

# Bankruptcy Reform and the Housing Crisis

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April 16, 2012

## Abstract

The Bankruptcy Abuse Prevention & Consumer Protection Act (BAPCPA) of 2005 significantly raised the costs of filing for bankruptcy and reduced the amount of debt that could be discharged. By making bankruptcy more costly, the BAPCPA may have contributed to the severity of the recent housing crisis by inducing homeowners that would have previously filed for bankruptcy and remained in their home to instead default on their mortgage. We quantify the impact of the BAPCPA on the housing crisis using a quantitative equilibrium model of consumer default in which households have access to short-term unsecured debt and long-term mortgages. On one hand, we find that the BAPCPA reduces the benefit of homeownership for high income households and induces more risky lending in unsecured credit markets, both of which tend to increase the quantity of mortgage defaults. Rational mortgage lenders, however, internalize these changes and tighten their lending standards which reduces the number of defaults. While we find that the BAPCPA leads to an increase in mortgage defaults upon implementation, our analysis suggests that its impact on the housing crisis was quantitatively insignificant as these opposing forces largely cancel each other out. Accounting for the general equilibrium effects of changes in household incentives on unsecured debt and mortgage interest rates is therefore crucial for understanding the impact of bankruptcy reform on the housing crisis.

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# 1 Introduction

Prior to 2005, the availability of debt relief through bankruptcy was widely known, the cost of filing was low, and little stigma was attached to those who filed. Bankruptcy was thus an attractive option for homeowners that wished to remain in their homes and could afford their mortgage payments if relieved of other debt obligations, such as credit card bills. This changed in 2005 as the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) significantly raised the cost of filing and reduced the amount of debt that could be discharged. These changes to the bankruptcy code made it more difficult for struggling homeowners to loosen their budget constraints via bankruptcy, increasing the relative attractiveness of mortgage default. As a result, bankruptcy reform may have contributed to the severity of the housing crisis by inducing some homeowners to default that would have otherwise chosen to declare bankruptcy and keep their homes.

To understand exactly how the BAPCPA affected homeowners' incentives, consider a homeowner with negative home equity who, prior to the BAPCPA, could have had their unsecured debt discharged under Chapter 7 and remained in their home. With the introduction of the BAPCPA, this homeowner's ability to file under Chapter 7 now depends on their income. In particular, if the homeowner has income above their state's median, they cannot file under Chapter 7 and are instead forced to file under Chapter 13 and enter into a repayment plan to which they must commit all of their non-exempt income for five years. Thus, bankruptcy became more costly for such a homeowner. If bankruptcy and mortgage default are substitutes, this higher cost will induce some households to default on their mortgage that would not have

done so in the absence of the reform.<sup>1</sup> Because negative home equity is a necessary condition for mortgage default, the large decline in house prices that forced many homeowners underwater on their mortgage during the recent housing crisis may have amplified this rise in the mortgage default rate.<sup>2</sup>

Empirical work on the BAPCPA has reinforced this intuition. [Li, White, and Zhu \(2011\)](#), for example, argue that homeowners treated bankruptcy and mortgage default as substitutes in response to the BAPCPA, shifting from bankruptcy to default when the cost of the former rose. Using data on individual mortgages from LPS Analytics, these authors estimate that the BAPCPA increased the probability of default by 24% for prime borrowers and 14% for sub-prime borrowers with mortgages originated in 2004 and 2005. In a complementary study, [Morgan, Iverson, and Botsch \(2011\)](#) document a significant rise in the default rate of subprime mortgages in response to the BAPCPA. Although neither of these studies explicitly consider data from the housing market crash in their analysis, their conclusions support the view that the BAPCPA may have increased in the number of mortgage defaults during the housing crisis, thereby contributing to the severe and protracted decline in home prices.

Although this empirical work suggests that making bankruptcy more costly may have worsened the housing crash, theoretically this conclusion is ambiguous. While increasing the cost of filing for bankruptcy raises the relative attractiveness of mort-

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<sup>1</sup>We think of bankruptcy and mortgage default as being complements or substitutes just as we would any other goods. That is, they are substitutes (complements) if raising the cost of one increases (decreases) the incidence of the other.

