Bankruptcy Reform and Foreclosure Crisis in the Great Recession

Nathalie Pouokam

November 29, 2012

Abstract

Between the first quarter of 2007 and the last quarter of 2009, the average price for U.S. single-family houses fell by 26%. The three year foreclosure rate subsequently rose from 0.48% in 2002-2004 to 1.88% in 2007 − 2009 among U.S. states where the percentage fall in housing prices and the 2009 unemployment rates were close to national levels. This paper investigates the impact of the 2005 bankruptcy reform law on this explosive rise in the foreclosure rate. Prior to the bankruptcy reform law, U.S. households in bankruptcy had to repay their unsecured debts only up to the amount of their non-exempt home equity. The 2005 bankruptcy reform law requires that above-median income earners repay their unsecured debts in bankruptcy up to the maximum between their non-exempt home equity and 5 years of "disposable income"(income over necessary living expenses). To assess the quantitative impact of the bankruptcy reform law on the foreclosure crisis, I model a life-cycle economy in which households face idiosyncratic income and expense risks; they access homeownership by entering into 30-year fixed interest rate mortgage contracts with a default option; they smooth consumption by borrowing in a second mortgage market and in an unsecured credit market; and they discharge unsecured debts through a bankruptcy system that mimics key features of both Chapter 7 and Chapter 13 of the U.S. bankruptcy code. My results show that the reform lowers borrowing interest rates and raises the opportunity cost of bad credit, thereby making households less likely to default on both mortgage and unsecured markets. I find that the three year foreclosure rate would have been 0.24 points higher during the period 2007-2009, had the bankruptcy reform law not taken place prior to the fall of housing prices. In other words, if the housing bust had occurred in the pre-bankruptcy reform world, then an additional 120,000 houses would have been foreclosed during the period 2007-2009. This result comes in stark contrast to suggestions from previous research that the bankruptcy reform has pushed toward a higher foreclosure rate.

Introduction

Between the first quarter of 2007 and the last quarter of 2009, the average price of U.S. single-family houses as measured by the Housing Price Index[1] of the Federal Housing Finance Agency fell by 26%. Mortgage markets responded aggressively as the three year foreclosure rate subsequently rose from 0.48% in 2002-2004 to 1.88% in $2007 - 2009$ among U.S. states where the percentage fall in housing prices and the 2009 unemployment rates were close to national levels.. Almost concomitant with the 2007 housing bust was the introduction of a new bankruptcy law that was implemented in October 2005 and that reduced the amount of unsecured debts that high income earners may discharge in bankruptcy. In fact, Prior to the 2005 bankruptcy reform law, U.S. households in bankruptcy had to repay their unsecured debts only up to the amount of their non-exempt home equity. The 2005 bankruptcy reform law requires that above-median income earners repay their unsecured debts in bankruptcy up to the maximum between their non-exempt home equity and 5 years of disposable income (defined as the difference between the household's income and its necessary living expenses).

This paper investigates the impact of the 2005 bankruptcy reform on the foreclosure crisis. Specifically, I ask if the foreclosure crisis would have been milder or harsher, had the bankruptcy reform not taken place prior to the housing bust and drop in average earnings that occurred during the great recession. I find that the bankruptcy reform did not worsen the foreclosure crisis and has instead limited it. This result is in stark contrast with the suggestion of Li, White & Zhu (2009) that the bankruptcy reform has induced a higher foreclose rate by making it more difficult for households to discharge unsecured debts in bankruptcy in order to relax their budget constraints and continue making mortgage payments.

To assess the impact of the bankruptcy reform law on the foreclosure crisis, I model a small open life-cycle economy in which households face idiosyncratic income and expense risks; they access homeownership by entering into 30-year fixed interest rate mortgage contracts with a default option; they smooth consumption by borrowing in a second mortgage market and in an unsecured credit market; and they discharge unsecured debts through a bankruptcy system that mimics key features of both Chapter 7 and Chapter 13 of the U.S. bankruptcy

[1] I use the expanded Housing Price Index of the Federal Housing Agency which includes sales price information from Fannie Mae and Freddie Mac mortgages as well as transactions records for houses with mortgages endorsed by the Federal Housing Agency and county recorder data licensed from DataQuick Information Systems.

code. The risk-free rate is assumed exogenous to the model but interest rates in mortgage markets and in unsecured credit markets reflect endogenous default premia.

My model assumes the existence of a linear technology that transforms consumption goods into housing capital as in Corbae & Quintin (2011). Housing prices are hence exogenous, allowing me to simulate the housing bust of the great recession as a partially anticipated shock to the relative productivities of housing and production capital. I calibrate the model to jointly match several moments of the U.S. economy in the period 2002-2004 characterized by the old bankruptcy code and high housing prices, and in the period 2007-2009 characterized by low housing prices, lower average earnings, a lengthier foreclosure process and the post-reform bankruptcy code.

The methodology of this paper views U.S states as effectively "non-recourse states". In theory, U.S. states are divided among recourse and non-recourse states. A state is referred to as a non-recourse state if mortgage lenders are prohibited from going after households for any remaining mortgage debts in the event that the mortgage balance exceeds the proceeds from the sale of a house in foreclosure. Recourse states are states in which mortgage lenders may obtain deficiency judgments that allow them to go after mortgagors for remaining mortgage debts in such case. In practice however, mortgage lenders in recourse states tend not to pursue lawsuits to claim deficiency judgments against mortgagors in foreclosure because recovery rates on mortgage debts associated with a foreclosure tend to be too low to cover for the legal fees implied. In that sense, mortgage loans secured by properties located in recourse states are "de facto non-recourse loans" [2] (Oren Bar-Gill(2009)). Direct data on the frequency of deficiency judgments on loans in foreclosure is not available. In the empirical section, I test for the ineffectiveness of the recourse technology under the hypothesis that if deficiency judgments were relatively cheap to mortgagees, then conditional on having gone through a foreclosure, households would file for bankruptcy more often in recourse states than in non-recourse states. In a random sample of $38,289,370$ fixed-interest rate first mortgage residential loans from LPS Applied Analytics followed over the period 1992-2012, I document that among loans that started the foreclosure process during the period, 20% were registered into bankruptcy after the start of the foreclosure process in recourse-states, compared to 19% in recourse states. The fact that these numbers are of similar magnitudes suggests that in practice, the recourse technology is ineffective: households in recourse states are very likely to get away from a foreclosure owing nothing to the mortgage lender, even when the loan was under water.

[2] See Oren Bar-Gill(2009), page 41.

My model succeeds at explaining 89% of the foreclosure rate observed in non-recourse states over the period 2007-2009. My model predicts that the 2005 bankruptcy reform has contributed toward a lower foreclosure rate in non-recourse states once housing prices fell during the great recession. Specifically, the model predicts that the foreclosure rate in a great recession world without the bankruptcy reform would have been 0.24 percentage points higher. This amounts to an additional $120,000$ houses that would have been foreclosed between 2007 and 2009 if the bankruptcy reform law had not taken place prior to the crisis.

Using non-recourse states as a benchmark, I use my model to predict what the foreclosure rate would have been in U.S. recourse states during the same period, had the recourse technology been perfect in the sense that mortgage lenders could obtain deficiency judgments at a zero-cost. My model predicts that in a perfect-recourse world jointly shocked with a 26% drop in housing prices, with lower labor productivity, and with the introduction of the new bankruptcy code, the foreclosure rate would have been 0.94 percentage points lower than the average foreclosure rate observed during the period 2007-2009 among U.S. recourse states. I also find that in recourse states, the bankruptcy reform still leads to a smaller foreclosure rate during the great recession, but the magnitude of the impact of the reform is smaller in the recourse case relative to the non-recourse case. Specifically, the model predicts that in a perfect-recourse world, the foreclosure rate following the housing bust and economic crisis would have be 0.18 percentage points higher (versus 0.24 percentage points in the non-recourse case), had the old bankruptcy code been maintained.

The mechanism driving the results is as follows. High income earners with moderately negative home equity which in the great recession world with the old bankruptcy code would have chosen to simultaneously go though bankruptcy and foreclosure are instead likely to choose not to go through foreclosure in the post-reform world. This is so because given the new bankruptcy code, high income earners are typically unable to discharge most of their unsecured debts in bankruptcy and are hence most likely to find themselves trapped with large unsecured debts and a bad credit record, had they chosen the foreclosure option. When their home equity is not too negative, the opportunity cost of a bad credit record is sufficiently high to discourage them from the foreclosure option, especially given that the reform makes borrowing in the unsecured credit market particularly cheaper for high income earners. For this reason, during the great recession, the bankruptcy reform not only contributed toward a smaller number of bankruptcies, but it also contributed toward a smaller number of foreclosures.

Moreover, the reform also reduces the number of foreclosures among homeowners with moderately positive liquid assets and which in a great recession world without the reform would have chosen to go through a foreclosure not associated with bankruptcy filing. In fact, even when it is not associated with bankruptcy filing, foreclosure tarnishes a household's credit record and restricts the household's access to credit markets. Because the reform makes borrowing particularly cheaper for high income earners, high-income earners with moderately negative home equity which in a great recession world without the reform would have chosen the foreclosure option behave differently in the post-reform world. Specifically, in the post-reform world, these homeowners do not choose the foreclosure option but instead either sell their houses or continue to make mortgage payments in order to maintain their access to credit markets.

The impact of the bankruptcy reform on the foreclosure crisis appears to be smaller in the recourse world because in the recourse world, foreclosures occur only among low-income earners. This is so because foreclosure is particularly onerous in the recourse world: a homeowner which chooses to simply walk away from its house in the recourse world has to repay all mortgage debts not covered for by the proceeds of the foreclosure sale while its credit record suffers. Given that a foreclosure costs households access to credit markets, a foreclosure in the recourse world is hence optimal for households only when it is associated with bankruptcy filing and a discharge of the additional debts incurred from the difference between the mortgage debts and the proceeds of the foreclosure sale. Now, given bankruptcy-specific costs, homeowners in the recourse world tend to choose the foreclosure option only when they do not hold significant liquid assets, insofar as liquid assets in bankruptcy would be applied toward the repayment of unsecured debts incurred from mortgage loans. But given that households have a strong incentive to save for retirement, the young households that start a period with significantly negative liquid assets holdings tend to be households that in a recent past have been hit by a series of bad income shocks realizations. Because the income process is very persistent, these households also tend to be current low income earners. For this reason, homeowners in foreclosure in recourse states are primarily low income earners with large unsecured debts. Since the reform binds only for high income earners, it hence turns out that the impact of the reform on the foreclosure rate in recourse state is rather moderate in the artificial recourse world.

I next explain why the mechanism suggested by Li, White & Zhu (2009) did not cause the bankruptcy reform to contribute to the surge of the foreclosure rate during the great recession. Households which file for bankruptcy and choose to keep their houses rather than foregoing them to bankruptcy trustees are primarily high income earners for whom the law binds. For this reason, consistently with the suggestion of Li, White & Zhu (2009), my model predicts that the reform has reduced the number of homeowners which file for bankruptcy in order to discharge their unsecured debts and use their relaxed budgets to continue making mortgage payments and keep their houses. However, contrary to the suggestion of Li, White & Zhu (2009), the foreclosure option is not the next best alternative once the law makes the bankruptcy option unattractive for those who before the reform would have sought relief in bankruptcy in order to maintain ownership of their homes. In fact, households which would go through bankruptcy with the intention of keeping their houses typically have large unsecured debts but positive home equity that they seek to hold onto. When bankruptcy becomes less generous because of the new law, these households become more likely to either sell their houses, or to continue making payments mortgage payments rather than going through foreclosure and suffering the costs of bad credit while still burdened with large unsecured debts that they can no longer discharge in bankruptcy. This is precisely the reason why the reform did not lead to a higher foreclosure rate as suggested by Li, White & Zhu (2009).

The study the most closely related to the current work is that of Mitman (2011) which studies an infinite horizon model where unsecured and mortgage lending markets are linked through the bankruptcy system. The work of Mitman (2011) shows that cross-state variations in homestead exemptions and foreclosure laws explain a significant share of the variations observed in bankruptcy and foreclosure rates. Mitman (2011) finds that in the absence of a shock to housing prices, the bankruptcy reform increases welfare, but leads to a higher foreclosure rate and a higher bankruptcy rate as it induces households to take on more unsecured debts (given that unsecured borrowing becomes cheaper after the reform), and to leverage their mortgages more highly (as the reform reduces the amount of home equity that can effectively be sheltered away from a bankruptcy trustee). During the transition period following the introduction of the new bankruptcy law in its model, Mitman (2011) finds that foreclosure rates increase for four years before stabilizing to new levels higher than pre-reform levels. From these findings, Mitman (2011) concludes that the bankruptcy reform led to a higher foreclosure rate as was suggested by Li, White & Zhu (2009). My paper shows the importance of taking account of large and unexpected shocks to home equity by demonstrating that at bad times, homeowners in credit markets behave differently than they do in periods of constant or rising housing prices. Using a new and rich quantitative model of households' debts, I show that given unexpected large shocks to their home equity, homeowners in the great recession world with the new bankruptcy reform have abandoned their houses in foreclosure less often than they would have done it if the bankruptcy reform had not taken place prior to the crisis.

In addition to offering a different approach for the understanding of the foreclosure crisis, my paper also proposes a model that is different from that of Mitman (2011) in three fundamental ways. First, Mitman (2011) models first mortgages as one-period bond contracts while I model first mortgages as 30-year period fixed interest rate contracts with an initial downpayment requirement that equals the average downpayment requirement in the U.S. between 2002 and 2004. Modeling first mortgages as 30-year period contracts with a fixed-interest rate realistically gives households with advantageous first mortgage interest rates an incentive not to default on their mortgage contracts either non-strategically when they go through financial hardship, or strategically when they are hit with a negative shock to their home equity. The initial downpayment requirement is necessary to properly account for the implications of a 26% drop in housing prices as observed during the great recession, on the resulting distribution of negative home equity among households.

Second, my model allows for a mechanism by which households file for bankruptcy in order to free up their budget constraint with the goal of holding onto a first mortgage contract with a particulary attractive interest rate as suggested by Li, White & Zhu (2009). This mechanism is nonexistent in Mitman (2011) which models first mortgages as one-period bonds.

Third, my paper models second mortgages and treats them as unsecured debts in bankruptcy in the event that the household's first mortgage debt exceeds the market value of the household's house. This feature of the model captures the fact that in the U.S. when a household's first mortgage debt exceeds its house's market value, junior liens are stripped off in Chapter 13 and as a result, second mortgages are treated like unsecured debts in such case. For this reason, when housing prices are unexpectedly shocked negatively, second mortgages have important implications for both the probability that a homeowner would go through foreclosure (because a homeowner with a second mortgage is more likely to face negative equity when housing prices fall) and the probability that a homeowner would go through bankruptcy (because second mortgages are treated like unsecured debts whenever the first mortgage is under water). Second mortgages are not present in Mitman (2011).

The rest of the paper is organized as follows. Section 1 presents empirical facts on household default from the LPS Applied Analytics's database. Section 2 describes the U.S. bankruptcy code and explains how it is modeled in the paper. The complete model is described in section 3. Section 4 explains the calibration strategy. Results are given in section 5 and concluding remarks in section 6.

1 Empirical Facts on Household Default

In this section, I present key facts related to household default and supported with evidence from the LPS Applied Analytics's residential mortgage loans database, which is the largest residential mortgage loan-level database available at the national level. The dataset used comprises $38,289,370$ loans all classified as "first-mortgage" loans and secured by a real estate property occupied by the borrower as either a primary or a secondary residence. These loans represent about two-ninth of all first-mortgage loans in the U.S. residential mortgage servicing market. The dataset is nationally representative, as it covers all major mortgage loans servicers and properties over all U.S. states. Each loan in the database entered it for the first time at some point between April 1992 and April 2012, and was followed throughout on a monthly basis, except if the mortgage contract had been terminated. I define foreclosure on a property as the occurrence of a liquidation sale or a repossession of the real estate by the mortgage lender following one or several months of delinquency. The foreclosure start date is defined as the date of the first foreclosure flag since the loan stopped being current. The foreclosure start date therefore does not necessarily coincide with the date of the first missed payment. The foreclosure end date is defined as the date of liquidation sale or real estate repossession.

Findings

Facts #1: Mortgage loans secured by properties involved in a foreclosure-start during the period 1992-2011 were continuously delinquent for a median of 420 days from the date of the first missed mortgage payment to the date of the liquidation sale or repossession by the mortgage lender. In other words, borrowers were never current on their loans for a median of 420 days prior to the end of the foreclosure process. This first fact points to the importance of free-renting in a household's decision to forego its house in foreclosure. The median number of days of free-rent associated with the foreclosure process rose from 320 days for loans that started foreclosure in the period 2002-2004, to a median of 506 days for the loans that started foreclosure during the period 2007-2009.

