5	0.96110
cons	base: meanstest=1	0.74094
cons	new: meanstest=5	0.74158
save	base: meanstest=1	0.73689
save	new: meanstest=5	0.73974
m	base: meanstest=1	2.99426
m	new: meanstest=5	2.99775
eq	base: meanstest=1	2.46444
eq	new: meanstest=5	2.46778
val	base: meanstest=1	10.03838
val	new: meanstest=5	10.00054
PrBK7	base: meanstest=1	0.00301
PrBK7	new: meanstest=5	0.00333
PrBK13	base: meanstest=1	0.00148
PrBK13	new: meanstest=5	0.00145
interest	base: meanstest=1	1.14831
interest	new: meanstest=5	1.00627
	Consumption Tax	0.99989

Table 12: statistics increasing BAPCPA meanstest

8.4 Increasing the BAPCPA meanstest

With respect to the baseline model, we don't see much of an effect here. This means that for people with income much above the BAPCPA restriction, filing for chapter 7 is less attractive a priori. Given that chapter 13 may keep their house regardless their level of equity, this makes intuitive sense.

9 Conclusions

We specify and estimate a rich model of consumption, housing demand and labor supply in an environment where individuals may file for bankruptcy or default on their mortgage. Uncertainty in the model is driven both by house price shocks and income shocks, while bankruptcy is governed by the basic institutional framework in the US as implied by chpater 7 and chapter

13.

The aim of the paper is to offer a framework for understanding and evaluating alternative systems for bankruptcy protection and mortgage default. These systems provide some insurance against important adverse shocks to individuals but also generate some moral hazard and increase the costs of credit. Understanding how these effects should be weighed against each other and evaluating the overall welfare effects of such legislation is key for evidence based design of legislation.

The model is estimated[12] using a combination of data from credit records and mortgages together with individual level data from the American Community Survey. We then use the model for counterfactual simulations to address the questions raised above.

References

Aiyagari, S. (1994): "Uninsured idiosyncratic risk and aggregate saving," *The Quarterly Journal of Economics*, 109, 659–684.

Athreya, K. B. (2008): "Default, insurance, and debt over the life-cycle," *Journal of Monetary Economics*, 55, 752–774.

Attanasio, O. P., R. Bottazzi, H. W. Low, L. Nesheim, and M. Wakefield (2012): "Modelling the demand for housing over the life cycle," *Review of Economic Dynamics*, 15, 1 – 18.

Bajari, P., C. Chu, and M. Park (2008): "An empirical model of subprime mortgage default from 2000 to 2007," *NBER Working Paper*.

Baragatti, M., A. Grimaud, and D. Pommeret (2013): "Likelihood-free parallel tempering," *Statistics and Computing*, 23, 535–549.

Chatterjee, S., D. Corbae, M. Nakajima, and J.-V. Ríos-Rull (2007): "A Quantitative Theory of Unsecured Consumer Credit with Risk of Default," *Econometrica*, 75, 1525 – 1589.

[12]Not yet - we are working on this!

De Nardi, M., G. Fella, and G. P. Pardo (2016): "The implications of richer earnings dynamics for consumption and wealth," Tech. rep., National Bureau of Economic Research.

Fay, S., E. Hurst, and M. White (2002): "The household bankruptcy decision," *American Economic Review*, 92, 706–718.

Ghent, A. and M. Kudlyak (2009): "Recourse and Residential Mortgage Default: Theory and Evidence from US States," *Richmond Fed WP*.

Gropp, R., J. K. Scholz, and M. J. White (1997): "Personal Bankruptcy and Credit Supply and Demand," *The Quarterly Journal of Economics*, 112, 217–251.

Guiso, L., P. Sapienza, and L. Zingales (2009): "Moral and social constraints to strategic default on mortgages," .

Hintermaier, T. and W. Königer (2009): "Debt Portfolios," *Queen Mary University Working Papers*.