<sup>2</sup>If a household has positive home equity net of transaction costs, then selling their home and repaying their mortgage will always dominate the option to default.

gage default, rational mortgage lenders will respond by raising interest rates on those households who are more likely to default in order to offset the potential for greater losses. Higher interest rates, in turn, will tend to discourage these households from taking out a mortgage to purchase a home. Importantly, this effect is concentrated on households who bought homes in 2005 and 2006 – exactly those homeowners who are most likely to find themselves underwater as a result of a collapse in house prices – and works to reduce the mortgage default rate during the crisis. Given the presence of these opposing forces, the net impact on mortgage defaults could be either positive or negative depending on the relative magnitude of each effect.

In this paper, we quantify the effects of the BAPCPA on the housing market crash of 2007 using a quantitative-theoretic, equilibrium model of the U.S. housing market. In our framework, households optimally choose between renting and owning their housing space and can finance the purchase of a home by taking out a mortgage. Households interact in credit markets with rational lenders who provide unsecured credit and mortgage loans at terms that fully reflect the general equilibrium incentives each household has to renege on their obligations. Each period, homeowners optimally choose between remaining in or selling their home, filing for bankruptcy, defaulting on their mortgage, or simultaneously declaring bankruptcy and defaulting on their mortgage. Thus, our model is rich enough to determine whether tighter mortgage lending standards in the years prior to the crisis dominated the increased attractiveness of mortgage default during the crisis.

We calibrate our model to match salient characteristics of the U.S. economy prior to 2005 and then conduct several tests to ensure that our model adequately captures

key empirical facts regarding the BAPCPA and the housing market crash. First, we discipline the model to match the empirical findings of [Li et al. \(2011\)](#) by calibrating the bankruptcy cost under reform to produce a rise in the mortgage default rate of 21.6% for new homeowners in response to the BAPCPA.<sup>3</sup> Next, we test whether the model produces a decline in house prices and a rise in mortgage default rates, on the order of that found in the data, in response to a housing crash. Following [Chatterjee and Eyigungor \(2011b\)](#), we model this crash as an unexpected increase in the economy’s owner-occupied housing supply and find that our model is able to capture a decline in house prices and rise in mortgage default rates similar to the data. The model also replicates key dynamics in the bankruptcy filing rate, unsecured debt-to-income ratio and price-rent ratio during the crash. The fact that our model is able to replicate these empirical facts gives us confidence about its implications for the counterfactual exercise that is central to our analysis. As our main quantitative experiment, we construct a counterfactual transition in the U.S. economy in which there is no bankruptcy reform in 2005 but the economy still undergoes a housing crisis in 2007. We then compare the data from this housing crisis to an economy that implemented bankruptcy reform in 2005.

Contrary to existing arguments in the empirical literature, our results suggest that the BAPCPA did not contribute significantly to the severity of the housing crisis. In particular, the mortgage default rate is only 2.7% higher in 2007 while the path of house prices during the crisis is virtually unchanged as a result of bankruptcy reform.

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<sup>3</sup>Throughout we will refer to homeowners that purchased their home in the previous period as new homeowners.

In our model, bankruptcy and mortgage default appear to be treated as substitutes by households in response to the BAPCPA as its implementation leads to lower bankruptcy and higher mortgage default rates in the aggregate. Indeed, some households find it optimal to default on their mortgage in states where they would have optimally decided to declare bankruptcy in the absence of BAPCPA. Bankruptcy and mortgage default are substitutes for these households, and by making bankruptcy more costly to file, mortgage default becomes more likely. However, there are additional forces at work in our model which are of greater quantitative importance in generating our results.