Facts #2: Among mortgage loans that were registered in bankruptcy some time between 1992 and 2009, 33% entered bankruptcy after being continuously delinquent for a minimum of 90 days. However, among these loans which entered bankruptcy after a minimum of 90 days of delinquency, only 56% had terminated in a foreclosure sale or real estate repossession by April 2012. The remaining 44% were saved from the occurrence of a foreclosure after bankruptcy filing. I interpret this fact as evidence of the existence of a mechanism by which households file for bankruptcy in order to stop or prevent an imminent foreclosure.

Facts #3: In the pool of loans that were delinquent for a minimum of 90 days prior to a registration in bankruptcy during the period 1992 and 2009, but that had not terminated in foreclosure by April 2012, the average number of days of continuous delinquency prior to registration in bankruptcy was 302 days.

Facts #4: In certain U.S. states, in the event of a foreclosure, households are charged for the difference between the mortgage balance and the sale price of the real estate. This difference is referred to as a deficiency. States in which deficiency liens are applicable are known as recourse states. States in which deficiency liens are not applicable are known as non-recourse states.

In the sample, 10% of loans associated with both bankruptcy and foreclosure entered bankruptcy within 3 years prior to their foreclosure start dates; 38% entered bankruptcy in the year of their foreclosure start; 48% entered bankruptcy within 1 to 3 years after their foreclosure start date, and 87% were registered in their most recent bankruptcy either in the year of their foreclosure start date or at a later date. Very similar proportions are obtained when the sample is divided between recourse-state loans and non-recourse state loans.

In fact, among loans that were associated with both bankruptcy and foreclosure in non-recourse states, 38% were registered in their most recent bankruptcy in the year of their foreclosure start, and 88% were registered in their most recent bankruptcy either in the year of their foreclosure start date or at a later date (as opposed to being registered in bankruptcy prior to the foreclosure start). The fact that bankruptcy filing typically follows (rather than precedes) a foreclosure start in non-recourse states seems to indicate that financially distressed households first seek relief in foreclosure and then file for bankruptcy only in the last resort. From the significantly high proportion of loans that go into bankruptcy in the year of their foreclosure start date, it appears that bankruptcy and foreclosure are closely related events for households in financial distress.

Finally, in recourse states, 23% of loans in foreclosure were also registered in bankruptcy at some point in time, compared to an equivalent proportion of 22% for loans associated with foreclosure in non-recourse states. This implies an insignificant variation between recourse and non-recourse states in terms of registration in bankruptcy for loans associated with a foreclosure. In theory, one would expect a much higher proportion of loans associated with a foreclosure to be also associated with bankruptcy filing in recourse states, insofar as households facing a foreclosure in recourse states (compared to those in non-recourse states) have additional incentives to file for bankruptcy as they would wish to discharge the unsecured debts caused by deficiency liens in foreclosure. I interpret this last finding as evidence of an ineffective recourse technology in practice. The recourse technology is understood as the means by which a mortgage lender may sue the mortgagor for the difference between the mortgage debts and the foreclosure sale price.

Summary Statistics

In tables 1 and 2, column (1) gives the median number of days of delinquency prior to foreclosure for loans that entered foreclosure in the year of interest. Column (2) shows the means of the number of days of delinquency prior to bankruptcy filing for loans that in the relevant year entered bankruptcy after being delinquent for a minimum of 90 days and that had not started foreclosure by the end of April 2012. Column (3) gives the average downpayment at origination for each year. Column (4) shows the mean net-interest rate at origination for loans originated in a given year. The net-interest rate is defined as the difference between the gross interest rate and the service-fee rate charged for securitized transactions. [3]. Table 1 shows these statistics across all U.S. states while Table 2 displays them for U.S. states separated into recourse and non-recourse groups.

Table 1: LPS summary statistics

	(1)	(2)	(3)	(4)
2002	330	246	21.5%	5.82%
2003	330	247	23.8%	5.16%
2004	300	238	24.2%	5.38%
2005	360	256	24.8%	5.49%
2006	360	304	26.1%	5.12%
2007	420	297	27.7%	6.07%
2008	600	284	28.3%	5.72%
2009	600	290	28.8%	4.77%
2010	540	351	28.03%	4.46%

[3]Table 10 in the appendix summarizes the same statistics for U.S. states separated into high-homestead and low-homestead groups. A state qualifies as a high-homestead state if the ratio of its homestead exemption over its 2001- median income is higher than 1. Among all 51 states, 40 are recourse states and 24 are high-homestead states

(a) Recourse States

	(1)	(2)	(3)	(4)
2002	360	248	20.8%	5.85%
2003	330	253	22.5%	5.18%
2004	330	242	22.8%	5.41%
2005	360	257	23.4%	5.52%
2006	360	304	24.4%	6.16%
2007	450	298	26.3%	6.11%
2008	630	287	26.9%	5.75%
2009	660	296	26.8%	4.78%
2010	540	349	26.3%	4.46%

(b) Non-Recourse States

	(1)	(2)	(3)	(4)
2002	300	240	23.2%	5.76%
2003	300	224	26.2%	5.13%
2004	270	223	27.3%	5.31%
2005	300	248	27.7%	5.41%
2006	330	290	30.1%	6.01%
2007	330	294	31.3%	5.95%
2008	510	269	32.4%	5.64%
2009	480	276	33.8%	4.73%
2010	420	359	31.8%	4.45%

Table 2: Summary Statistics Across the Recourse and Non-Recourse Groups

During the period 2002-2009, average net-interest rates at origination associated with fixed interest mortgages were consistently higher in recourse states than in non-recourse states. However, the average downpayment at origination on first mortgages is consistently higher in recourse states, suggesting that mortgage lenders use both the downpayment requirement and the interest rate to simultaneously adjust for an individual's specific risk and for the aggregate risk of a fall in housing prices. Because a foreclosure is more costly to mortgage lenders when it occurs in a non-recourse state relatively to when it occurs in a recourse state, mortgage lenders then tend to require larger downpayments in the former case. The median number of days in foreclosure is higher in the period 2007-2009 relative to the period 2002-2009 in both the recourse and non-recourse groups. Also, this statistic is consistently higher in the recourse case, even though the magnitude of the difference is not too large [4].

Foreclosure Rates

Table 3 and 4 display the average foreclosure rate by recourse and homestead categories for 3 pools of states: a first pool that includes all U.S. states (All-States pool), a second pool that is referred to as Subgroup 1 and that restricts to U.S. states in which average housing prices dropped by a percentage between 20% and 30% from 2007 to 2009, and a third pool (Subgroup 2) made by restricting to those states in Subgroup 1 for whom the

[4] The fact that the number of days of free-rent due to a lengthy foreclosure process is higher in recourse states seems due to the fact that foreclosure in recourse states tend to be judicial foreclosures which are lengthier by nature.

2009 unemployment rate was below the 2009 unemployment rate in the US[5]. In Subgroup 1, the average percentage change in housing prices is −25% for the recourse subset and −26% for the non-recourse subset. In Subgroup 2, the numbers are −25% and −25%, respectively. Statistics in Table 3 and 4 show that foreclosure rate tends to be higher for recourse states in the All-State pool where states are included without any restriction. However, in Subgroup 2, that restricts to states with comparable unemployment rates and comparable percentage changes in housing prices, the foreclosure rate appears to be slightly higher for the non-recourse subset. In Subgroup 2, the foreclosure rate is also slightly higher for the Low-Homestead subset, relative to the High Homestead subset.

(a) ALL-States

	R	NR
2002	0.32%	0.22%
2003	0.30%	0.17%
2004	0.30%	0.15%
2005	0.30%	0.12%
2006	0.43%	0.16%
2007	0.58%	0.36%
2008	0.9%	0.82%
2009	1.15%	1.14%

(b) Subgroup 1

	R	NR
2002	0.28%	0.30%
2003	0.25%	0.24%
2004	0.25%	0.19%
2005	0.26%	0.12%
2006	0.38%	0.16%
2007	0.53%	0.27%
2008	0.82%	0.56%
2009	1.14%	0.93%

(c) Subgroup 2

	R	NR
2002	0.18%	0.27%
2003	0.13%	0.22%
2004	0.11%	0.17%
2005	0.09%	0.13%
2006	0.12%	0.19%
2007	0.29%	0.3%
2008	0.58%	0.59%
2009	1.0%	0.9%

Table 3: Foreclosure Rates In the Recourse and Non-Recourse Groups

(a) ALL-States

	L	H
2002	0.36%	0.24%
2003	0.33%	0.20%
2004	0.33%	0.20%
2005	0.34%	0.18%
2006	0.47%	0.26%
2007	0.59%	0.47%
2008	0.84%	0.92%
2009	1.4%	1.6%

(b) Subgroup 1

	L	H
2002	0.30%	0.19%
2003	0.28%	0.16%
2004	0.29%	0.12%
2005	0.29%	0.10%
2006	0.41%	0.16%
2007	0.56%	0.30%
2008	0.87%	0.54%
2009	1.50%	0.9%

(c) Subgroup 2

	L	H
2002	0.22%	0.19%
2003	0.15%	0.16%
2004	0.14%	0.12%
2005	0.10%	0.10%
2006	0.11%	0.16%
2007	0.28%	0.3%
2008	0.62%	0.54%
2009	1.10%	0.9%

Table 4: Foreclosure Rates In the Low and High Homestead Groups

[5]See the Appendix for the list of states in each pool.

2 U.S. Bankruptcy Code: Real World and Model

The U.S. bankruptcy system allows households to use either Chapter 7 or Chapter 13 to discharge their unsecured debts. Prior to the 2005 bankruptcy reform, households in bankruptcy were required to avail only their non-exempt home equity for the repayment of their unsecured debts, no matter whether they filed for Chapter 7 or Chapter 13. Non-exempt home equity is defined as the difference between the household's home equity and the amount of homestead exemption in the household's state of residency. Before the reform, in Chapter 7, the household's house would be liquidated whenever it carried non-exempt equity that should be used toward repaying the household's unsecured debts. In Chapter 13 on the other hand, a household filing could either abandon its house, or could instead choose to keep it and repay its unsecured debts from future income through a 3-to-5 year Chapter 13 repayment plan. In that case, the filer would propose a Chapter 13 bankruptcy repayment plan that the bankruptcy court would approve only if over the lifetime of the plan, the household would have repaid its unsecured debts by at least the amount of non-exempt home equity listed at the time of bankruptcy filing.

The 2005 U.S. bankruptcy reform law introduced an income means-test that forces households which in the past six months prior to bankruptcy filing earned above their state median income to file under Chapter 13. The reform did not changed the amount of unsecured debts dischargeable in Chapter 7. However, the reform significantly limited the amount of unsecured debts that could be discharged in Chapter 13. Specifically, after the reform, bankruptcy filers are required to avail the maximum between their non-exempt home equity and five years of their current disposable income toward the repayment of their unsecured debts. Disposable income in the bankruptcy code is defined as the difference between the household's wage income and the household's necessary living expenses. Households in bankruptcy after the reform may still choose between keeping or foregoing their houses in bankruptcy. The key difference between the pre-reform and post-reform worlds is that U.S. households filing after the reform whether or not they choose to keep their houses must avail the maximum between their non-exempt home equity and five years of disposable income for the repayment of their unsecured debts, while only non-exempt home equity sufficed before the reform.

In the model, I use median income as a proxy for necessary living expenses. This allows me to simplify both the pre-reform and post-reform bankruptcy codes as a single option filing menu for non-owners, but a two-option filing menu for homeowners who choose to either keep or toss out their houses when filing. In the model as in the real world, before the reform households in bankruptcy would be requested to avail at least their non-exempt home equity toward the repayment of their unsecured debts. In the model, after the reform, given the use of median income as a proxy for non-disposable income, unsecured creditors in bankruptcy may receive as much as the maximum between the filer's non-exempt home equity and 5 years of the difference between the filer's current income and the median income. The means-test is then well accounted for in the model, given that the change in the bankruptcy code only binds for above-median income earners.

In the U.S. bankruptcy code, Chapter 13 is particularly attractive to homeowners for whom the first mortgage is underwater, given that junior liens are stripped off in Chapter 13 whenever the house value is smaller than the first mortgage debt. For instance, a household which owes a second mortgage debt and has its first mortgage under water will see its second mortgage debt discharged in the same fashion as its unsecured debts, while the household may continue to make mortgage payments in order to keep its house after bankruptcy filing. This unique feature of Chapter 13 existed before the reform and was not affected by the reform. In my model, I explicitly account for this provision of the U.S. bankruptcy code by treating second mortgage debts as unsecured debts in the case that the filer's house value is smaller that the first mortgage debts and the filer chooses to keep its house rather than foregoing it when filing for bankruptcy.

3 The model

The model economy is populated with households, first mortgage lenders, second mortgage lenders, unsecured credit lenders, and a housing sector. The housing sector consists of a housing firm which transforms physical capital into housing capital, and a rental agency. Mortgage lenders, unsecured lenders, the housing firm, and the rental agency are risk neutral and may borrow or lend at risk free rate r which is exogenous to the economy.

3.1 Households

3.1.1 Demographics and Preferences

Households live at most J periods. Staring with $\psi_1 = 1$, in every period, $\forall j \geq 2$, households of age $j-1$ survive to age j with probability ψ_j, while those of age J die with certainty at the end of the period. Every period, a constant measure of age one households is born so that population is kept constant. Households discount the future at rate $\beta \in (0,1)$. Households value non-durable consumption good $c > 0$ and housing services $h > 0$.

Households'preferences over c and h are given by $u(c,h)$. The expected discounted lifetime utility of an age 1 household is then given by: $E\sum_{j=1}^{J}\beta^{j-1}\psi_{j+1}\ u(c_j,h_j)$.

3.2 The Housing Sector

The housing firm uses a linear technology that transforms one unit of production capital into A units of housing capital available in the form of houses. Houses come in four possible sizes. A house of size $i \in \{1,2,3,4\}$ does not depreciate and produces housing services h_i in every period. One unit of housing capital hence trades for price equal to $\frac{1}{A}$ units of physical capital. The rental agency purchases houses of all sizes from the housing firm and rents them to households which are then entitled to the housing services provided by these houses.

Households may rent all houses, but may purchase only houses of sizes 3 and 4. Households incur per unit transaction cost τ_s when selling a house, and per unit transaction cost τ_c when purchasing one if they are age $j < J$. Housing transactions initiated by the oldest retirees do not involve transaction costs. As renters, households pay a rent to the intermediary per unit of housing service provided. To purchase a house, households borrow the necessary funds from a first mortgage lender. Loans contracted for home purchase are repaid according to the terms of a first mortgage contract that is specified later.

3.3 Housing Boom and Bust

The model economy starts in a boom characterized by an initial productivity level of housing capital $A = A_0$. Then, in every future period when $A = A_0$, agents anticipate that A may change from A_0 to $A_1 < A_0$ in the next period with probability γ and will remain equal to A_1 forever whenever it changes. In other words, agents anticipate with probability γ that the economy will fall in an absorbing state of low housing prices. In the rest of the paper, I will use Z to denote the aggregate state of the economy, with $Z = B$ if housing prices are high ($A = A_0$) and $Z = B$ if housing prices are low ($A = A_1$). For all $Z \in \{B, R\}$, I will use $P(Z)$ and $Rent(Z)$ to denote the per-unit housing price and rent that prevail given aggregate state Z.

3.4 Credit Markets

3.4.1 First Mortgage Contracts

In order to purchase a house of size $i \in \{3, 4\}$ given aggregate state Z, households must pay $\mu P(Z)h_i$ out of pockets and must borrow $(1-\mu)P(Z)h_i$ from a first mortgage lender at an interest rate r_m that depends on the household's characteristics. Loans offered by first mortgage lenders are to be reimbursed in at most T periods.

A first mortgage contract is hence indexed by the 4-tuple (i, r_m, τ, θ), where i the size of the house securing the contract, r_m is the associated fixed interest rate, $\tau \in \{1, \cdots, T+1\}$ is such that $T+1-\tau$ is the number of periods left for the loan to be repaid in full, and $\theta \in \{0, 1\}$ indicates whether the securing house was purchased when housing prices where either high (in which case $\theta = 0$) or if it was purchased when housing prices were low (in which case $\theta = 1$). Later on, r_m will be specified to come from a pricing function that allows first mortgage lenders to charge a fixed interest rate that depends on the size of the house purchased, on the aggregate state of the economy, and on the characteristics of the home buyer.