Livshits, I., J. MacGee, and M. Tertilt (2007): "Consumer bankruptcy: A fresh start," *The American Economic Review*, 402–418.

Low, H., C. Meghir, and L. Pistaferri (2010): "Employment Risk and Wage Risk over the Life Cycle," *American Economic Review*.

Mitman, K. (2016): "Macroeconomic Effects of Bankruptcy & Foreclosure Policies," *American Economic Review*, 106, 2219–2255.

Pavan, M. (2008): "Consumer durables and risky borrowing: The effects of bankruptcy protection," *Journal of Monetary Economics*, 55, 1441–1456.

Sullivan, T., E. Warren, and J. Westbrook (1999): *As we forgive our debtors: Bankruptcy and consumer credit in America*, Beard Books Inc.

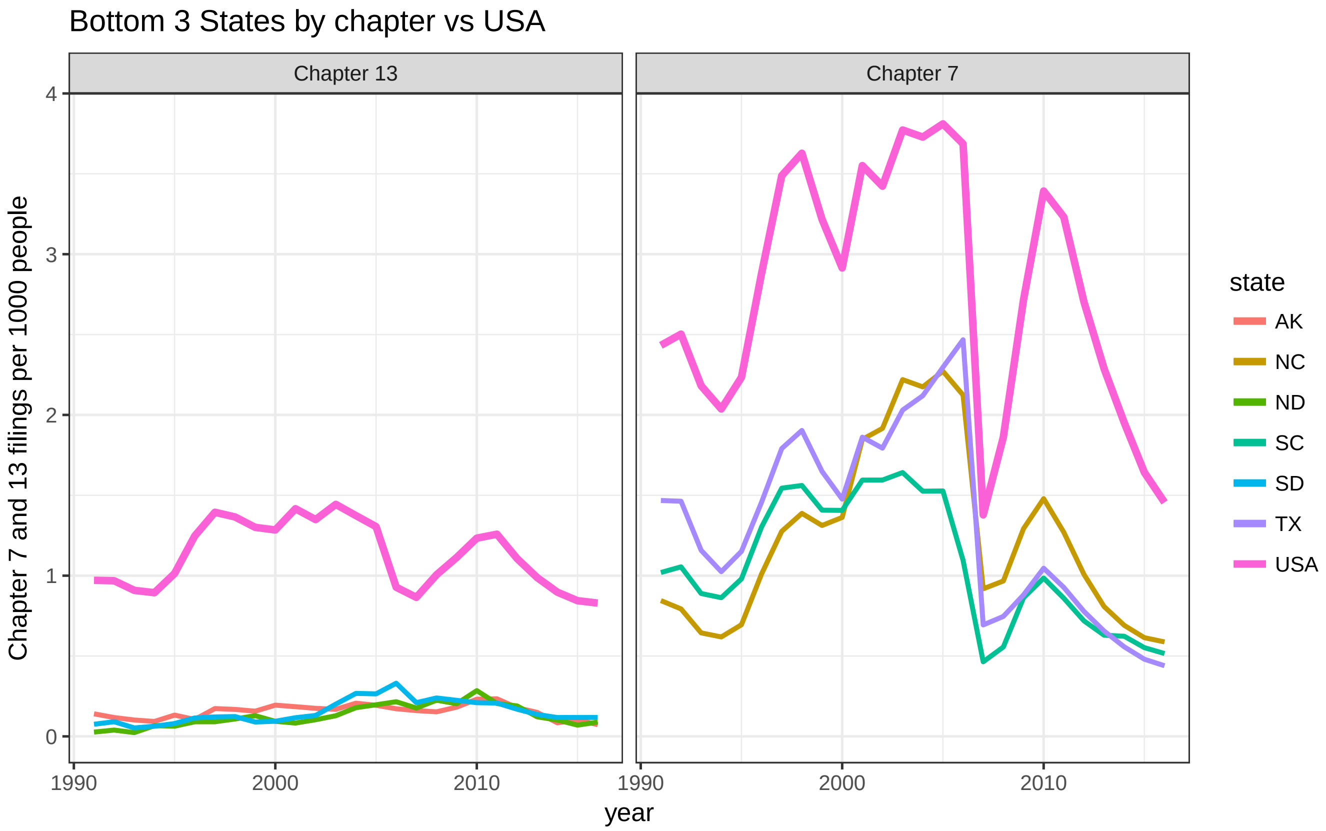
Traczynski, J. (2011): "Divorce rates and bankruptcy exemption levels in the US," *Journal of Law and Economics*.