Prior to the BAPCPA, a household's home equity in excess of their state's homestead exemption would be paid to creditors in the event of bankruptcy. Non-exempt home equity thus served as collateral for unsecured debt contracts, leading to lower interest rates for homeowners with high home equity. Under the BAPCPA, homeowners with high income relative to their non-exempt home equity are forced into a repayment plan, meaning that their non-exempt home equity no longer serves as collateral for their unsecured debt obligations. For these households, interest rates on unsecured debt are now independent of their homeownership status which reduces the benefits of homeownership. While homeowners with negative home equity are not directly impacted by this change, the continue value of remaining in their home falls, inducing the marginal homeowner to default on their mortgage.<sup>4</sup>

Second, since the BAPCPA increased the cost of bankruptcy for high income

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<sup>4</sup>In order for default to be optimal in our model, a homeowner must not only have negative home equity (a necessary condition for default), but must also want to move. Homeowners want to move in our model because shocks to their income, assets or house size have made their current mortgage-house combination suboptimal.

households, making it less likely that these households will declare bankruptcy, unsecured creditors are able to offer lower interest rates and engage in more risky lending.<sup>5</sup> If we assume that a household must repay their unsecured debt if they default on their mortgage (and do not simultaneously declare bankruptcy), bankruptcy and mortgage default are complementary as the former reduces the costs associated with the latter. A rise in risky lending which leads to an increase in bankruptcy filings will thus also tend to cause an increase in the mortgage default rate.

In our model, rational mortgage lenders internalize these changes in homeowners' incentives and respond by tightening lending standards in the years prior to the housing crisis. Higher mortgage interest rates lead new home buyers to choose smaller homes with lower initial loan-to-income, loan-to-value, and mortgage payment-to-income ratios, on average. These mortgage contracts are inherently less risky, making these new home buyers far less likely to default on their mortgage during the crisis. This force offsets the increased attractiveness of default and ultimately drives our conclusion that the BAPCPA caused only a slightly higher default rate during the housing crisis and had little effect if any on the severity of the drop in house prices. Accounting for the general equilibrium response of unsecured debt and mortgage interest rates to changes in households' incentives is therefore crucial to adequately assess the impact of the BAPCPA on the housing crisis.

The remainder of the paper is structured as follows. In the next section we briefly discuss papers that are relevant to our current analysis. Section 3 then provides a detailed description of our full quantitative framework prior to bankruptcy reform.

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<sup>5</sup>Risky lending refers to unsecured debt contracts for which the household's bankruptcy decision in the following period is non-trivial.

Next, Section 4 describes the BAPCPA and specifies how we model this reform in our quantitative analysis. The following section presents our parameterization and the model fit to the pre-crash period. Section 6 details our quantitative results, describing the effect of the BAPCPA on impact and during the housing crash and discussing the intuition for our findings. Finally, Section 7 concludes.

## 2 Literature Review

Several recent papers aim to isolate and quantify the effects of the BAPCPA. Much of this work is empirical in nature.<sup>6</sup> As described in the introduction, the most relevant for our work are [Li et al. \(2011\)](#) and [Morgan et al. \(2011\)](#) who document that mortgage default rates increased in response to the BAPCPA. A primary benefit of our quantitative approach relative to their empirical analysis is that we are able to construct the counterfactual experiment that these authors envision.

In response to the recent housing crisis, there is a rapidly growing literature that aims to explain the rise in mortgage defaults and decline in house prices using quantitative models of the U.S. housing market. [Corbae and Quintin \(2011\)](#), for example, assess the importance of mortgage innovations, through the introduction of non-traditional mortgages, and conclude that this channel can explain approximately 40% of the rise in foreclosures during the crisis. Recent work by [Jeske, Krueger, and Mitman \(2011\)](#) evaluates the impact of interest rate subsidies

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<sup>6</sup>Two notable exceptions are [Chatterjee, Corbae, Nakajima, and Rios-Rull \(2007\)](#) and [Li and Sarte \(2006\)](#), who quantitatively analyze the impact of introducing means testing, in the spirit of the BAPCPA, on the consumer bankruptcy decision but do not consider the reform's impact on mortgage default decisions.



by the government sponsored enterprises on housing market outcomes. They determine that these subsidies substantially increase mortgage origination and lower aggregate welfare, but have little impact on default rates. Closely related to our study is that of [Chatterjee and Eyigungor \(2011b\)](#) who demonstrate that an unexpected increase in the supply of owner-occupied housing, along with frictions in the mortgage market and foreclosure delays, can go quite a long way toward explaining both the sharp increase in foreclosures and precipitous drop in home prices.