In each of the τ terms of a first mortgage contract indexed by (i, r_m, τ, θ), the household is asked to either make a constant payment M to the mortgage lender, or to repay the current balance $\ell(i, r_m, \tau, \theta)$ owed in full. The period mortgage payment $M = \mathit{Mortgage}(i, r_m, \theta)$ is given by:

$$\mathit{Mortgage}(i, r_m, \theta) = (1-\mu)Ph\frac{r_m}{1-(1+r_m)^{-T}},$$

where

$$P = \mathbb{1}_{\{\theta=0\}}P(B) + \mathbb{1}_{\{\theta=1\}}P(R).$$

The law of motion of ℓ is given by:

$$\begin{aligned}
\ell(i, r_m, 1, \theta) &= (1-\mu)Ph_i \\
\ell(i, r_m, \tau+1, \theta) &= \left(\ell\left(i, r_m, \tau, \theta\right) - \mathit{Mortgage}\left(i, r_m, \theta\right)\right).(1+r_m), \forall \ \tau \ \ s.t. \ \ 1 \le \tau \le T-1 \\
\ell(i, r_m, T+1, \theta) &= 0
\end{aligned}$$

3.4.2 Second Mortgage Constracts or Home Equity Loans

A Homeowner in first mortgage contract indexed by (i, r_m, τ, θ) and which for at least one period has owned a house of size i worth $P(Z)h_i$ may borrow against it by purchasing a home equity bond of face value b' from a second mortgage lender, where $b' \in \mathbb{B} \equiv \{\mu \times P(B)h_3,\ \mu \times P(B)h_4\}$ and where $0 \leq b' \leq P(Z)h_i - \ell(i, r_m, \tau, \theta)$ [6]. If the household purchases a home equity bond at per unit price q_s, then the household's period resources will be increased by $q_s \times b'$ and the household will have to promise to repay b' to the second mortgage lender in the following period. Later on, q_s will be specified to come from a pricing function that allows second mortgage lenders to charge a price that depends on the size of the loan, on the aggregate state of the economy, and on the characteristics of the borrower.

3.4.3 Unsecured Credit Contracts

Households borrow in the unsecured credit market by purchasing an unsecured bond with face value $a' \in \mathbb{R}$ from an unsecured lender. Given $a' < 0$, a household which purchases an unsecured bond with face value $a' < 0$ at per unit price q_u increases its current period resources by $q_u \times (-a')$ units of the consumption good. In return, this household promises to repay $(-a')$ units of consumption tomorrow. On the other hand, when $a' > 0$, the household charged a per unit price q_u sees its period resources decreased by $q_u \times a'$ and in return is promised to receive a' units of consumption tomorrow. Later on, q_u will be specified to come from a pricing function that allows unsecured lenders to charge a price that depends on the size of the loan, on the aggregate state of the economy, and on the characteristics of the borrower.

3.4.4 Contract Termination Upon the Death of the Household

In the event of the death of a homeowner, its house of size i is sold for a net value $P(Z)h_i$ and the proceeds of the sale are used to repay the first mortgage lender only. I assume that second Mortgage lenders and unsecured lenders do not obtain any compensation upon the death of the borrower. In the event of the death of a household with positive unsecured bond holdings, the unsecured lender keeps the household's savings[7].

[6] Homeowners in this fashion are allowed to take second mortgage loans for an amount equal to a small house downpayment or a big house downpayment

[7] Not allowing mortgage lenders to share a household's liquid assets upon its death simplifies computations tremendously. Given this separation assumption, allowing second mortgage lenders to share the proceeds of the sale of a deceased household's house may create a profitable arbitrage condition. This is the case because under the assumption that second mortgage lenders share the proceeds of the sale of a deceased household's

3.4.5 Voluntary Default

Households are not committed to any credit market contract. They may jointly default on first and second mortgage contracts, and may default independently on unsecured credit contracts. Specifically, households may default in three possible ways:

- they may default on mortgage contracts only **(or walk-away from their home without going though bankruptcy)**
- they may jointly default on all mortgage contracts and on unsecured credit contracts **(bankruptcy option for tossers)**
- they may default on an unsecured credit contract only **(bankruptcy option for keepers)**.

Defaulting on an unsecured credit contract or on a second mortgage contract consists in not repaying the amount due to the unsecured credit lender or to the second mortgage lender. In a given period, a homeowner faced with $\zeta \in [0,1]$ voluntarily defaults on a first mortgage contract (i, r_m, τ, θ) by repaying only $(1-\zeta) \times Mortgage(i, r_m, \tau, \theta)$ to the mortgage lender in that period. A homeowner which voluntarily defaults on its mortgage contracts continues to enjoy the housing services provided by the house during the period of default, but loses the house at the end of the period to a risk neutral intermediary which avails $\frac{(1-\phi)E(p)h_i}{1+r}$ to be used to repay the first mortgage lender in first priority and the second mortgage lender in second priority,

where given aggregate state Z,

$$E(p) = \begin{cases} (1-\gamma)\frac{1}{A_0} + \gamma\frac{1}{A_1} & \text{if Z=B} \\ \frac{1}{A_1} & \text{if Z=R.} \end{cases}$$

A household's eligibility for borrowing on any credit markets is conditioned by its credit record. Households are assumed born with a clean credit record. However, following a mortgage default without bankruptcy filing, the household's credit record is tarnished with a foreclosure flag that disappears in any subsequent period with probability λ. Following bankruptcy filing, the household's credit record is tarnished with a bankruptcy flag that

house , when the probability of a fall of housing prices is very small, interest rate premia on home equity loans are close to zero, and households find it profitable to take on second mortgages and invest the resources as savings by purchasing an unsecured bond. This is especially true for older households with relatively low survival rates.

disappears in any subsequent period with probability λ. Only households with no flag in their credit record may borrow in any market.

3.5 Legal Environment in the Benchmark Economy

The legal environment in the economy is indexed by a pair (E, R_c). $E \geq 0$ is the economy's homestead exemption level.

$$R_c = \begin{cases} 0 & \text{if the economy is a non-recourse economy} \\ 1 & \text{if the economy is a recourse economy} \end{cases}$$

In a recourse economy, following a default on mortgage contracts, the household is liable for all mortgage debts that remains once all the proceeds of the house sale have been exhausted toward repaying the mortgage lenders. In such economy, following a mortgage default, unpaid mortgage debts become unsecured debts. In a non-recourse economy, households are not liable for the mortgage debts that remain once the proceeds of the house sale do not suffice to repay the mortgage lenders.

3.6 Households' Idiosyncratic Shocks and Timing

Retired households face no idiosyncratic risk. However, working age households face income shocks, expense shocks, and housing luck shocks. Specifically, in each period, households of age $j < J_r$ draw a persistent income shock ξ, a transitory income shock ϵ, an expense shock $x \in \{0, \chi\}$, and a housing luck shock $\zeta \in \{0, \zeta_{R_c}\}$, where $\chi > 0$, and $\zeta_{R_c} > 0$, $\forall R_c \in \{0, 1\}$. In each period, expense shock $x = \chi$ with probability p_x and housing luck shock $\zeta = \zeta_{R_c}$ with probability p_{Rc}. ζ is the fraction of first mortgage payment that the household is allowed to default upon in the current period.

3.6.1 The income process

Every period t, a household of age $j \in \{1, \cdots, J_r\}$ receives endowments in the form of a persistent income shock ξ_t and a transitory income shock ϵ_t, where $\xi_t = \rho\xi_{t-1} + \upsilon_t$, $\upsilon \sim N(0, \sigma_\upsilon^2)$ and $\epsilon \sim N(0, \sigma_\epsilon^2)$. Households retire at mandatory retirement age $J_r < J$. Wage income at date t for a household of age $j < J_r$ is given by $y_t = \vartheta_j\ u_t$, where ϑ_j is the labor efficiency of individuals of age j and $u_t = exp(\xi_t + \epsilon_t)$.

J_r is the mandatory retirement age. After retirement, households of age $j \geq J_r$ receive pension income y_{ss} defined by $y_{ss} = Pens + \varsigma.exp(\xi_{J_r-1})$, where ς and $Pens$ are constant parameters, and ξ_{J_r-1} is the households' persistent shock in the pre-retirement age [8]. The model economy's median income is denoted by y_{med}.

3.6.2 Timing

The timing in a period is the following. At the beginning of the period, working age households first draw their income, expense, and housing luck shocks. Then, the housing and credit markets open simultaneously. Next, households which did not borrow on any credit market choose whether or not to default and select among the default options. Thereafter, households make mortgage and rents payments. Then, defaulters which have chosen the bankruptcy option get their current and future period cash-in-hand position readjusted according to the bankruptcy code. Consumption occurs and a new period starts.

Households are assumed born as non-owners with a clean credit record and with second mortgage and unsecured bonds of face values equal to zero. Afterwards, the credit status, ownership status and assets positions of the household evolve depending on choices made. let $\eta \in \{0, 1, 2\}$ represent a household's credit status: $\eta = 0$ if the household currently has a clean credit record and, $\eta = 1$ if the household only has a foreclosure flag, and $\eta = 2$ if the household either has a bankruptcy flag or has both bankruptcy and foreclosure flags. Let $o \in \{0, 1\}$ determine the household's ownership status: $o = 0$ if the household starts the period as a non-owner and $o = 1$ if it starts as a homeowner. Also, let θ indicate if a homeowner's house was bought during the boom or during the recession: $\theta = 0$ if the household's house was bought in the boom and $theta = 1$ otherwise. Then, for a household of age j which has drawn idiosyncratic shocks ξ, ϵ, x, and ζ, the idiosyncratic state vector is given by :

$$\{j, \eta, a, b, \epsilon, \xi, x, \zeta, o, (i, M, \tau, \theta)\},$$

where a is the household's beginning-of-period unsecured bond holding, b is the household's beginning-of-period second mortgage bond, M is the household's period mortgage payment, i is the size of the household's house, and τ is such that $1 \leq \tau \leq T + 1$ and $(T + 1 - \tau)$ is the number of terms left in the first mortgage contract. Because (i, M, τ, θ) is irrelevant for non-owners, I will restrict to $(i, M, \tau, \theta) = (3, 0, 1, 0)$ when the household starts a period as a non-owner.

In what follows, y will be used to denote the household's before-tax wage income, and $\overline{y}$ will be used to denote the household's after-tax wage income specified in section 3.9. Also, ℓ_0

[8] Pens is the part of pension income that is independent of earnings during working life.

will be used to denote a homeowner' current first mortgage debt. That is, for a homeowner in a first mortgage contract indexed with (i, r_m, τ, θ),

$$\ell_0 = \ell(i, r_m, \tau, \theta).$$

3.7 Description of the Bankruptcy Code

Consider a homeowner in idiosyncratic state $\{j, \eta, a, b, \epsilon, \xi, x, \zeta, o, (i, M, \tau, \theta)\}$ and living in an economy indexed by (E, R_c) when the aggregate state is Z. Bankruptcy costs homeowners δ_o units of consumption if they have started the period as homeowners and δ_{no} units of consumption if they have started as non-owners.

3.7.1 Bankruptcy for Homeowners

Define:

$$\begin{cases} \textit{Home Equity} & = \max\{0, (\frac{(1-\phi).E(p)h_i}{1+r} - (\ell_0 - (1-\zeta)M) - b)\} \\ \textit{Exempt Equity} & = \min\{E, \textit{Home Equity}\} \\ \textit{Non Exempt Equity} & = \max\{0, \textit{Home Equity} - \textit{Exempt Equity}\}. \end{cases}$$

Now, let's define by $\hat{A}_{toss}(Z, s)$ the before-bankruptcy adjusted cash-in-hand position of the household at the time of bankruptcy filing given that the household has also chosen to default on its mortgage payments.

Then,

$$\hat{A}_{toss}(Z, s) = \begin{cases} a - x & \text{if } R_c = 0 \\ a - x + a_1 + a_2 & \text{if } R_c = 1, \end{cases}$$

where a_1 and a_2 in absolute values are the mortgage debts still owed to the first and second mortgage lenders after exhaustion of the expected discounted sale proceeds in a recourse world:

$$\begin{cases} a_1 & = \min\{0, \frac{(1-\phi)E(p)h_i}{1+r} - (\ell_0 - (1-\zeta)M)\} \\ a_2 & = \min\{0, \max\{0, \frac{(1-\phi)E(p)h_i}{1+r} - (\ell_0 - (1-\zeta)M)\} - b\}. \end{cases}$$

Bankruptcy if the household tosses its house away

If the household tosses its house away while filing for bankruptcy, then it will start the future period with after-bankruptcy adjusted cash-in-hand $D_{toss}(Z, s)$. In the period of bankruptcy filing, the household's consumption is given by:

$$c = \overline{y} - \delta_o - (1-\zeta)M + (\textit{Exempt Equity} + \max\{0, \hat{A}_{toss}(Z,s) + \textit{Non Exempt Equity}\} + D_{toss}(Z,s)).$$

The after-bankruptcy adjusted cash-in-hand $D_{toss}(Z,s)$ is the key variable that differentiates a pre-bankruptcy reform world from a post-bankruptcy reform world for a homeowner which chooses to abandon its house when filing for bankruptcy. In order to define it, let's first define *Creditor Hit* to be the loss incurred by unsecured creditors after all non-exempt proceeds have been exhausted toward repaying them:

$$\textit{Creditor Hit} = \min\{0, \hat{A}_{toss}(Z,s) + \textit{Non Exempt Equity}\}.$$

Then,

$$D_{toss}(Z,s) + \frac{D_{toss}(Z,s)}{(1+r)} = \textit{Additional Payment},$$

where *Additional Payment*

$$= \begin{cases} 0 & \text{pre-bankruptcy reform} \\ -\min\{\text{-}\textit{Creditor Hit}, \textit{Ability to Pay}\} & \text{post-bankruptcy reform,} \end{cases}$$

and

$$\textit{Ability to pay} = \max\{0, \kappa \max\{0, y - y_{med}\} - \textit{Non Exempt Equity}\}.$$

Bankruptcy if the household keeps its house

When the household chooses to keep its house while filing for bankruptcy, its before-bankruptcy adjusted cash-in-hand is given by:

$$\hat{A}_{keep}(Z,s) = \begin{cases} a - x - b & \text{if } ph_i - (\ell_0 - M) < 0 \\ a - x & \text{if } ph_i - (\ell_0 - M) \geq 0. \end{cases}$$

In other words, the second mortgage is considered an unsecured debt for a household which has a first mortgage under water and which chooses to keep its house while filing for bankruptcy. In this case, the household starts the following period with after-bankruptcy adjusted cash-in-hand $D_{keep}(Z,s)$ and the household's current consumption is given by:

$$c = \begin{cases} \overline{y} - \delta_o - M + \max\{0, \hat{A}_{keep}(Z,s)\} + D_{keep}(Z,s) & \text{if } P(Z)h_i - (\ell_0 - M) < 0 \\ \overline{y} - \delta_o - M - b + \max\{0, \hat{A}_{keep}(Z,s)\} + D_{keep}(Z,s) & \text{if } P(Z)h_i - (\ell_0 - M) \geq 0. \end{cases}$$

where

$$D_{keep}(Z,s) + \frac{D_{keep}(Z,s)}{(1+r)} = -\min\{-\min\{0, \hat{A}_{keep}(Z,s)\}, \textit{Ability to Pay for keepers}\}.$$

To define *Ability to Pay for keepers*, let

$$\textit{Virtual Proceeds} = \max\{0, \max\{0, (1-\phi)ph_i - \ell_0 - b\} - E\}.$$

Then,

Ability to Pay for keepers

$$= \begin{cases} \textit{Virtual Proceeds} & \text{pre-bankruptcy reform} \\ \max\{\textit{Virtual Proceeds}, \max\{0, \kappa(y - y_{med})\}\} & \text{post-bankruptcy reform.} \end{cases}$$

3.7.2 Bankruptcy for Non-Owners

Beginning-of-period non-owners may only rent when they file for bankruptcy. A non-owner which chooses to rent a house of size i and file for bankruptcy will start the following period with after-bankruptcy adjusted cash-in-hand position $D_{no}(Z,s)$. In the period of bankruptcy filing, the non-owner's consumption is given by:

$$c = \overline{y} - \delta_{no} - \textit{Rent}(Z)h_i + \max\{0, a - x\} + D_{no}(Z,s),$$

where

$$D_{no}(Z,s) + \frac{D_{no}(Z,s)}{(1+r)} = -\min\{-\min\{0, a-x\}, \textit{Ability to Pay for non-owners}\},$$

and

Ability to Pay for non-owners

$$= \begin{cases} 0 & \text{pre-bankruptcy reform (Z=B)} \\ \max\{0, \kappa(y - y_{med})\} & \text{post-bankruptcy reform (Z=R)} \end{cases} .$$

3.8 Households' Choices

Households face the same choices, independently of whether the aggregate state of the economy. I next define the choices faced by a household in idiosyncratic state $\{j, \eta, a, b, \epsilon, \xi, x, \zeta, o, (\theta, i, M, \tau)\}$. If the households is of age J (oldest age), then it may only rent. A household of age J that starts the period as a homeowner hence has to sell its house at no transaction cost and rent.

Conditional on starting with a clean credit status, retired households of age $j < J$ may either rent or purchase a house when they start as non-owners, and may either stay current in their mortgage contract, or sell their houses to either rent or buy a new house when they start as homeowners. A retiree of age $j < J$ that starts a period with a flagged credit record may only rent if it starts as a non-owner, and may either stay current or sell to rent if it starts as a homeowner.