A Tables

State	Deficiency	Home.Exemption	medinc	hex.fraction	sd.delta.p	group
NC	No	18500.00	45607.13	0.41	3.18	1
WA	No	40000.00	59951.18	0.67	7.38	1
AK	No	54000.00	63456.71	0.85	7.70	2
CA	No	50000.00	58509.89	0.85	10.26	2
MT	No	100000.00	43752.43	2.29	5.70	2
ND	No	80000.00	51275.34	1.56	6.25	2
AZ	No	150000.00	49907.10	3.01	8.96	3
MN	No	200000.00	59445.86	3.36	5.16	3
AL	Yes	5000.00	43445.55	0.12	3.06	4
GA	Yes	10000.00	49418.75	0.20	3.79	4
IL	Yes	7500.00	54433.88	0.14	4.91	4
IN	Yes	7500.00	48301.03	0.16	3.62	4
KY	Yes	5000.00	42728.06	0.12	3.03	4
MD	Yes	0.00	68697.79	0.00	6.56	4
OH	Yes	5000.00	49214.44	0.10	3.66	4
TN	Yes	5000.00	43074.65	0.12	3.16	4
VA	Yes	5000.00	62967.78	0.08	5.37	4
WY	Yes	10000.00	53708.11	0.19	6.90	4
AR	Yes	17425.00	41227.34	0.42	3.73	5
CO	Yes	45000.00	61377.39	0.73	5.58	5
DE	Yes	50000.00	56565.67	0.88	5.76	5
HI	Yes	17425.00	64089.82	0.27	10.51	5
LA	Yes	25000.00	42654.21	0.59	5.51	5
ME	Yes	35000.00	50249.51	0.70	6.27	5
MI	Yes	17425.00	51084.04	0.34	5.79	5
MO	Yes	15000.00	48774.10	0.31	3.74	5
NE	Yes	12500.00	53861.02	0.23	3.29	5
NJ	Yes	17425.00	68284.69	0.26	7.62	5
NM	Yes	30000.00	45115.96	0.66	5.35	5
OR	Yes	25000.00	52448.20	0.48	7.25	5

PA	Yes	17425.00	51987.45	0.34	4.24	5
SC	Yes	17425.00	44104.29	0.40	3.12	5
SD	Yes	30000.00	49528.12	0.61	3.62	5
UT	Yes	20000.00	60398.63	0.33	6.44	5
WI	Yes	40000.00	53704.30	0.74	4.35	5
WV	Yes	25000.00	42656.15	0.59	4.35	5
CT	Yes	75000.00	67675.40	1.11	8.04	6
ID	Yes	104471.00	50053.53	2.09	5.83	6
MA	Yes	100000.00	63015.52	1.59	8.03	6
MS	Yes	75000.00	38908.97	1.93	3.24	6
NH	Yes	100000.00	68438.14	1.46	8.01	6
NV	Yes	550000.00	54782.10	10.04	10.06	6
NY	Yes	50000.00	52655.17	0.95	6.79	6
RI	Yes	200000.00	55399.59	3.61	8.63	6
VT	Yes	75000.00	55026.47	1.36	5.56	6
FL	Yes	∞	47917.01		7.97	7
IA	No	∞	52378.80		3.85	7
KS	Yes	∞	48913.09		3.33	7
OK	Yes	∞	46108.99		5.60	7
TX	Yes	∞	48876.19		4.83	7

Table 13: Grouping of US states by legal environment concerning bankruptcy and mortgage default. Columns 2 and 3 are taken from Mitman (2016).