Each of these quantitative studies, though, abstracts from unsecured credit, and thus from the bankruptcy versus mortgage default decision. [Mitman \(2011\)](#) takes up this task and exploits variations in homestead exemptions and recourse laws across states in order to demonstrate that while bankruptcy rates are lower in states with higher homestead exemptions, foreclosure rates are higher. Mitman also examines his model's predictions for the long-run effects of the BAPCPA, but does not explore the implications of bankruptcy reform for the severity of the housing crisis, which is the primary focus of our analysis.

Moreover, [Mitman \(2011\)](#) chooses to model mortgages as one-period contracts and abstract from the transaction costs associated with buying and selling a home. Although these assumptions improve analytical tractability and perhaps are appropriate for a steady state analysis, the inherent risks to both households and lenders in a long-term mortgage contract, such as changes in income and house prices, are of first order importance for our dynamic analysis. It is therefore crucial that we model mortgages as long-term contracts and explicitly account for transaction costs in order to adequately assess how the BAPCPA impacted the subsequent housing crisis.

To the best of our knowledge, ours is the first paper to allow for both short-term, unsecured debt and long-term, collateralized mortgage loans in a model of optimal consumer default.<sup>7</sup>

### 3 Model Economy

We consider an environment in which time is discrete and infinite. The economy is populated by a continuum of infinitely lived households, a pool of perfectly competitive, risk neutral financial intermediaries, and a government. There is an exogenous and perfectly elastic supply of a homogeneous consumption good which is taken as the numeraire. The economy also has exogenous and perfectly divisible supplies of owner-occupied ( $K_t$ ) and rental ( $H_t$ ) housing space with prices  $P_t$  and  $R_t$  at date  $t$ , respectively. Households derive utility from consumption and the size of their housing space. Financial intermediaries accept deposits and offer competitively priced one-period unsecured debt contracts and multi-period mortgages, the latter of which households can use to help finance the purchase of housing space. The government levies income taxes on households, but does not provide transfers or goods and services that affect the household's problem.

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<sup>7</sup>In fact, the only other model, again to the best of our knowledge, to simultaneously consider short and long-term debt is [Arellano and Ramanarayanan \(2010\)](#), who consider unsecured debt instruments of different maturities in a sovereign default model.

In considering long-term debt, we build on the work introducing longer maturity bonds into models of sovereign default by [Chatterjee and Eyigungor \(2011a\)](#) and [Hatchondo and Martinez \(2009\)](#) and consumer default by [Chatterjee and Eyigungor \(2011b\)](#).

### 3.1 Households

Households are heterogeneous with respect to their homeownership status, house size  $k_t$ , mortgage payment  $x_t$ , assets  $a_t$ , endowment  $y_t$ , and credit status. We use  $k_t = 0$  and  $x_t = 0$  to denote a household that does not own a home and therefore does not have a mortgage.

Households in our model face three sources of uncertainty. First, each household receives an idiosyncratic and stochastic endowment  $y_t$  each period, the log of which evolves according to a first-order autoregressive process:

$$\log(y_t) = \rho \log(y_{t-1}) + \varepsilon_t$$

where  $\varepsilon_t \sim N(0, \sigma)$  is i.i.d over time and across households. Second, owner-occupied housing is subject to idiosyncratic proportional depreciation shocks,  $\delta_t$ , that are i.i.d. across households and time.<sup>8</sup> The value of this shock is given by:

$$\delta_t = \begin{cases} \bar{\delta} & \text{with probability } \phi \\ 0 & \text{otherwise} \end{cases} .$$

A household that exits period  $t$  with a house of size  $k_t$  and experiences depreciation shock  $\delta_{t+1}$  enters period  $t + 1$  with a house of size  $k_{t+1} = (1 - \delta_{t+1})k_t$ . Finally,

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<sup>8</sup>We introduce this feature to capture two important characteristics of the U.S. housing market: (1) homeowners occasionally choose to default on their mortgage obligations, and (2) homeowners move frequently. Depreciation shocks create the potential for negative home equity, a prerequisite for mortgage default, in a steady state in which owner-occupied house prices are constant. These shocks also tend to result in a suboptimal combination of mortgage loan and house size given a household's assets and income, which is the main reason why homeowners choose to move in our model.