By contrast, households of working age $j < J_r$ face idiosyncratic risk and are allowed to default on credit market contracts. Their choices are specified next.

3.8.1 Choices of Homeowners of age $j < J_r$

Consider a homeowner of age $j < J_r$ in a first mortgage contract (i, M, τ, θ) with an unsecured bond holding a, a second mortgage bond b, and credit status η.

Case of the working age homeowner with $\eta = 0$:

The choices available to the clean homeowner can then be summarized as follows:

- sell the house and either rent or purchase a new house, repay all debts **(selling option)**
- repay b, $max(0, -a)$, and M **(stay current)**.
- repay $max(0, -a)$, pay only fraction $(1 - \zeta)$ of M, and default on b **(walk-away without bankruptcy filing)**
- default on b and $max(0, -a)$, and pay only fraction $(1 - \zeta)$ of M, and **(bankruptcy option for tossers)**
- repay M and b, but default on $max(0, -a)$ **(bankruptcy option for keepers)**.

In the event of a default without bankruptcy, the homeowner chooses next period unsecured bond holdings $a' \geq 0$ and second mortgage bond holdings $b' = 0$. In the event of bankruptcy filing, the face value of the next period unsecured bond a' is settled by the bankruptcy code, and next period second mortgage bond holding $b' = 0$. Because households may only borrow when they start the period with $\eta = 0$, it turns out that homeowners cannot start a period with $\eta = 1$ (given that a homeowner loses its house after a mortgage default). Neither can they start a period simultaneously with $\eta = 2$ and with second mortgage bond holdings that have a nonzero face value.

Case of the working age homeowner with $\eta = 2$:

The choices available to a flagged homeowner are as follows:

- sell the house and rent a new house, repay all debts **(selling option)**
- repay $max(0, -a)$, and M **(stay current)**
- repay $max(0, -a)$, pay only fraction $(1 - \zeta)$ of M **(walk-away without bankruptcy filing)**.

3.8.2 Choices of non-owners of age $j < J_r$

A non-owner of age $j < J_r$ starting the period with ($\eta = 1$ or $\eta = 2$) (flagged non-owners) may only rent and purchase an unsecured bond holding with face value $a' \geq 0$. A Non-owner of age $j < J_r$ starting the period with $\eta = 0$ (clean non-owners) and with an unsecured bond of face value a, may :

- repay $max(0, -a)$ and either rent or buy a house,
- or default on $max(0, -a)$ and rent during the period **(bankruptcy option for non-owers)**.

3.8.3 Involuntary Default

Households for whom all the available choices lead to an empty budget set default involuntarily. Beginning-of-period non-owners rent a house of size 1 during a period of involuntary default. In the event of an involuntary default for a homeowner, the house is sold and the homeowner must rent a house of size 1. The proceeds of the sale are used to repay the first mortgage lender, then the second mortgage lender and finally the unsecured lender. Involuntary default leads to a fresh-start in the following period as a non-owner with a bankruptcy flag and with an unsecured bond holding of face value zero.

3.9 The Tax Code

Consider a household in state $\{j, \eta, a, b, \epsilon, \xi, x, \zeta, o, (\theta, i, M, \tau)\}$ with current period wage income y. Now, let:

$$m = \begin{cases} 0 & \text{if the household rents} \\ Mortgage(i', r_m', \mathbb{1}_{\{Z=R\}}), & \text{if the household enters new contract } (i'r_m', 1, \mathbb{1}_{\{Z=R\}}) \\ 0 & \text{if } \tau > T \text{ and the household does not sell} \\ M & \text{if } \tau \leq T \text{ and the household stays current} \\ (1-\zeta)M & \text{if } \tau \leq T \text{ and default on first mortgage.} \end{cases}$$

Also, let $\bar{\ell} = \begin{cases} \ell(i, r_m, \tau, \theta) & \text{if } \tau \geq 2 \text{ and the household stays current} \\ \ell(i', r_m', 1, \mathbb{1}_{\{Z=R\}}) & \text{if the household purchases a new house.} \end{cases}$

Let $A = y + max(0, a) \times (1 - Q(j))$. Then, the household's taxable income is given by:

$$y_d = \begin{cases} A - b \times (1 - Q(j)) - r_m \times (\bar{\ell} - m) & \text{if homeowner does not sell} \\ A - b \times (1 - Q(j)) - r_{m'} \times (\bar{\ell} - m) & \text{if homeowner sells and buys} \\ A - b \times (1 - Q(j)) & \text{if homeowner sells and rents} \\ A & \text{if non-owner rents} \\ A - r_{m'} \times (\bar{\ell} - m) & \text{if non-owner buys} \end{cases}$$

where $\forall j$,

$$Q(j) = \frac{\psi_j}{1+r}.$$

A household's with taxable income y_d has after-tax income given by:

$$\bar{y} = \max(0, y_d) \times (1 - \tau_\omega),$$

where τ_ω is the economy's constant marginal tax rate. Hence, the tax code features interest-deductibility for both first and second mortgages[9].

3.10 The household's problem

I now formally define the problem of a household in idiosyncratic state $s = \{j, \eta, a, b, \epsilon, \xi, x, \zeta, o, (\theta, i, M, \tau)\}$. Let ω denote the non-stochastic component of a household's idiosyncratic state vector: $\omega = \{j, \eta, a, b, o, (\theta, i, M, \tau)\}$. As before, let the economy's aggregate state be given by Z such that $Z = B$ if housing prices are high, and $Z = R$ if housing prices are low.

Now, $\forall\ Z \in \{B, R\}$, let V_Z denote the household's value function given aggregate state Z. Let denote by s' the household's state vector in the next period. Define $\omega' = \{j', \eta', a', b', o', (\theta', i', M', \tau')\}$. $\forall \xi$, and $\forall\ Z \in \{B, R\}$. Now, for $V = (V_B, V_S)$ define operator $E_{Z|\xi}$ by:

$$\begin{cases} (E_{R|\xi}V)(\omega') = & \int V_R(s')\ d\Phi(\Delta'|\xi) \\ (E_{B|\xi}V)(\omega') = & \left[\int V_R(s')\ d\Phi(\Delta'|\xi)\right] \times (1-\gamma) + \left[\int V_B(s')\ d\Phi(\Delta'|\xi)\right] \times \gamma \end{cases}$$

where $\Delta' = (\epsilon', \xi', x', \zeta')$ and

$$d\Phi(\Delta'|\xi) = Pr(\epsilon') \times Pr(\xi'|\xi) \times Pr(x') \times Pr(\zeta').$$

$\forall\ (Z, s)$ I define $Q_u(Z, \xi, \omega')$ to be the per unit price of an unsecured bond of face value a' offered to a household with current persistent shock ξ and future non-stochastic state component ω' when the aggregate state of the economy is Z. Similarly, $Q_s(Z, \xi, \omega')$ is the per unit price of a second mortgage bond of face value b' offered to such household. In the same way, $R_m(Z, \xi, \omega')$ denotes the interest rate offered on a first mortgage contract to a household that will start the next period with future non-stochastic state component ω' when the current state of the economy is Z and the household's current persistent income

[9] Later, it is shown that given the assumption that unsecured lenders keep the positive cash-in-hand position of a deceased household, the zero-profit condition implies that for $a' > 0$, the per unit price of a cash-in-hand bond with face value a' sold to a household of age j is $Q(j+1)$. Hence, if $r_s(j)$ is the savings interest rate offered to a household of age $j-1$, then $(1 - Q(j)) = \frac{r_s(j)}{1+r_s(j)}$, so that $a \times \frac{r_s(j)}{1+r_s(j)}$ is the net interest pocketed by a household of age j starting the period with positive unsecured bond position a. Because prices on second mortgage bonds turn out to be larger than those on an unsecured bond with equal positive face value by a factor that accounts for the household's default probability, (1-Q(j)) is used as a cap on the interest-deductibility of second mortgages. This allows to capture U.S. tax incentives to borrow on second mortgage markets, without the additional burden of carrying prices of second mortgage bonds as state variables .

shock is ξ.

Let parameter $stig$ be the utility loss associated with bankruptcy filing. Also, let parameters δ_o and δ_{no} respectively be the pecuniary costs associated with bankruptcy filing when the household files after starting the period as a non-owner and when it files after starting as a homeowner. Let parameter ν denote the utility loss a household incurs when selling, or when foregoing its house either in bankruptcy or by simply walking away. ν proxies for reasons to hold onto a house that are not explicitly modeled in this paper, such as the sentimental value of one's house, or expectations of an appreciation of housing prices. I assume the expense shock value $x = 0$ when the household is a retiree.

3.10.1 Problem of an age J household

Case 1: non-owner of age j=J :

$$V_Z(s) = \max_{i' \in \{1,2,3,4\}} u(c, h_{i'}) \text{ s.t. } c = \overline{y} + a - x - Rent(Z)h_{i'}$$

Case 2: owner of age j=J :

$$V_Z(s) = \max_{i' \in \{1,2,3,4\}} u(c, h_{i'}) \text{ s.t. } c = \overline{y} + a - x - b - Rent(Z)h_{i'} + (P(Z)h_i - \ell(i, r_m, \tau, \theta))$$

3.10.2 Problem of Other Retirees

Case 1: retiree which is a clean homeowner ($\eta = 0$):

$$V_Z(s) = \max\{V_Z^{sell,rent}(s), V_Z^{sell,buy}(s), V_Z^{current}(s)\},$$

where

1.

$$\begin{aligned}
V_Z^{sell,rent}(s) &= \max_{i' \in \{1,2,3,4\}, a'} u(c, h_{i'}) + \beta\psi(j+1) \times (E_{Z|\xi}V)(\omega') - \nu \\
\text{s.t. } c &= \overline{y} + a - b - x - Q_u(Z, \xi, \omega')a' + (1 - \tau_s)P(Z)h_i - \ell_0 - Rent(Z)h_{i'} \\
\omega' &= \{j+1, 0, a', 0, 0, (0, 3, 0, 0)\} \\
\ell_0 &= \ell(i, r_m, \tau, \theta)
\end{aligned}$$

2.

$$\begin{aligned}
V_Z^{sell,buy}(s) &= \max_{i' \in \{3,4\}, a'} u(c, h_{i'}) + \beta\psi(j+1) \times (E_{Z|\xi}V)(\omega') - \nu \\
\text{s.t. } c &= \overline{y} + a - b - x - Q_u(Z,\xi,\omega')a' + (1-\tau_s)P(Z)h_i - \ell_0 - (\tau_b + \mu)P(Z)h_{i'} - m \\
\omega' &= \{j+1, 0, a', 0, 1, (\theta', i', m, 2)\} \\
\ell_0 &= \ell(i, r_m, \tau, \theta) \text{ and } m = Mortgage(i, R_m(Z,\xi,\omega'), \theta') \\
\theta' &= \mathbb{1}_{\{Z=R\}}
\end{aligned}$$

3.

$$\begin{aligned}
V_Z^{current}(s) &= \max_{a', b'} u(c, h_i) + \beta\psi(j+1) \times (E_{Z|\xi}V)(\omega') \\
\text{s.t. } c &= \overline{y} + a - b - x - Q_u(Z,\xi,\omega')a' + Q_s(Z,\xi,\omega')b' - M \\
\omega' &= \{j+1, 0, a', b', 1, (\theta, i, M, \min(\tau+1, T+1))\} \\
0 &\leq b' \leq P(Z).h_i - \ell_0
\end{aligned}$$

Case 2: retiree which is a flagged homeowner ($\eta = 2$):

$$V_Z(s) = \max\{V_Z^{sell,rent}(s), V_Z^{current}(s)\},$$

where

1.

$$\begin{aligned}
V_Z^{sell,rent}(s) &= \max_{i' \in \{1,2,3,4\}, a' \geq 0} u(c, h_{i'}) + \beta\psi(j+1) \times \big(\lambda(E_{Z|\xi}V)(\omega') + (1-\lambda)(E_{Z|\xi}V)(\hat{\omega}')\big) - \nu \\
\text{s.t. } c &= \overline{y} + a - b - x - Q_u(Z,\xi,\omega')a' + (1-\tau_s)P(Z)h_i - \ell_0 - Rent(Z)h_{i'} \\
\omega' &= \{j+1, 0, a', 0, 0, (0, 3, 0, 0)\} \\
\hat{\omega}' &= \{j+1, \eta, a', 0, 0, (0, 3, 0, 0)\} \\
\ell_0 &= \ell(i, r_m, \tau, \theta)
\end{aligned}$$

2.

$$
\begin{aligned}
V_Z^{current}(s) &= \max_{a' \geq 0} u(c, h_i) + \beta\psi(j+1) \times \big(\lambda(E_{Z|\xi}V)(\omega') + (1-\lambda)(E_{Z|\xi}V)(\hat{\omega}')\big) \\
\text{s.t. } c &= \overline{y} + a - b - x - Q_u(Z, \xi, \omega')a' - M \\
\omega' &= \{j+1, 0, a', 0, 1, (\theta, i, M, \min(\tau+1, T+1))\} \\
\hat{\omega}' &= \{j+1, \eta, a', 0, 1, (\theta, i, M, \min(\tau+1, T+1))\}
\end{aligned}
$$

Case 3: retiree which is a clean non-owner ($\eta = 0$):

$$
V_Z(s) = \max\{V_Z^{rent}(s), V_Z^{buy}(s)\},
$$

where

1.

$$
\begin{aligned}
V_Z^{rent}(s) &= \max_{i' \in \{1,2,3,4\}, a'} u(c, h_{i'}) + \beta\psi(j+1) \times (E_{Z|\xi}V)(\omega') \\
\text{s.t. } c &= \overline{y} + a - b - x - Q_u(Z, \xi, \omega')a' - Rent(Z)h_{i'} \\
\omega' &= \{j+1, 0, a', 0, 0, (0, 3, 0, 0)\}
\end{aligned}
$$

2.

$$
\begin{aligned}
V_Z^{buy}(s) &= \max_{i' \in \{3,4\}, a'} u(c, h_{i'}) + \beta\psi(j+1) \times (E_{Z|\xi}V)(\omega') \\
\text{s.t. } c &= \overline{y} + a - b - x - Q_u(Z, \xi, \omega')a' - (\tau_b + \mu)P(Z)h_{i'} - m \\
\omega' &= \{j+1, 0, a', 0, 1, (\theta', i', m, 2)\} \\
m &= Mortgage(i, R_m(Z, \xi, \omega'), \theta') \\
\theta' &= \mathbb{1}_{\{Z=R\}}.
\end{aligned}
$$

Case 4: retiree which is a flagged non-owner ($\eta = 1$ **or** $\eta = 2$):

$$
V_Z(s) = V_Z^{rent}(s),
$$

where

$$
\begin{aligned}
V_Z^{rent}(s) &= \max_{i' \in \{1,2,3,4\}, a' \geq 0} u(c, h_{i'}) + \beta\psi(j+1) \times \big(\lambda(E_{Z|\xi}V)(\omega') + (1-\lambda)(E_{Z|\xi}V)(\hat{\omega}')\big) \\
\text{s.t. } c &= \overline{y} + a - b - x - Q_u(Z, \xi, \omega')a' - Rent(Z)h_{i'} \\
\omega' &= \{j+1, 0, a', 0, 0, (0, 3, 0, 0)\} \\
\hat{\omega}' &= \{j+1, \eta, a', 0, 0, (0, 3, 0, 0)\}.
\end{aligned}
$$

3.10.3 Problem of Working Age households

Case 1: Working age household which is a clean homeowner ($\eta = 0$):

$$
V_Z(s) = \max\{V_Z^{sell,rent}(s), V_Z^{sell,buy}(s), V_Z^{current}(s), V_Z^{walk}, V_Z^{bk,toss}, V_Z^{bk,keep}\},
$$

where $V_Z^{sell,rent}(s)$, $V_Z^{sell,buy}(s)$, and $V_Z^{current}(s)$ are similar as in the retiree case, and

1.

$$
\begin{aligned}
V_Z^{walk}(s) &= \max_{a' \geq 0} u(c, h_{i'}) + \beta\psi(j+1) \times (E_{Z|\xi}V)(\omega') - \nu \\
\text{s.t. } c &= \overline{y} + a - x - Q_u(Z, \xi, \omega')a' - (1-\zeta)M + B \\
B &= (\mathbb{1}_{\{R_c=1\}} \times A + \mathbb{1}_{\{R_c=0\}} \times max(0, A)) \\
A &= \frac{E(P)(1-\phi)h_i}{1+r} - (\ell_0 - (1-\zeta)M) - b \\
\ell_0 &= \ell(i, r_m, \tau, \theta) \\
\omega' &= \{j+1, 1, a', 0, 0, (0, 3, 0, 0)\}
\end{aligned}
$$

2.

$$
\begin{aligned}
V_Z^{bk,toss}(s) &= u(c,h_{i'}) + \beta\psi(j+1)\times(E_{Z|\xi}V)(\omega') - stig - \nu \\
\text{s.t. } c &= \overline{y} - (1-\zeta)M(i,r_m) + (H_e + a_{new} + D_{toss}(R_c,Z,s) - \delta_o \\
a_{new} &= \max\{0, \hat{A}_{toss}(R_c,Z,s) + H_n\} \\
\ell_0 &= \ell(i,r_m,\tau,\theta) \\
H &= \max\{0, (\frac{(1-\phi).E(p)h_i}{1+r} - (\ell_0 - (1-\zeta)M(i,r_m)) - b)\} \\
H_e &= \min\{E,H\} \\
H_n &= H - H_e \\
a' &= D_{toss}(R_c,Z,s) \\
\omega' &= \{j+1, 2, a', 0, 0, (0,3,0,0)\}
\end{aligned}
$$

3.

$$
\begin{aligned}
V_Z^{bk,keep}(s) &= u(c,h_{i'}) + \beta\psi(j+1)\times(E_{Z|\xi}V)(\omega') - stig \\
\text{s.t. } c &= \overline{y} - M + a_{new} - \delta_o \quad \text{if} \quad P(Z)h_i - (\ell_0 + b) < 0 \\
c &= \overline{y} - M - b + a_{new} - \delta_o \quad \text{if} \quad P(Z)h_i - (\ell_0 + b) \geq 0 \\
a_{new} &= \max\{0, \hat{A}_{keep}(R_c,Z,s)\} + D_{keep}(R_c,Z,s) \\
\ell_0 &= \ell(i,r_m,\tau,\theta) \\
a' &= D_{keep}(R_c,Z,s) \\
\omega' &= \{j+1, 2, a', 0, 1, (\theta, i, M, \min(\tau+1, T+1))\}
\end{aligned}
$$

$\hat{A}_{toss}(R_c,Z,s)$ and $\hat{A}_{keep}(R_c,Z,s)$ respectively are the before-bankruptcy adjusted cash-in-hand position as defined in section 3.7, for the cases when the household chooses to toss its house out and when it chooses to keep it. Similarly, $D_{toss}(R_c,Z,s)$ and $D_{toss}(R_c,Z,s)$ respectively are the after-bankruptcy adjusted cash-in-hand positions of the household if it chooses to toss or save its house in bankruptcy, as defined in section 3.7.