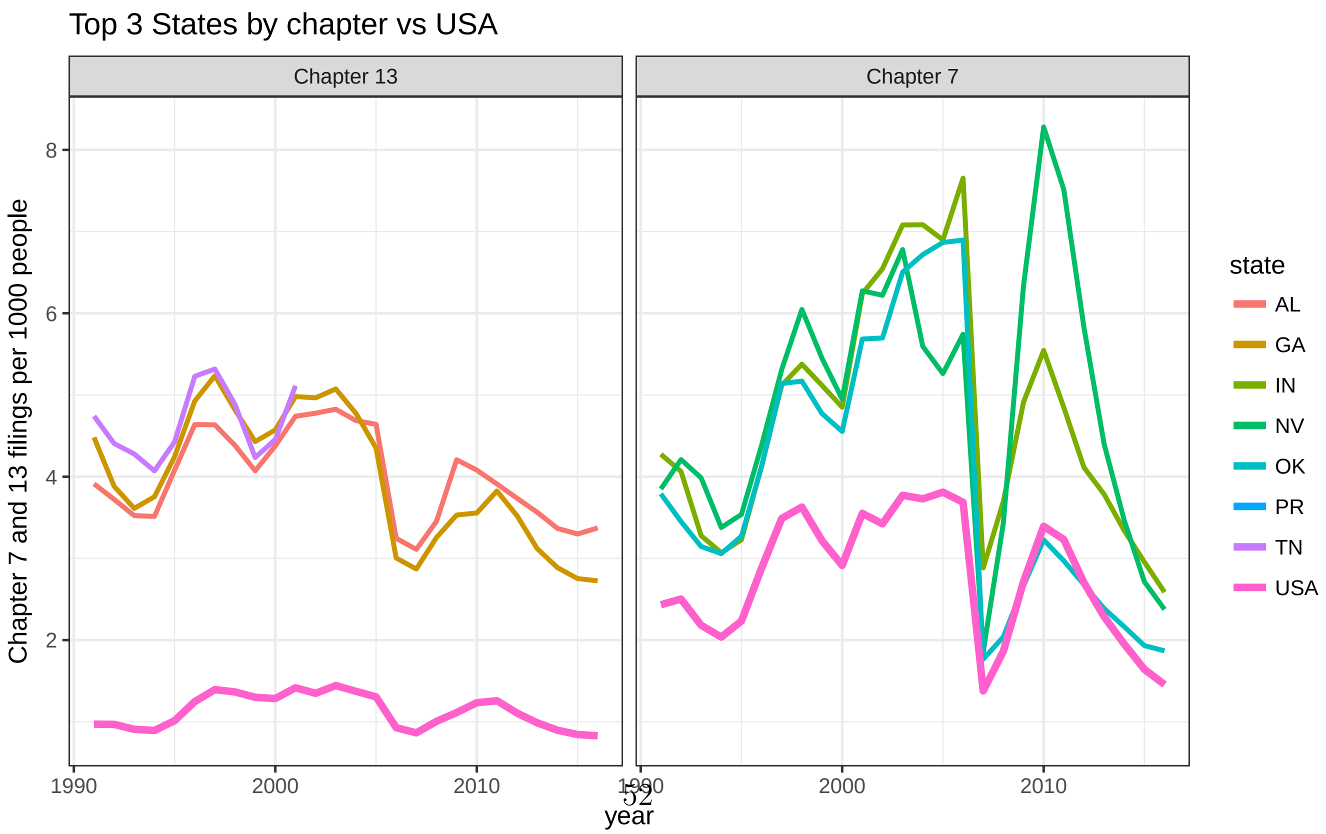


Figure 12: Top/Bottom 3 states in the filings rate distribution.