households are subject to an idiosyncratic expense shock,  $e_t$ , which directly reduces the assets with which they enter the period.<sup>9</sup> This expense shock is also assumed to be i.i.d. across households and time, and its value is given by:

$$e_t = \begin{cases} \bar{e} & \text{with probability } \xi \\ 0 & \text{otherwise} \end{cases}$$

A household that exits period  $t$  with assets  $a_t^*$  and experiences expense shock  $e_{t+1}$  enters period  $t + 1$  with assets  $a_{t+1} = a_{t+1}^* - e_{t+1}$ .

Figure 1 depicts how households move between different homeownership and credit statuses in our model. For example, a household that enters the period as a homeowner with good credit can become (i) a *homeowner with bad credit* by declaring bankruptcy and having home equity less than the homestead exemption, (ii) a *renter with bad credit* by defaulting on their mortgage, declaring bankruptcy and defaulting on their mortgage, or declaring bankruptcy with home equity in excess of the homestead exemption, or (iii) a *renter with good credit* by selling their home.<sup>10</sup>

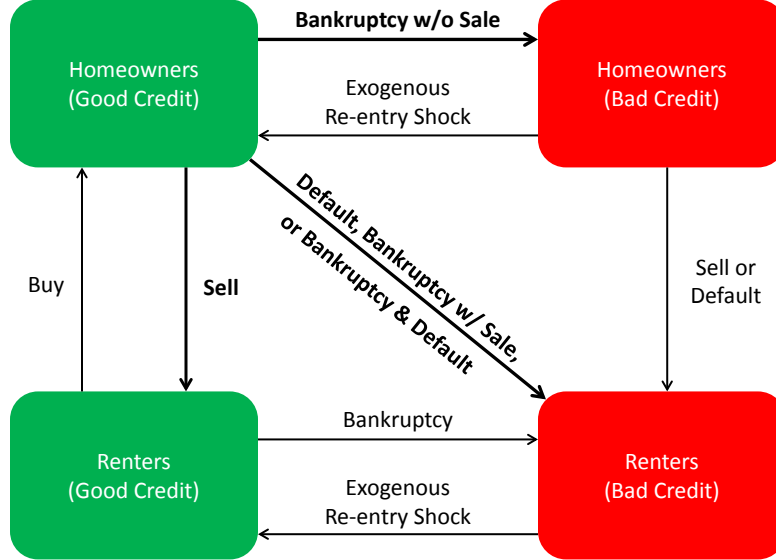
We begin by describing the decision problems for a homeowner with good credit because their decision to file for bankruptcy versus defaulting on their mortgage is affected by the BAPCPA and is thus the focus of our analysis.

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<sup>9</sup>Expense shocks are meant to capture unanticipated household expenses relating to medical expenses, divorce costs, unexpected births of children, among others, which are commonly cited by bankrupts as contributing to their decision to file. See [Livshits, MacGee, and Tertilt \(2007\)](#) and [Livshits, MacGee, and Tertilt \(2010\)](#) for further discussion on the importance of expense shocks for the consumer bankruptcy decision.

<sup>10</sup>We will use the term “good credit” to mean a household that has access to credit markets and “bad credit” to mean a household that is excluded from credit markets due to a past bankruptcy filing and/or mortgage default.

Figure 1. Model Summary



### 3.1.1 Problem of a Homeowner with Good Credit

A homeowner with good credit must decide between making their mortgage payment and continuing as a homeowner ( $O_t$ ), selling their home ( $S_t$ ), defaulting on their mortgage ( $D_t$ ), filing for bankruptcy ( $B_t$ ), or both filing for bankruptcy and defaulting on their mortgage ( $BD_t$ ). The value of having this decision is given by:

$$V_t(k_t, x_t, a_t, y_t) = \max_{O_t, S_t, D_t, B_t, BD_t} \{O_t(k_t, x_t, a_t, y_t), S_t(k_t, x_t, a_t, y_t),$$