Case 2: Working Age household which is a flagged homeowner ($\eta = 2$):

$$V_Z(s) = \max\{V_Z^{sell,rent}(s), V_Z^{current}(s), V_Z^{walk}(s)\},$$

with $V_Z^{sell,rent}$, $V_Z^{current}$ as defined earlier, and with V_Z^{walk} for $\eta = 2$ defined as:

$$\begin{aligned}
V_Z^{walk}(s) &= \max_{a' \geq 0} u(c, h_{i'}) + \beta\psi(j+1) \times (E_{Z|\xi}V)(\omega') - \nu \\
\text{s.t. } c &= \overline{y} + a - x - Q_u(Z, \xi, \omega')a' - (1-\zeta)M + B \\
B &= (\mathbb{1}_{\{R_c=1\}} \times A + \mathbb{1}_{\{R_c=0\}} \times max(0, A)) \\
A &= \frac{E(P)(1-\phi)h_i}{1+r} - (\ell_0 - (1-\zeta)M) - b \\
\ell_0 &= \ell(i, r_m, \tau, \theta) \\
\omega' &= \{j+1, 2, a', 0, 0, (0, 3, 0, 0)\}
\end{aligned}$$

Note that a household would not start as a homeowner with $\eta = 1$. This is so because $\eta = 1$ in the current period implies that the household defaulted on mortgages in the previous period and did not file for bankruptcy to discharge unsecured debts. However, when a household defaults on mortgages but not on unsecured debts, it is assumed that the household loses its house at the end of the period and starts the following period as a non-owner.

Case 3: Working age household which is a clean non-owner ($\eta = 0$):

$$V_Z(s) = \max\{V_Z^{rent}(s), V_Z^{buy}(s), V_Z^{def}(s)\},$$

where V_Z^{rent} and $V_Z^{buy}(s)$ where defined earlier, and

$$\begin{aligned}
V_Z^{def}(s) &= \max_{i' \in \{1,2,3,4\}, a' \geq 0} u(c, h_{i'}) + \beta\psi(j+1) \times (E_{Z|\xi}V)(\omega') - stig \\
\text{s.t. } c &= \overline{y} + a - x - Rent(Z)h_{i'} + D_{no}(Z, s) - \delta_{no} \\
a' &= D_{no}(Z, s) \\
\omega' &= \{j+1, 2, a', 0, 0, (0, 3, 0, 0)\}.
\end{aligned}$$

In the above equation, $D_{no}(s)$ is the after-bankruptcy adjusted cash-in-hand position of a non-owner in bankruptcy as defined in section 3.7.

Case 4: Working age household which is a flagged non-owner ($\eta = 1$ **or** $\eta = 2$):

$$V_Z(s) = V_Z^{rent}(s),$$

where V_Z^{rent} was defined in the retiree case.

3.10.4 Problem of an involuntary defaulter

Case 1: The involuntary defaulter is a non-owner

$$\begin{aligned} V_Z(s) &= u(c, h_1) + \beta\psi(j+1) \times (E_{Z|\xi}V)(\omega') - stig \\ \text{s.t. } c &= \overline{y} - Rent(Z)h_1 \\ \omega' &= \{j+1, 2, a', 0, 0, (0, 3, 0, 0)\}. \end{aligned}$$

Case 2: The involuntary defaulter is a homeowner

When a homeowner goes through involuntary default, its house is sold at the beginning of the period. However, its before-bankruptcy cash-in-hand position is adjusted in a similar way as for households which choose to toss their houses when filing for bankruptcy. Involuntary defaulters start the following period with an unsecured bond of face value equal to zero. Specifically, let a_1 and a_2 equal the negatives of the mortgage debts still owed to the first and second mortgage lenders after exhaustion of the expected discounted sale proceeds following an involuntary default in a recourse world:

Then, let

$$\begin{cases} a_1 &= \min\{0, (1-\phi)P(Z)h_i - \ell_0\} \\ a_2 &= \min\{0, \max\{0, (1-\phi)P(Z)h_i - \ell_0\} - b\}. \end{cases}$$

Then, let

$$\hat{a} = \begin{cases} a - x & \text{if } R_c = 0 \\ a - x + a_1 + a_2 & \text{if } R_c = 1. \end{cases}$$

The value function of an involuntary defaulter which is a homeowner is then given by:

$$
\begin{aligned}
V_Z(s) &= u(c,h_1)+\beta\psi(j+1)\times(E_{Z|\xi}V)(\omega')-stig\\
\text{s.t. } c &= \overline{y}-Rent(Z)h_1+H_e+a_{new}\\
a_{new} &= \max\{0,\hat{a}+H_n\}\\
H &= \max\{0,((1-\phi)P(Z)h_i-\ell_0-b)\}\\
\ell_0 &= \ell(i,r_m,\tau,\theta), H_e=\min\{E,H\}, H_n=H-H_e, \text{ and } a'=0\\
\omega' &= \{j+1,2,a',0,0,(0,3,0,0)\}
\end{aligned}
$$

3.11 Profit Functions of Lenders

If the household starts the period as a homeowner, let $W_{m_1,Z}(s)$ denote the expected discounted flows to the first mortgage lender which has loaned to the household and let $W_{m_2,Z}(s)$ denote the expected discounted flows to the second mortgage lender. Let $W_{u,Z}(s)$ denote the expected discounted flows to the unsecured lender from whom the household has purchased its current unsecured bond. Finally, let $W_{m_1}=(W_{m_1,B},W_{m_1,R})$, $W_{m_2}=(W_{m_2,B},W_{m_2,R})$, and $W_u=(W_{u,B},W_{u,R})$. $W_{m_1,Z}$, $W_{m_1,Z}$, and $W_{m_1,Z}$ are derived in the appendix. Let $\Omega'(Z,s)$ be the household's choice for tomorrow's non-stochastic component of the individual's state vector given current state (Z,s). Finally, let $g_b(\Omega'(Z,s))$ and $g_a(\Omega'(Z,s))$ respectively be the face values of the second mortgage and unsecured bonds associated with $\Omega'(Z,s)$. Then, expected profits to a first mortgage lender on a first mortgage contract $(i',R_m(Z,\xi,\Omega'(Z,s)),1,\mathbb{1}_{\{Z=R\}})$ offered to a household in state (Z,s) that will start tomorrow with a non-stochastic state component $\Omega'(Z,s)$ are given by:

$$
\Pi_{m_1}(Z,\xi,\Omega'(Z,s)) = -(1-\mu)P(Z)h_{i'}+\text{Mortgage}(i',R_m(Z,\xi,\Omega'(Z,s)),\mathbb{1}_{\{Z=R\}}) + \frac{(E_{Z|\xi}W_{m_1})(\Omega'(Z,s))}{1+r}.
$$

Expected profits to a second mortgage lender which lends at per unit price $Q_s(Z,\xi,\Omega'(Z,s))$ to a household that will start the following period with a non-stochastic state component $\Omega'(Z,s)$ are given by:

$$
\Pi_{m_2}(Z,\xi,\Omega'(Z,s)) = -Q_s(Z,\xi,\Omega'(Z,s))\times g_b(\Omega'(Z,s))+\frac{(E_{Z|\xi}Wm_2)(\Omega'(Z,s))}{1+r}.
$$

Expected profits to an unsecured lender which lends at per unit price $Q_u(Z, \xi, \Omega'(Z, s))$ to a household that will start the following period with a non-stochastic state component $\Omega'(Z, s)$ are given by:

$$\Pi_u(Z, \xi, \Omega'(Z, s)) = Q_u(Z, \xi, \Omega'(Z, s)) \times g_a(\Omega'(Z, s)) + \psi_{j+1} \frac{(E_{Z|\xi} Wu)(\Omega'(Z, s))}{1 + r}.$$

3.12 Equilibrium Conditions

The economy is in equilibrium when:

1. Households optimize

2. The rental agency makes zero expected profits:

$$\begin{cases} Rent(R) = P(R) \times \frac{r}{1+r} \\ Rent(B) = P(B) \times \frac{\gamma+r}{1+r} - P(R) \times \frac{\gamma}{1+r} \end{cases}$$

3. Pricing functions R_m,Q_s, and Q_u are such that first and second mortgage lenders and unsecured lenders make zero expected profits on each loan offered

An equilibrium is a steady state equilibrium if there is a zero mass of beginning-of-period homeowners in state s with $\theta \neq \mathbb{1}_{\{Z=R\}}$. In the rest of the paper, I study steady state boom equilibria which are steady state equilibria with $Z = B$ such that after having started with high housing prices, the economy remains an economy of high housing prices in spite of agents' expectations for a potential fall of housing prices. In this sense, a steady-state equilibrium will be understood as an equilibrium in which housing prices are high and all beginning-of-period homeowners have purchased their houses at a time of high housing prices.

4 Calibration

Birth age and retirement age respectively correspond to real world ages of 25 and 64. Households die with certainty at age $J = 79$. Survival probabilities $\{\psi_j\}_{j=2,\cdots,J}$ are derived from the 2000 United States Life Tables 2000 from the National Center for Health Statistics. The functional form of households' utility function of households is given by:

$$u(c,h) = \frac{\left(c^{\mu}\left(\left(1+\varpi \times \mathbb{1}_{\{o=1\}}\right)\times h\right)^{1-\mu}\right)^{1-\sigma}}{1-\sigma},$$

where ϖ denotes the homeownership premium.

The weighted average of the ratio (homestead exemption/state's 2002 median income) among U.S states is 1.81. I match this number by setting the amount of homestead exemption E equal to 1.81 $\times$ median income. The foreclosure discount rate ϕ is set to 0.25, so that houses in foreclosure sale for about 25% of their values. Campbell, Giglio, and Pathak (2011) documents that the foreclosure discount rate was on average 27% in the period 1987-2009 for houses located in the state of Massachusetts. Using a nationally broader dataset of single-family 30-year fixed rate mortgages originated between 1995 and 1999 combined with the Office of Federal Housing Enterprise Oversight (OFHEO) repeat sales index, Pennington-Cross (2006) finds that foreclosed properties appreciate on average 22% less than the metropolitan area average appreciation rate. I hence target a foreclosure discount rate of 25% which is the average of the discount rates found in the two studies.

The model period corresponds to 3 years. A first mortgage contract hence lasts for at most $T = 10$ periods (or 30 years). The average downpayment μ is set equal to 0.23, which is the average downpayment on fixed interest residential first mortgage contracts over the period 2002-2004 obtained from the LPS Applied Analytics's database. Following Livshits, Macgee & Tertilit (2008), the annual risk-free rate is set equal to the 4% average return on capital reported by McGrattan and Prescott (2000). Housing transaction costs τ_b and τ_s are taken from Sommer et al. (2010) and are set as $\tau_b = 0.025$ and $\tau_s = 0.07$.

The probability λ of a reversal of bad credit into good credit is set to 0.3, so that the average duration $\frac{1}{\lambda}$ of a bankruptcy flag on a household's credit record is 10 years, or $\frac{10}{3}$ model period. Given a model period of 3 years, fraction κ of disposable income (disposable income is defined as the difference between wage income and average income) assigned to the repayment of unsecured debts in bankruptcy in the post-reform world is set equal to 1.67, so that after the bankruptcy reform unsecured creditors may be repaid by as much as 5 times the difference between the household's annual income and the annual median income.

In the great recession world, The fraction of a period mortgage payment that a household may default upon is set as $\zeta_0 = 0.4$ in the non-recourse world and $\zeta_1 = 0.53$ in the recourse world. Given a model period of 3 years, this is equivalent to about 440 days and 580 days of free-rent in the event of a default in non-recourse and recourse worlds, respectively (these are the median number of days of free-rent in the period 2007-2009 in non-recourse and recourse states respectively). In the steady-state world, both ζ_0 and ζ_1 are set equal to 0.3, which is equivalent to 330 days of free-rent (median number of days of free-rent in the period 2002-2004 in both recourse and non-recourse states).

All remaining parameters are set to match moments of the U.S. economy before 2004, except for the probability γ of a fall in housing prices, probabilities of housing luck p_{ζ_0} and p_{ζ_1}, and the attachment parameter ν which are chosen to match moments of the U.S. economy in 2009. Specifically, p_{ζ_0} and p_{ζ_1} (probabilities that a household obtains free-rent when defaulting in non-recourse and recourse worlds) are chosen such that during the transition following the shock to housing prices, about 50% of households that default on mortgages partially rent for free. This implies a median of 440 and 580 days of free-rent in the non-recourse and recourse worlds, which is consist with the findings of the empirical section.

γ is chosen to match the proportion of residential properties with negative home equity that in absolute value amounted between 5% and 25% of the market value of the house at the end of 2009 among residential properties that secured a positive mortgage debt. ν is chosen to match the foreclosure rate among residential properties that at the end of 2009 implied an amount of negative home equity that in absolute value amounted to less than 5% of the market value of the house. According to the Corelogic Report on Negative Equity for the fourth quarter of 2009, 13% of residential properties had negative home equity that in absolute value amounted between 5% and 25% of the house value, and the pre-foreclosure rate among residential properties associated with negative home equity that in absolute value amounted to less than 5% of house value was 3%. Assuming that most pre-foreclosures are cured when negative home equity equity is larger than 5% of the value of the house, I target a foreclosure rate of 1% on houses with negative home equity equity which is larger than 5% of the value of the house.

The strategy is to choose γ and ν such that when the economy is shocked with a 26% fall in housing prices combined with a completely unanticipated downward shift of the labor productivity age profile and a completely unanticipated introduction of the new bankruptcy code, about 13% of homeowners with a positive loan-to-value ratio have negative home equity that in absolute value amounted between 5% and 25% of the house value, and such that the foreclosure rate is about 1% among homeowners with negative home equity which is larger than 5% of the value of the house.

Filing costs δ_{no} and δ_o and $stig$ are chosen to match the total bankruptcy rate, the bankruptcy rate among households aged between 25 and 29 in bankruptcy, and the proportion of homeowners in bankruptcy. Sullivan, Warren, and Westbrook (2000) document from a 1991 consumer bankruptcy survey that the bankruptcy filing rate among households with heads aged between 25 and 29 in bankruptcy was 0.62% in 1991, which corresponds to a 3-annual rate of 1.86%. In the same study, they find that about 50% of bankrupts where homeowners at the time of bankruptcy filing, with a quarter of them having negative home equity at the time of filing. Given that homeowners in the steady-state of the model may not have negative home equity, I target a fraction of homeowners in bankruptcy equal to $50\% \times 75\% = 38\%$ in the steady state. Bankruptcy statistics from the U.S. districts courts show that the three year bankruptcy rate over the period 2002-2004 was 2.24%. After removing the 25% of homeowners assumed to have entered bankruptcy with negative home equity between 2002 and 2004, this gives a target of 1.97% for the total bankruptcy rate in the steady state.

The Income Process

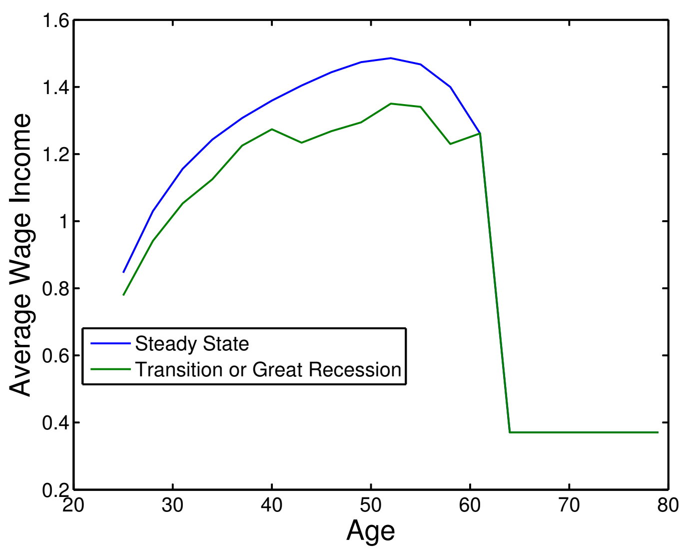

Figure 1: Labor Efficiency Profile $\{\vartheta_j\}_{j=1,\cdots,J_r}$

The autocorrolelation coefficient ρ and the variance σ_v^2 of persistent shock ξ have tri-annual values of 0.863 and 0.363, respectively, which correspond to the respective annual [10] values of 0.95 and 0.168 reported by Storesletten, Telmer & Yaron (2004). The variance σ_ϵ^2 of the transitory income shock ϵ has its tri-annual value set equal to 0.765, which corresponds to the annual value of 0.255 reported by Storesletten, Telmer & Yaron (2004).

[10] if ρ_1 and $\sigma_{v,1}^2$ are used to denote annual values, then tri-annual values are obtained as $\rho = \rho_1^3$ and $\sigma_v^2 = \sigma_{v,1}^2(\rho_1^4 + \rho_1^2 + 1)$. The tri-annual variance of the transitory income shock is found in a similar way.

For retirement's income, $Pens$ and ς are set equal to 0.05 and 0.33 so that the ratio of the average pension of retirees over the average wage income, and the ratio of the standard deviation of pension income over average wage income are 0.37 and 0.27 respectively, as found from the CPS data for the period 2002-2004. The persistent and transitory income processes are discredited into 5 and 3-state Markov Process, respectively, using the Method of Tauchen (1986) as described in Adda and Cooper (2003).

The Expense Shock Process

The expense shock process is derived from the estimations of Livshits, Macgee & Tertilit (2008) for the period 1996-1997. They estimate a tri-annual divorce probability of 3.73% and a proportion 1.5% of unplanned pregnancy over a three year period. They determine the value of a divorce shock and of an unplanned pregnancy over three years to be $36,558 and $24,000 respectively. These two shocks assumed independent amount to a probability 5.23% of a $32956 expense shock. Following Livshits, Macgee & Tertilit (2008), I combine these two shocks with their estimated proportion 1.874% of households that received a medical shock of a magnitude close to $32956 or 0.26 × three year average wage income over their period of study. [11] This gives an estimate $p_\chi = 0.071$ for the expense shock probability, and $\chi = 0.26$ for the size of the expense shock, after normalizing average wage income to 1.

Parameter values are summarized in Tables 5 and 6. Table 5 summarizes independently determined parameters, while Table 6 summarizes jointly determined parameters and displays the calibration targets.

5 Results

5.1 Steady State in the Non-Recourse World

In the steady-state of the model's non recourse world, 39% of homeowners own a small size property (property of size 3) and the remaining 61% own a large size property (property of size 4). Homeownership rates by age are depicted in figure 2 for both the model's non-recourse world and the U.S. economy in 2002.

In the steady-state of the model's non recourse world, the proportion of households which file for bankruptcy and choose to keep their houses is 0.35%, compared to a three year rate of

[11] Using the 1996 and 1997 waves of the Medical Expenditure Panel Survey and aggregate data from the US Health Care Financing Administration, Livshits, Macgee & Tertilit (2008) estimate that over the period 1996-1997, 1.874% of households receive a medical expense shock of a magnitude close to $32956.

downpayment	23%
annual risk-free saving rate	4%
Mortg.default Fraction ζ_0 for $(R^c = 0)$	0.40
Mortg. default Fraction ζ_1 for $(R^c = 1)$	0.53
expense shock χ	0.26 Units
Annual Prob. of positive expense shock p_χ	0.023
Transaction cost on selling	7%
Transaction cost on buying	2.5%
Probability λ	0.3
σ	2
κ (post-reform fraction of disposable income assigned to repay unsecured debts in bankruptcy)	1.67
Foreclosure discount rate ϕ	0.25
Homestead Exemption E	0.69

Table 5: Parameters Independently Determined

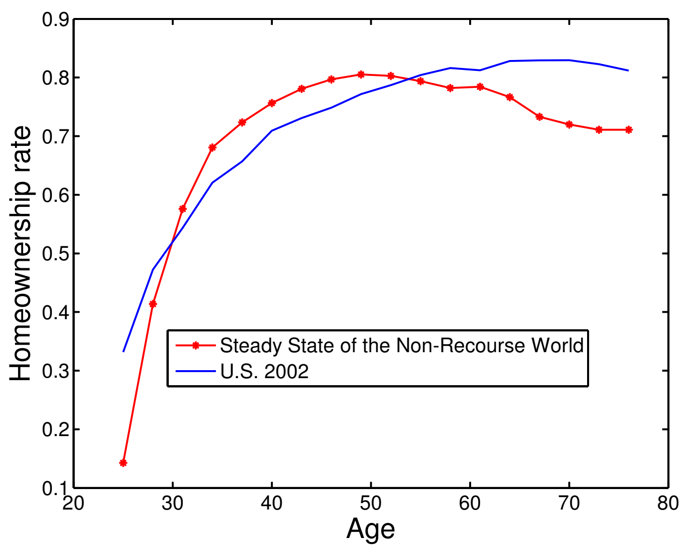

Figure 2: Homeownership Rates: Steady-State of the Non-Recourse World and U.S. Data

0.64% for Chapter 13 filers in the U.S. between 2002 and 2004. 47% of bankrupt homeowners choose to keep their houses when filing for bankruptcy. The foreclosure rate is defined as the proportion of households with a positive loan-to-value ratio which choose to either walk away from their houses or which choose to abandon their houses while filing for bankruptcy. Homeowners which choose to go through foreclosure in the steady state are only those that own a small size property. In the steady state. the foreclosure rate equals 0.33%, with all

Parameter	Data Target	Data Value	Model Value
annual $\beta = 0.89$	Negative Networth/GDP	7.97%	7.18%
$\mu = 0.77$	Housing share of expenditures	19%	20%
Tax rate $\tau_\omega = 18\%$	Government Expenditure/Output	19%	20%
$A = 0.6$	Avg. Loan at Orig.	0.95 units[12]	0.93
$p_{\zeta_0} = 0.33$	Proportion in foreclosure with at least 440 days of free-rent	0.5	0.46
$p_{\zeta_1} = 0.43$	Proportion in foreclosure with at least 580 days of free-rent	0.5	0.54
$h_1 = 0.001$	Proportion living in shelter	1%	1.2%
$h_2 = 0.16$	(Rent/Inc) for those below 30th percentile	40%	41%
$h_3 = 0.5$	Ownership rate for workers	65%	68%
$h_4 = 1$	Owners'housing share of expenditures	17.7%	18%
Ownership $prem = 1.06$	Ownership rate	70%	69%
Filing Cost $\delta_{no} = 0.09$	Bankruptcy rate	1.97%	1.4%
Filing Cost $\delta_o = 0.05$	Bankruptcy rate for age 25-28	1.81%	2.3%
utility cost stig = 5	Proportion of homeowners in bankruptcy	38%	31%
attachment cost $\nu = 0.1$	Foreclosure rate among those with negative home equity $> -5\%$	1%	0.97%
Prob. of price fall $\gamma = 0\%$	Prop. with negative home equity in $[-25\%, -5\%]$ during Transition	13%	11.15%

Table 6: Parameters Jointly Determined

foreclosures being associated small size properties and with bankruptcy filing. Foreclosure in the steady state only occurs jointly with bankruptcy because in the steady state, home equity is necessarily positive and households do not choose to simply walk away from their houses. In the data, the three year period foreclosure rate for non-recourse states is 0.66% for the period 2002-2004.

In the steady state of the non-recourse world, 17% of households borrow on the unsecured market, and the average unsecured debt is 10% of the model economy's average wage income. The fractions borrowing on the unsecured credit market are 25% for households living as renters, 10.6% for households living as homeowners and 10.78% for home buyers. The ratio (average unsecured debts/economy's average wage income) is 11%, 6.4%, 17%, and 26%

for renters, for current period owners, and for home buyers. 29% of homeowners aged less than 64 have a second mortgage loan, and the average second mortgage loan is 8.9% of the economy's average wage income. The average loan-to-value ratio is 60% among homeowners with a positive loan-to-value ratio. The average income of bankrupt households which start the period as homeowners almost equals the economy's median income, while the average income of bankrupt households starting the period as non-owners is significantly lower and equals 40% of the median income.

5.2 Steady State in the Recourse World

Given the calibrated parameters, there is virtually no difference between the steady states of the recourse and non-recourse worlds. The only difference worth noting is an average second mortgage debt among households of a working age that is slightly higher in the recourse world: 8.9% of the average wage income of the economy in the non-recourse world, versus 9.61% in the recourse world. This is explained by the fact that given $\gamma = 0$ as calibrated, and given that the foreclosure discount parameter $\phi = 0.25$ that is not too much larger than the downpayment $\mu = 0.23$, first mortgages carry virtually no premium in the steady state. However, second mortgage loans which are repaid only in second priority in the event of a foreclosure carry a larger premium than first mortgages, and the premium on second mortgages is even higher in the non-recourse world in which mortgage lenders are only repaid from proceeds of foreclosure sale. For this reason, households in the recourse world tend to borrow more significantly on the second mortgage markets relative to households in the non-recourse world. In the steady-state, the homeownership rates and all other relevant statistics in the recourse and non-recourse worlds are virtually equal.

5.3 Transition Analysis

The quantitative experiment carried next aims at assessing the impact of the 2005 bankruptcy reform law on the foreclosure crisis once housing prices started to fall in 2007. The experiment is carried over in two steps in both the recourse and non-recourse model' artificial worlds. First, four permanent features are added to the steady-state to define the post-reform transition world: a 26% drop of housing prices, a 10% downward shift of the labor efficiency profile as shown in figure 1, a lengthening of the foreclosure process through an increase of the median number of days of free-rent in foreclosure (from 330 days to 440 days for the non-recourse world and from 330 days to 580 days for the recourse world), and a shift to the new bankruptcy code. In other words, the model's world is permanently changed to a new world where housing prices are lower, earnings are lower, the foreclosure process is longer, the bankruptcy code looks like the U.S. bankruptcy code after October 2005, and things are expected to remain as such. Afterward in a second step, the pre-reform transition world is studied. The pre-reform transition differs from the post-reform transition world in that it uses the old bankruptcy code and hence only has three features that differentiates it from the steady-state world: lower housing prices, lower earnings and a lengthier foreclosure process. The strategy is then to compare the outcomes of the pre-reform and post-reform transition economies in order to conclude on the impact of the bankruptcy reform on the foreclosure crisis during the transition implied by the great recession.

5.3.1 Transition Analysis of The Non-Recourse World

Transition Results in The Non-Recourse Post-Reform World

For the non-recourse case , the model predicts a foreclosure rate of 1.67% during the first period of transition into the great recession world with the new bankruptcy code . This amounts to 89% of the average foreclosure rate of 1.88% observed among U.S. non-recourse states for the period 2007-2009, as documented in the empirical section for U.S. states in Subgroup 2. In the model, 77% of foreclosures in the transition occur among owners of small size properties, and the remaining 23% among those of large size properties. Foreclosures occur mainly among younger and poorer households. Predicted foreclosure rates by homeowners' ages are depicted in figure 3 for owners of small and large size properties aged less than 52. For owners of small properties, the age-specific foreclosure rate picks up from 2.16% at age 55 to 3.18% at age 58 before gradually falling and staying at zero after age 64. In the case of owners of large properties, the age specific foreclosure rate picks up from 0.68% at age 55 to 0.94% at age 61, then falls and remains at zero after age 64. During the transition after the fall of housing prices in the model, foreclosure rates pick up for homeowners that are close to retirement age as households rush through foreclosure before retiring whenever necessary, given that they are no longer allowed to default once they retire[13].

During the first period of transition, the proportion of homeowners which simultaneously

[13]Not allowing households to default after retirement helps to prevent them from accumulating debt excessively with the goal in mind to default at the end of their lives. This assumption is theoretically compelling and is also not inconsistent with the data, given that foreclosures and bankruptcy filings tend to be concentrated among young households (Sullivan, Warren, Westbrook (2000) document from their 1991 Consumer Bankruptcy Project that only 3% of bankruptcy filings occurred among households with heads above 65.)

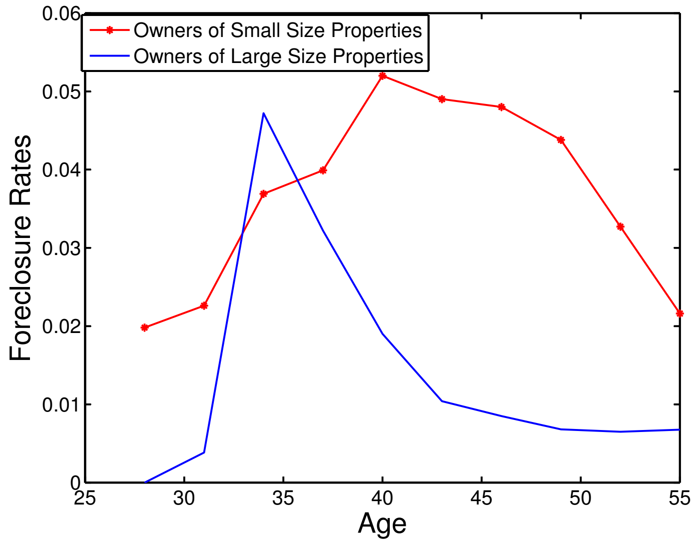

Figure 3: Foreclosure Rates: Steady-State of the Non-Recourse World

go through bankruptcy and foreclosure appears over predicted. This proportion is 51% for the model's non-recourse world, while from the LPS Applied Analytics's database, only 22% of residential fixed rate mortgages associated with a foreclosure start had also been in bankruptcy within a three year period of the foreclosure start date.[14] In the model's first period of transition, the average wage income and the average face value of unsecured bonds for beginning of period homeowners are respectively 1.19 and 1.73 times the average wage income of the steady-state economy used as numeraire in both the stead-state and transition worlds. Homeowners are hence both both income richer and wealth richer than non-owners. Yet, in the first period of transition in the model, the average wage income of homeowners which file for bankruptcy and choose to keep their houses equals 35% of the average income of the steady-state economy, while in the steady-state world, it amounts to 56% of the average income of the steady state economy. Hence, in the post-reform great recession world compared to the steady state world, households that use bankruptcy to discharge their unsecured debts while maintaining their ownership status are poorer. This happens because in the post-reform great recession world, incomes are lower and the bankruptcy code is less generous to indebted households with high earnings. The proportion of homeowners which choose to file for bankruptcy and to keep their homes when doing so increases slightly from 0.35%

[14]The proportion of 22% is for all fixed rate residential loans that were involved in a foreclosure start during the period 1992-2012. It would be interesting to recalculate it while restricting to loans that entered into foreclosure sometime between the period 2007-2009. The proportion might be larger because households' credit card balances have only increased over time.

in the steady-state world to 0.44% in the post-reform great recession world. This happens essentially because in the great recession world, earnings are lower. In fact, one could expect more households to be induced to choose to file for bankruptcy while keeping their homes, given that in bankruptcy, homeowners discharge second mortgage debts in the similar way that they discharge unsecured debts whenever their first mortgages are under water and they choose to keep their houses after bankruptcy. However, in the model's transition period, homeowners do not often use this additional arm, as it turns out that all homeowners which file for bankruptcy and keep their homes are homeowners that at the time of filing had positive home equity. The reason behind this result is twofold. First, only few homeowners have their first mortgage under water during the transition period, given the initial 23% downpayment and the comparable 26% fall of housing prices. Second, given that the reform makes bankruptcy less generous to indebted high earners, this option is relevant only to homeowners with simultaneously low earnings and large debts.