$$D_t(a_t, y_t), B_t(k_t, x_t, y_t), BD_t(y_t)\}$$

The value associated with making their mortgage payment and continuing as a

homeowner is

$$O_t(k_t, x_t, a_t, y_t) = \max_{c_t, a_{t+1}^*} u(c_t, k_t) + \beta \mathbb{E}_t[V_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})|y_t]$$

subject to

$$c_t + q_t(k_t, x_t, a_{t+1}^*, y_t)a_{t+1}^* + x_t = y_t - g(x_t, a_t, y_t) + a_t$$

$$y_t - g(x_t, a_t, y_t) + a_t \geq x_t.$$

$$k_{t+1} = (1 - \delta_{t+1})k_t, \quad x_{t+1} = \mu x_t, \quad a_{t+1} = a_{t+1}^* - e_{t+1}$$

The first constraint is the household's budget constraint, where  $q_t(k_t, x_t, a_{t+1}^*, y_t)$  is the price of a one-period unsecured debt contract for a household with house size  $k_t$ , mortgage payment  $x_t$ , and endowment  $y_t$  that wishes to carry assets  $a_{t+1}^*$  into the following period. Here  $g(x_t, a_t, y_t)$  represents the income tax levied by the government on a household with mortgage payment  $x_t$ , assets  $a_t$ , and endowment  $y_t$ . The second constraint restricts the household from paying their mortgage with unsecured debt by ensuring that their mortgage payment does not exceed their after-tax income plus their resources from their bond holdings with which they entered the period, net of the expense shock. The final three constraints represent the laws of motion for the household's home size, mortgage payment, and assets. While we discuss in detail our assumptions about mortgage contracts in the following section, for now it suffices to convey that mortgage payments decay over time at the constant rate  $\mu \in (0, 1)$ . Moreover, while the household chooses assets  $a_{t+1}^*$  with which to exit the period, while the assets that it enters with in the following period depends on

the realized expense shock  $e_{t+1}$ . Note that the expectation on the right hand side of the value function is taken with respect to all three sources of uncertainty: the household's next period endowment, depreciation shock, and expense shock.

If instead they choose to sell their home, they receive the proceeds from the sale  $P_t k_t$  less a proportional transaction cost  $\chi_S$ . The household must also repurchase their mortgage contract from the lender for an amount equal to the present value of the promised stream of decaying mortgage payments, discounted at the risk-free interest rate. We assume that the sale and purchase of housing space occurs at the beginning of each period, and therefore the household must rent housing space in the current period. The value of selling is thus:

$$S_t(k_t, x_t, a_t, y_t) = \max_{c_t, a_{t+1}^*, h_t} u(c_t, h_t) + \beta \mathbb{E}_t[V_{t+1}(0, 0, a_{t+1}, y_{t+1})|y_t]$$

subject to

$$c_t + q_t(0, 0, a_{t+1}^*, y_t) a_{t+1}^* + R_t h_t = y_t - g(0, a_t, y_t) + a_t + P_t k_t (1 - \chi_S) - \left(1 + \frac{\mu}{r + 1 - \mu}\right) x_t.$$

$$a_{t+1} = a_{t+1}^* - e_{t+1}$$

The household may also decide to default on their mortgage. In this case they are relieved of their mortgage payment but must relinquish their home to the lender. The household must also rent housing space in the current period and is temporarily excluded from credit markets. We assume that households with bad credit are allowed to reenter credit markets with probability  $\lambda$  each period. Hence, the value

of defaulting is

$$D_t(a_t, y_t) = \max_{c_t, a_{t+1}^* \geq 0, h_t} u(c_t, h_t) + \beta \mathbb{E}_t[\lambda V_{t+1}(0, 0, a_{t+1}, y_{t+1}) \\ + (1 - \lambda) X_{t+1}(0, 0, a_{t+1}, y_{t+1}) | y_t]$$

subject to

$$c_t + q_t(0, 0, a_{t+1}^*, y_t) a_{t+1}^* + R_t h_t = y_t - g(0, a_t, y_t) + a_t$$

$$a_{t+1} = a_{t+1}^* - e_{t+1}$$

where  $X_{t+1}(0, 0, a_{t+1}, y_{t+1})$  is the value of being a renter with bad credit. Note that the value of defaulting is independent of  $k_t$  and  $x_t$  since the household loses their home and is relieved of their mortgage in the current period.