The model predicts that not all households with negative home equity choose the foreclosure option during the transition period. In fact, in the model, 0.8% of homeowners find themselves with negative home equity that in absolute value is less than 5% of the value of the house; 4.25% find themselves with negative home equity that amounts between −10% and −5% of the house value, while 6.1% of households find themselves with negative home equity that amounts between −25% and −10% of the house value; and no household has negative home equity below −25% of the house value. Yet, 0.97% of homeowners with negative home equity that in absolute value amounts to less than 5% of the house value go through foreclosure; while 5% of homeowners with negative home equity between −10% and −5% of the house value choose the foreclosure option, and 13% of homeowners with negative home equity between −25% and −10% of the house value choose it. In fact, 76% of homeowners faced with negative home equity choose to continue to make mortgage payments and maintain their ownership status, while 5% choose to sell their homes and use out-of-pocket cash to compensate for the unpaid mortgage balance.

5.3.2 Comparing Transition in the Non-Recourse Pre and Post-Reform Worlds

Table 7 summarizes results for the transition non-recourse economy in the pre and post-bankruptcy reform cases. The unit of measure in the table is the average wage income of the steady state economy. Bankrupt tossers are referred to as the homeowners which jointly choose foreclosure and bankruptcy. Bankrupt keepers are homeowners which choose to file for bankruptcy and choose to keep their homes. Walkers are homeowners which walk away from their homes and do not file for bankruptcy. Current homeowners are homeowners which choose to continue to make mortgage payments in order to maintain ownership of their homes. In the table, cash-in-hand for a household is defined as $a - x$, where a is the face value of the beginning-of-period unsecured bond, and x is the size of the expense shock drawn at the beginning of the period.

Key findings are as follows. The reform led to a foreclosure rate that is 0.24 percentage points higher in the transition non-recourse world. There is no significant difference in the foreclosure rate for large size properties between the pre-reform transition world and the post-reform transition world. However, in the case of small size properties, the foreclosure rate in the pre-reform transition economy is 0.54 points higher compared to its level in the post-reform economy.

By reducing the amount of unsecured debts dischargeable for high income earners, the reform in the transition economy also leads to fewer homeowners choosing to file for bankruptcy while keeping their homes. In fact, in the pre-reform transition economy, 0.72% of homeowners choose this option, compared to 0.44% in the post-reform transition economy. However, in the post-reform economy, households which in the pre-reform economy would have chosen to become bankrupt keepers do not choose to walk away from their houses and stay burdened with large unsecured debts once bankruptcy becomes less generous to them. Instead, they prefer to either sell their homes or to remain current in their mortgage contracts. This is so because homeowners which choose to become bankrupt keepers usually have significant home equity that they try to hold onto. When bankruptcy becomes less generous to them, they prefer to either sell or keep current, rather than walking away, especially that bankruptcy becomes less generous only when they are also high income earners. This is the sense in which foreclosure is not the next best alternative when keeping one's house while discharging unsecured debts in bankruptcy becomes less effective because of the bankruptcy reform.

In the transition economy, the foreclosure rate is higher in the absence of the reform because given the reform, income rich homeowners that are unable to discharge significant unsecured debts in bankruptcy prefer to maintain a good credit status by avoiding a foreclosure whenever their home equity is not too negative. In fact, had these households decided that bankruptcy is not favorable because of the reform and had they chosen the foreclosure option instead, they would find themselves trapped simultaneously with large unsecured debts and bad credit. The opportunity cost of such action would be a restriction to credit markets which dampens their ability to smooth consumption by taking advantage of reform-induced lower interest rates in unsecured markets in the adverse event of bad income or expense shocks realizations. In the post-reform world relative to the pre-reform world, it hence takes home equity equity to be more significantly negative to induce income rich homeowners to walk away from their homes when they are unable to simultaneously discharge unsecured debts in bankruptcy. Because owners of small size properties are usually poorer and more indebted in unsecured markets than owners of large size properties, it turns out that small property owners are the most affected by the mechanism described. This explains why the effect of the reform on the foreclosure rate is more significant for small property owners.

	Post-Reform	Pre-Reform
Foreclosure rate	1.67%	1.91%
Foreclosure among owners of small size properties	2.86%	3.4%
Foreclosure among owners of large size properties	0.82%	0.86%
Prop. of walkers among those in foreclosure	49%	47%
Prop. with negative home equity among walkers	97%	92%
Average wage of walkers	0.70 units[15]	0.66 units
Average cash-in-hand of walkers	1.09 units	1.01 units
Prop. of bankrupt tossers among those in foreclosure	51%	53%
Average wage of bankrupt tossers	0.19 units	0.17 units
Average cash-in-hand of bankrupt tossers	−0.51 units	−0.42
Prop. of bankrupt keepers among homeowners	0.44%	0.72%
Prop. with negative home equity among bankrupt keepers	0%	3.3%
Average wage of bankrupt keepers	0.35 units	0.52 units
Average cash-in-hand of bankrupt keepers	−0.73 units	−0.82 units
Prop. of sellers among those with negative home equity	5%	4.63%
Avg. Income of sellers with negative home equity	1.75 units	1.88 units
Avg. cash-in-hand of sellers with negative home equity	−0.022 units	−0.024 units
Prop. current among those with negative home equity	76%	75%
Avg. Income of current with negative home equity	1.50 units	1.52 units
Avg. cash-in-hand of current with negative home equity	2.91 units	2.94 units

Table 7: Transition Results for the Non-Recourse World

5.3.3 Transition Analysis of The Recourse World

Table 8 summarizes results for the transition recourse economy in the pre and post-bankruptcy reform cases. The unit of measure in the table remains the average wage income of the steady state economy. It is worth noting three key observations from the table.

1. In both the pre-reform and post-reform cases, the foreclosure rate is significantly lower in recourse states. The magnitude of the difference in both cases is about 0.72 percentage points.

2. In the recourse world, for both the pre-reform and post-reform cases, all foreclosures are associated with bankruptcy filings.

3. As in the non-recourse world, the reform also leads to a smaller foreclosure rate in the recourse world. However, the impact of the reform is more moderate in the reform world. Specifically, the reform in the recourse world leads to a foreclosure rate which is 0.18 points lower in the post-reform case relative to the pre-reform case, compared to the 0.24 difference obtained in the non-recourse world.

These findings are explained by the fact that walking away from one's house is particularly onerous in the recourse world: a homeowner which chooses to simply walk away from its house in the recourse world has to repay all mortgage debts not covered for by the proceeds of the foreclosure sale while its credit record suffers. This feature of the recourse world induces households to choose to go through foreclosure only when at the same time they find it advantageous to file for bankruptcy in order to discharge the additional debts incurred from the difference between the mortgage debts and the proceeds of the foreclosure sale. For this reason, foreclosure is optimal in the recourse world only when the homeowner does not have significant liquid assets (defined as the face value of the discount bond when it is positive) insofar as liquid assets in bankruptcy would be applied toward the repayment of unsecured debts incurred from mortgage loans. Given that bankruptcy filing implies a utility cost, it turns out that homeowners that choose the foreclosure option in recourse states are homeowners that started the period significantly indebted in the unsecured market. Now, given that households have a strong incentive to save for retirement, it also turns out that the young that start a period with significantly large unsecured debts tend to be households that in a recent past have been hit by a series of bad income shocks realizations. Because the income process is very persistent, these households also tend to be current low income earners. For this reason, homeowners in foreclosure in recourse states are primarily low income earners with large unsecured debts. Since the reform binds only for high income earners, it hence turns out that the impact of the reform on the foreclosure rate in recourse state is rather moderate.

	Post-Reform	Pre-Reform
Foreclosure rate	0.95%	1.13%
Foreclosure among owners of small size properties	2.34%	2.78%
Foreclosure among owners of large size properties	0%	0%
Prop. of walkers among those in foreclosure	0%	0%
Prop. of bankrupt tossers among those in foreclosure	100%	100%
Average wage of bankrupt tossers	0.19 units	0.17 units
Average cash-in-hand of bankrupt tossers	−0.51 units	−0.42
Prop. of bankrupt keepers among homeowners	0.4%	0.684%
Prop. with negative home equity among bankrupt keepers	0%	2.96%
Average wage of bankrupt keepers	0.35 units	0.53 units
Average cash-in-hand of bankrupt keepers	−0.73 units	−0.82 units
Prop. of sellers among those with negative home equity	6.13%	5.92%
Avg. Income of sellers with negative home equity	1.9 units	1.96 units
Avg. cash-in-hand of sellers with negative home equity	0.25 units	−0.28 units
Prop. current among those with negative home equity	83%	83%
Avg. Income of current with negative home equity	1.35 units	1.35 units
Avg. cash-in-hand of current with negative home equity	2.50 units	2.52 units

Table 8: Transition Results for the Recourse World

6 Concluding Remarks

In the current paper, I have documented new facts on mortgage default from the LPS Applied Analytics's database. I have proposed a new and rich quantitative model that furthers our understanding of households' default decisions in mortgage and unsecured credit markets. I have used the model to demonstrate that:

1. households's decisions to forego their homes in foreclosure during the great recession was closely related to their indebtedness in unsecured credit markets

2. contrary to suggestions made in existing literature, the 2005 bankruptcy reform law increased the opportunity cost of bad credit and helped to mitigate the foreclosure crisis once housing prices fell in 2007.

Appendix

6.1 Classification of States among Recourse/Non-Recourse, High/Low Homestead Groups

The recourse/non-recourse lassification is from Ghent and Kudlyak (2011). A state is classified as a high homestead state if its homestead exemption is larger than its 2002 median income.

Table 9: Classification of U.S. States

	If Recourse	If High Homestead
Alaska	NO	YES
Alabama	YES	NO
Arkansas	YES	NO
Arizona	NO	YES
California	NO	YES
Colorado	YES	YES
Connecticut	YES	YES
Delaware	YES	NO
Florida	YES	YES
Georgia	YES	NO
Hawaii	YES	NO
Iowa	NO	YES
Idaho	YES	YES
Illinois	YES	NO
Indiana	YES	NO
Kansas	YES	YES
Kentucky	YES	NO
Louisiana	YES	NO
Massachusetts	YES	YES
Maryland	YES	NO
Maine	YES	NO
Michigan	YES	NO
Minnesota	NO	YES
Missouri	YES	NO

Mississippi	YES	YES
Montana	NO	YES
North Carolina	NO	NO
North Dakota	NO	YES
Nebraska	YES	YES
New Hampshire	YES	YES
New Jersey	YES	NO
New Mexico	YES	NO
Nevada	YES	YES
New York	YES	YES
Ohio	YES	NO
Oklahoma	YES	NO
Oregon	YES	NO
Pennsylvania	YES	NO
Rhode Island	YES	YES
South Carolina	YES	YES
South Dakota	YES	NO
Tennessee	YES	NO
Texas	YES	YES
Utah	YES	NO
Virginia	YES	NO
Vermont	YES	YES
Washington	NO	YES
Wisconsin	NO	YES
West Virginia	YES	NO
Wyoming	YES	NO

6.2 Lists of States in Subgroups 1 and 2

Subgroup 1 is made of 12 recourse states (Illinois, Georgia, Ohio, Idaho, New Jersey, New Hampshire, Connecticut, Virginia, Massachusetts, Delaware, Hawaii and Utah.) and 3 non-recourse states (Oregon, Minnesota, and Washington). Subgroup 1 is made of 6 high homestead exemption states (Idaho, New Hampshire, Minnesota, Connecticut, Washington, and Massachusetts), and of 9 low homestead exemption states (Illinois, Oregon, Georgia, Ohio, New Jersey, Virginia, Delaware, Hawaii, Utah).

Subgroup 2 is made of 9 recourse states (Idaho, New Jersey, New Hampshire, Connecticut, Virginia, Massachusetts, Delaware, Hawaii and Utah.) and 2 non-recourse states (Minnesota, and Washington). Subgroup 2 is made of 6 high homestead exemption states[16] (Idaho, New Hampshire, Minnesota, Connecticut, Washington, and Massachusetts), and of 5 low homestead exemption states (New Jersey, Virginia, Delaware, Hawaii, Utah).

6.3 Summary Statistics for the High and Low homestead examption Groups

The following table summarizes statistics for U.S. states separated into high-homestead and low-homestead groups. A state qualifies as a high-homestead state if the ratio of its homestead exemption over its 2001- median income is higher than 1. Among all 51 states, 40 are recourse states and 24 are high-homestead states. Column (1) gives the median number of days of delinquency prior to foreclosure for loans that entered foreclosure in the year of interest. Column (2) shows the means of the number of days of delinquency prior to bankruptcy filing for loans that in the relevant year entered bankruptcy after being delinquent for a minimum of 90 days and that had not started foreclosure by the end of April 2012. Column (3) gives the average downpayment at origination for each year. Column (4) shows the mean net-interest rate at origination for loans originated in the year of interest. The net-interest rate is defined as the difference between the gross interest rate and the service-fee rate charged for securitized transactions.

(a) High-Homestead States

	(1)	(2)	(3)	(4)
2002	385	238	21.8%	5.83%
2003	384	251	24.6%	5.17%
2004	401	230	25.5%	5.37%
2005	466	253	26.0%	5.46%
2006	511	285	27.6%	6.08%
2007	658	285	29.3%	6.02%
2008	737	267	31.3%	5.70%
2009	646	286	31.3%	4.77%
2010	496	358	29.5%	4.47%

(b) Low-Homestead States

	(1)	(2)	(3)	(4)
2002	449	253	21.2%	5.81%
2003	427	245	22.6%	5.16%
2004	444	243	22.3%	5.40%
2005	507	258	23.1%	5.51%
2006	511	311	24.1%	6.17%
2007	587	303	25.8%	6.12%
2008	674	295	25.3%	5.73%
2009	628	295	26.1%	4.76%
2010	501	345	26.2%	4.45%

Table 10: Summary Statistics Across the High and Low-Homestead Groups

[16]All the high homestead states of subgroup 1 have an unemployment rate below the 2009 US average

6.4 Flow Values and Profit Functions of Lenders

As in the text, Z and s respectively denote the economy's aggregate state and a household's idiosyncratic state. Let $\Omega'(Z,s)$ be tomorrow's optimal non-stochastic component of the individual's state vector given current state (Z,s) as induced by optimal choices. If $s = \{j, \eta, a, b, \epsilon, \xi, x, \zeta, o, (\theta, i, M, \tau)\}$ and $\Omega'(Z,s) = \{j', 0, a', b', o', (\theta', i', M', \tau')\}$, then let $\hat{\Omega}'(Z,s) = \{j', \eta, a', b', o', (\theta', i', M', \tau')\}$.

$g_b(\Omega'(Z,s))$ denotes the face value of the second mortgage bond optimally purchased in the current period by a household in state (Z,s) and $g_a(\Omega'(Z,s))$ denotes the face value of the unsecured bond optimally purchased in the current period by a household in state (Z,s).

Let $\mathbb{1}_{\{inv\}}$ be an indicator function that takes on value 1 if the household defaults involuntarily, and that takes on value 0 otherwise.

If the household starts as a homeowner, then let $\mathbb{1}_{\{sell\}}$ equal 1 if a household's house is sold at the beginning of the period either voluntarily by the household, or upon the household's death, and equal 0 otherwise. Similarly, let $\mathbb{1}_{\{toss\}}$ indicate if a homeowner chooses to file for bankruptcy and to toss its house. Let $\mathbb{1}_{\{toss\}}$ indicate if a homeowner chooses to file for bankruptcy and to keep its house. Let $\mathbb{1}_{\{walk\}}$ indicate if a homeowner chooses to walk away without filing for bankruptcy. and let $\mathbb{1}_{\{curr\}}$ indicate if it chooses to stay current. For a non-owner, let $\mathbb{1}_{\{walk\}}$ indicate if it chooses to file for bankruptcy.

If the household starts as a non-owner, let $\mathbb{1}_{\{bkrupt\}}$ equal 1 if the household chooses to file for bankruptcy and equal 0 otherwise.

Upon a default, the household's after-bankruptcy adjusted cash-in-hand position is equally distributed among the household's unsecured creditors which are: the unsecured bond lender, the expense shock sector, and also the household's first and second mortgage lenders if the household was subject to a deficiency shock.

Let a_1^{toss} and a_2^{toss} equal the negatives of the mortgage debts still owed to the first and second mortgage lenders after exhaustion of the expected discounted sale proceeds after a household has tossed out its house a bankruptcy:

$$\begin{cases} a_1^{toss} & = \min\{0, \frac{(1-\phi)E(p)h_i}{1+r} - (\ell_0 - (1-\zeta)M)\} \text{ if } R_c = 1 \\ a_1^{toss} & = 0 \text{ if } R_c = 0 \\ a_2^{toss} & = \min\{0, \max\{0, \frac{(1-\phi)E(p)h_i}{1+r} - (\ell_0 - (1-\zeta)M)\} - b\} \text{ if } R_c = 1 \\ a_2^{toss} & = 0 \text{ if } R_c = 0. \end{cases}$$

Define

$$\begin{cases} \alpha_1^{toss} &= \frac{a_1^{toss}}{a_1^{toss}+a_2^{toss}+\min\{0,a\}-x} \\ \alpha_2^{toss} &= \frac{a_2^{toss}}{a_1^{toss}+a_2^{toss}+\min\{0,a\}-x} \\ \alpha_3^{toss} &= \frac{\min\{0,a\}}{a_1^{toss}+a_2^{toss}+\min\{0,a\}-x} \end{cases}$$

Also recalling that second mortgage loans are treated as unsecured debts in bankruptcy when the first mortgage is under water, define:

$$\begin{cases} a_2^{toss} &= -b \text{ if } P(Z) - \ell_0 < 0 \\ a_2^{toss} &= 0 \quad \text{if } P(Z) - \ell_0 \geq 0 \end{cases}$$

and

$$\begin{cases} \alpha_1^{keep} &= \frac{\min\{0,a\}}{a_2+\min\{0,a\}-x}. \\ \alpha_2^{keep} &= \frac{a_2}{a_2+\min\{0,a\}-x} \end{cases}$$

Finally, for involuntary defaulters, let

$$\begin{cases} a_1^{inv} &= \min\{0, (1-\phi)P(Z)h_i - \ell_0\} \text{ if } R_c = 1 \\ a_1^{inv} &= 0 \text{ if } R_c = 0 \\ a_2^{inv} &= \min\{0, \max\{0, (1-\phi)P(Z)h_i - \ell_0\} - b\} \text{ if } R_c = 1 \\ a_2^{inv} &= 0 \text{ if } R_c = 0. \end{cases}$$

Define

$$\begin{cases} \alpha_1^{inv} &= \frac{a_1^{inv}}{a_1^{inv}+a_2^{inv}-x} \\ \alpha_2^{inv} &= \frac{a_2^{inv}}{a_1^{inv}+a_2^{inv}-x} \\ \alpha &= \frac{\min\{0,a\}}{\min\{0,a\}-x}. \end{cases}$$

If the household starts the period as a homeowner, let $W_{m_1,Z}(s)$ denote the expected discounted flows to the first mortgage lender which has loaned to the household. Then,

$$
\begin{aligned}
W_{m_1,Z}(s) = &\mathbb{1}_{\{sell\}} \times \ell(i, r_m, \tau, \theta) \\
&+ \mathbb{1}_{\{curr\}} \times W^{curr}_{m_1,Z}(s) \\
&+ \mathbb{1}_{\{keep\}} \times W^{keep}_{m_1,Z}(s) \\
&+ \mathbb{1}_{\{toss\}} \times W^{toss}_{m_1,Z}(s) \\
&+ \mathbb{1}_{\{walk\}} \times W^{walk}_{m_1,Z}(s) \\
&+ \mathbb{1}_{\{inv\}} \times W^{inv}_{m_1,Z}(s).
\end{aligned}
$$

I next define $W^{curr}_{m_1,Z}$, $W^{toss}_{m_1,Z}$, $W^{keep}_{m_1,Z}$, $W^{walk}_{m_1,Z}$, and $W^{inv}_{m_1,Z}$. Let $W_{m_1} = (W_{m_1,B}, W_{m_1,R})$. Then,

$$
W^{curr}_{m_1,Z}(s) = \begin{cases} M + \frac{(\lambda \times (E_{Z|\xi} W_{m_1})(\Omega'(Z,s)) + (1-\lambda) \times (E_{Z|\xi} W_{m_1})(\hat{\Omega}'(Z,s)))}{1+r} & \text{if } \eta \neq 0 \\ M + \frac{(\lambda \times (E_{Z|\xi} W_{m_1})(\Omega'(Z,s)) + (1-\lambda) \times (E_{Z|\xi} W_{m_1})(\hat{\Omega}'(Z,s)))}{1+r} & \text{if } \eta \neq 0 \end{cases}
$$

and,

$$
W^{keep}_{m_1,Z}(s) = M + \frac{(E_{Z|\xi} W_{m_1})(\Omega'(Z,s))}{1+r}.
$$

$$
\begin{aligned}
W^{toss}_{m_1,Z} = &\mathbb{1}_{\{R_c=0\}} \times ((1-\zeta)M + \min\{\ell_0 - (1-\zeta)M, \frac{(1-\phi)E(p)h}{1+r}\}) \\
&+ \mathbb{1}_{\{R_c=1\}} \times ((1-\zeta)M + \min\{\ell_0 - (1-\zeta)M, \frac{(1-\phi)E(p)h}{1+r}\}) \\
&+ \mathbb{1}_{\{R_c=1\}} \times \min\{\max\{0, \ell_0 - (1-\zeta)M - \frac{(1-\phi)E(p)h}{1+r}\}, \max\{0, a\} \times \alpha_1^{toss}\} \\
&+ \mathbb{1}_{\{R_c=1\}} \times (-D_{toss}(Z,s) \times \alpha_1^{toss}) \times (1 + \frac{1 - E_{Z|\xi}(\mathbb{1}_{\{inv\}}(B,.), \mathbb{1}_{\{inv\}}(R,.))(\Omega'(Z,s))}{1+r})
\end{aligned}
$$

$$
W^{walk}_{m_1,Z} = \mathbb{1}_{\{R_c=0\}} \times ((1-\zeta)M + \min\{\ell_0 - (1-\zeta)M, \frac{(1-\phi)E(p)h}{1+r}\}) + \mathbb{1}_{\{R_c=1\}} \times \ell(i, r_m, \tau, \theta).
$$

$$W^{inv}_{m_1,Z} = \mathbb{1}_{\{R_c=0\}} \times (\min\{\ell_0, (1-\phi)P(Z)h_i\})$$
$$+ \mathbb{1}_{\{R_c=1\}} \times (\min\{\ell_0, (1-\phi)P(Z)h_i\}) + \min\{\max\{0, \ell_0 - (1-\phi)P(Z)h_i\}, \max\{0, a\}\alpha^{inv}_1\}$$

In the period of home purchase, a household may only stay current in its mortgage contracts. The expected profits made on mortgage a contract $(i', R_m(Z, \xi, \Omega'(Z, s)), 1, \mathbb{1}_{\{Z=R\}})$ made to a household in state (Z, s) and starting tomorrow with a non-stochastic state component $\Omega'(Z, s)$ are hence given by:

$$\Pi_{m_1}(Z, \xi, \Omega'(Z, s)) = -(1-\mu)P(Z)h_{i'} + \text{Mortgage}(i', R_m(Z, \xi, \Omega'(Z, s)), \mathbb{1}_{\{Z=R\}}) + \frac{W_{m_1,Z}(s)}{1+r}.$$

6.4.1 Flow Values and Profit Function to Second Mortgage Lenders

If the household is a homeowner, let $W_{m_2,Z}(s)$ denote the expected discounted flows to the second mortgage lender. Then

$$\begin{aligned} W_{m_2,Z}(s) = {} & (1 - \mathbb{1}_{\{keep\}} - \mathbb{1}_{\{toss\}} - \mathbb{1}_{\{walk\}} - \mathbb{1}_{\{inv\}}) \times b \\ & + \mathbb{1}_{\{keep\}} \times W^{keep}_{m_2,Z}(s) \\ & + \mathbb{1}_{\{toss\}} \times W^{toss}_{m_2,Z}(s) \\ & + \mathbb{1}_{\{walk\}} \times W^{walk}_{m_2,Z}(s) \\ & + \mathbb{1}_{\{inv\}} \times W^{inv}_{m_2,Z}(s), \end{aligned}$$

where $W^{toss}_{m_2,Z}$, $W^{keep}_{m_2,Z}$, $W^{walk}_{m_2,Z}$, and $W^{inv}_{m_2,Z}$ are defined next.

$$\begin{aligned} W^{toss}_{m_2,Z} = {} & \mathbb{1}_{\{R_c=0\}} \times (\min\{b, \max\{0, \frac{(1-\phi)E(p)h}{1+r} - (\ell_0 - (1-\zeta)M)\}\}) \\ & + \mathbb{1}_{\{R_c=1\}} \times (\min\{b, \max\{0, \frac{(1-\phi)E(p)h}{1+r} - (\ell_0 - (1-\zeta)M)\}\}) \\ & + \mathbb{1}_{\{R_c=1\}} \times \min\{\max\{0, b - \max\{0, \frac{(1-\phi)E(p)h}{1+r} - (\ell_0 - (1-\zeta)M)\}\}, \max\{0, a\} \times \alpha^{toss}_2\} \\ & + \mathbb{1}_{\{R_c=1\}} \times (-D_{toss}(Z, s) \times \alpha^{toss}_2) \times (1 + \frac{1 - E_{Z|\xi}(\mathbb{1}_{\{inv\}}(B, .), \mathbb{1}_{\{inv\}}(R, .))(\Omega'(Z, s))}{1+r}) \end{aligned}$$

$$
\begin{aligned}
W^{keep}_{m_2,Z} &= \mathbb{1}_{\{P(Z)h-\ell_0\geq 0\}} \times b \\
&\quad + \mathbb{1}_{\{P(Z)h-\ell_0<0\}} \times (-D_{keep}(Z,s) \times \alpha_2^{keep}) \times (1 + \frac{1 - E_{Z|\xi}(\mathbb{1}_{\{inv\}}(B,.), \mathbb{1}_{\{inv\}}(R,.))(\Omega'(Z,s))}{1+r})
\end{aligned}
$$

$$
\begin{aligned}
W^{walk}_{m_2,Z} &= \mathbb{1}_{\{R_c=0\}} \times \min\{b, \max\{0, \frac{(1-\phi)E(p)(Z)h_i}{1+r} - (\ell_0 - (1-\zeta)M)\}\} \\
&\quad + \mathbb{1}_{\{R_c=1\}} \times b
\end{aligned}
$$

$$
\begin{aligned}
W^{inv}_{m_2,Z} &= \mathbb{1}_{\{R_c=0\}} \times \min\{b, \max\{0, (1-\phi)P(Z)h_i - \ell_0\}\} \\
&\quad + \mathbb{1}_{\{R_c=1\}} \times \min\{b, \max\{0, (1-\phi)P(Z)h_i - \ell_0\}\} \\
&\quad + \mathbb{1}_{\{R_c=1\}} \times \min\{\max\{0, b - \max\{0, (1-\phi)P(Z)h - \ell_0\}\}, \max\{0, a\} \times \alpha_2^{inv}\}
\end{aligned}
$$

Let $W_{m_2} = (W_{m_2,B}, W_{m_2,R})$. Then, the expected profits to a second mortgage lender which lends at per unit price $Q_s(Z, \xi, \Omega'(Z,s))$ to a household that will start the following period with a non-stochastic state component $\Omega'(Z,s)$ are given by:

$$
\Pi_{m_2}(Z, \xi, \Omega'(Z,s)) = -Q_s(Z, \xi, \Omega'(Z,s)) \times g_b(\Omega'(Z,s)) + \frac{(E_{Z|\xi} W m_2)(\Omega'(Z,s))}{1+r}.
$$

6.4.2 Flow Values and Profit Function to Unsecured Lenders

Let $W_{u,Z}(s)$ denote the expected discounted flows to the unsecured lender. **Case 1: The Household is a homeowner** Then,

$$
\begin{aligned}
W_{u,Z}(s) = & -\max\{0,a\} \\
& + (1-\mathbb{1}_{\{keep\}}-\mathbb{1}_{\{toss\}}-\mathbb{1}_{\{inv\}}) \times -\min\{0,a\} \\
& + \mathbb{1}_{\{keep\}} \times W^{keep}_{u,Z}(s) \times \mathbb{1}_{\{a<0\}} \\
& + \mathbb{1}_{\{toss\}} \times W^{toss}_{u,Z}(s) \times \mathbb{1}_{\{a<0\}} \\
& + \mathbb{1}_{\{inv\}} \times W^{inv}_{u,Z}(s) \times \mathbb{1}_{\{a<0\}},
\end{aligned}
$$

where for $H = \max\{0, (\frac{(1-\phi).E(p)h_i}{1+r} - (\ell_0 - (1-\zeta)M(i,r_m)) - b)\}$ and for $H_n = H - \min\{E,H\}$,

$$
\begin{aligned}
W^{toss}_{u,Z}(s) &= \alpha_3^{toss} \times \min\{-A_{toss}(Z,s), H_{ne}\} \\
&\quad - \alpha_3^{toss} \times (-D_{toss}(Z,s) + \frac{E_{Z|\xi}(W_u)(\Omega'(Z,s))}{1+r}) \\
W^{keep}_{u,Z}(s) &= \alpha_1^{keep} \times (-D_{keep}(Z,s) + \frac{E_{Z|\xi}(W_u)(\Omega'(Z,s))}{1+r}) \\
W^{inv}_{u,Z}(s) &= \min\{-a, \alpha \times \max\{0, (1-\phi)P(Z)h_i - E\}\}.
\end{aligned}
$$

Case 1: The Household is a non-owner

Then,

$$
\begin{aligned}
W_{u,Z}(s) = & -\max\{0,a\} \\
& + (1-\mathbb{1}_{\{bkrupt\}}-\mathbb{1}_{\{inv\}}) \times -\min\{0,a\} \\
& + \mathbb{1}_{\{bkrupt\}} \times \frac{\min\{a,0\}}{\min\{a,0\}-x} \times \left(-D_{no}(Z,s) + \frac{E_{Z|\xi}(W_u)(\Omega'(Z,s))}{1+r}\right) \times \mathbb{1}_{\{a<0\}}.
\end{aligned}
$$

Let $W_u = (W_{u,B}, W_{u,R})$. Then, the expected profits to an unsecured lender which lends at per unit price $Q_u(Z,\xi,\Omega'(Z,s))$ to a household that will start the following period with a non-stochastic state component $\Omega'(Z,s)$ are given by:

$$
\Pi_u(Z,\xi,\Omega'(Z,s)) = Q_u(Z,\xi,\Omega'(Z,s)) \times g_a(\Omega'(Z,s)) + \Psi_{j+1}\frac{(E_{Z|\xi}Wu)(\Omega'(Z,s))}{1+r}.
$$

References

Adda and Cooper (2003): " Dynamic Economics: Quantitative Methods and Applications. Cambridge, MA and London: MIT Press.

Campbell, Giglio, and Pathak (2011): "Forced Sales and House Prices. American Economic Review, 101(5): 210831.

Chatterjee, Corbae, Nakajima and Rios-Rull (2007): "A Quantitative Theory of Unsecured Consumer Credit with Risk of Default", Econometrica 74, 1525-1589.

Corbae & Quintin (2011): "Mortgage Innovation and the Foreclosure Boom", Working Paper.

Elias (2009): "The New Bankruptcy : Will it Work for You?", NOLO, third edition.

Elias & Leonard, J.D. (2010): "Chapter 13 Bankruptcy: Keep Your Property & Repay Debts Over Time", 10th Edition.

Ghent and Kudlyak (2011): "Recourse and Residential Mortgage Default: Evidence from US States" Review of Financial Studies. (2011)

Li (2001): " To forgive or not to forgive: an analysis of U.S. consumer bankruptcy choices", Economic Quarterly, Federal Reserve Bank of Richmond 87 (2), 122.

Li & Sarte (2006): "U.S. Consumer Bankruptcy Choice: The importance of general equilibrium effects".

Livshits, Macgee & Tertilit (2008): "Consumer Bankruptcy: A Fresh Start", American Economic Review.

McGrattan & Prescott (2008): "Is the Stock Market Overvalued? Federal Reserve Bank of Minneapolis Quarterly Review, 24(4): 2040.

Mitman (2011): "Macroeconomic Effects of Bankruptcy And Foreclosure Policies".

Morgan, Iverson & Botsch (2009): "Seismic Effects of the Bankruptcy Reform", Federal Reserve Bank of New York Staff Reports, no. 358.

Oren Bar-Gill(2009): "Subprime Mortgage Contracts", Cornell Law Review, Vol. 94:1073.

Pennington-Cross (2006) "The Value of Foreclosed Property Journal of Real Estate Research, 28(2).

Sommer, K., Sullivan, and R. Verbrugge (2010): “Run-up in the House Price-Rent Ratio: How Much Can Be Explained by Fundamentals?, BLS Working Papers 441.

Statistical Abstracts of the United States, Banking, Finance and Insurance: Payment Systems, Consumer Credit, Mortgage Debt.

Storesletten, Telmer & Yaron (2004): “Cyclical Dynamics in Idiosyncratic Labor Market Risk Journal of Political Economy, 112(3): 695717.

Sullivan, Warren and Westbrook (2000) “The Fragile Middle Class: Americans in Debt”. New Haven and London: Yale University Press.

United States Department of Justice, U.S. Trustee Program, Bankruptcy Statistics.

Walsh (2010): “The Complete Guide to Preventing Foreclosure on Your Home: Legal Secrets to Beat Foreclosure and Protect Your Home NOW”, Atlantic Publishing Group.

White, Li and Zhu (2011):“Did Bankruptcy Reform Cause Mortgage Defaults to Rise?”, Working Paper.