Alternatively, a household may choose to file for bankruptcy and have their unsecured debt obligations discharged in exchange for a one-time utility cost  $\nu > 0$  and temporary exclusion from credit markets. In addition, a household that files for bankruptcy may face either a one-time endowment cost  $\omega_t(y_t)$  or be forced to sell their home. Homeowners who declare bankruptcy and are forced to sell their home are allowed to retain any home equity up to the homestead exemption  $\zeta$  and must rent housing space in the current period.<sup>11</sup> We therefore divide the value of bankruptcy into two distinct pieces:

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<sup>11</sup>We state the conditions under which a household that declares bankruptcy is forced to sell their home in the following section.



**(1) The household is forced to sell their home:**

$$B_t(k_t, x_t, y_t) = \max_{c_t, a_{t+1}^* \geq 0, h_t} u(c_t, h_t) - \nu + \beta \mathbb{E}_t[\lambda V_{t+1}(0, 0, a_{t+1}, y_{t+1}) \\ + (1 - \lambda) X_{t+1}(0, 0, a_{t+1}, y_{t+1}) | y_t]$$

subject to

$$c_t + q_t(0, 0, a_{t+1}^*, y_t) a_{t+1}^* + R_t h_t = y_t - g(0, 0, y_t) + \zeta \\ a_{t+1} = a_{t+1}^* - e_{t+1}$$

Note that the value of filing for bankruptcy is independent of the household's debt since it is entirely discharged.

**(2) The household is allowed to keep their home:**

$$B_t(k_t, x_t, y_t) = \max_{c_t, a_{t+1}^* \geq 0} u(c_t, k_t) - \nu + \beta \mathbb{E}_t[\lambda V_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}) \\ + (1 - \lambda) X_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}) | y_t]$$

subject to

$$c_t + q_t(k_t, x_t, a_{t+1}^*, y_t) a_{t+1}^* + x_t = y_t - g(x_t, 0, y_t) - \omega_t(y_t) \\ k_{t+1} = (1 - \delta_{t+1}) k_t, \quad x_{t+1} = \mu x_t, \quad a_{t+1} = a_{t+1}^* - e_{t+1}$$

Finally, we allow a household to simultaneously file for bankruptcy and default

on their mortgage. The value of doing so is:

$$BD_t(y_t) = \max_{c_t, a_{t+1}^* \geq 0, h_t} u(c_t, h_t) - \nu + \beta \mathbb{E}_t[\lambda V_{t+1}(0, 0, a_{t+1}, y_{t+1}) \\ + (1 - \lambda) X_{t+1}(0, 0, a_{t+1}, y_{t+1}) | y_t]$$

subject to

$$c_t + q_t(0, 0, a_{t+1}^*, y_t) a_{t+1}^* + R_t h_t = y_t - g(0, 0, y_t) - \omega_t(y_t).$$

$$a_{t+1} = a_{t+1}^* - e_{t+1}$$

Here the value of defaulting and filing for bankruptcy together is only dependent on the household's endowment since defaulting results in the loss of housing space and mortgage payment, while bankruptcy relieves the household of its unsecured debt obligations.

### 3.1.2 Problem of a Homeowner with Bad Credit

Now consider the problem of a household that owns their housing space but is excluded from credit markets. Such a household necessarily has filed for bankruptcy in the past and has not yet regained access to credit markets. The decision problem of this type of household is analogous to that presented above, except that they are restricted from borrowing in unsecured credit markets and hence will not declare bankruptcy. The household chooses whether to repay their mortgage and continue as a homeowner ( $O_t^X$ ), sell their home ( $S_t^X$ ), or default on their mortgage ( $D_t^X$ ).

Their optimal choice is the one with the highest value:

$$X_t(k_t, x_t, a_t, y_t) = \max_{O_t^X, S_t^X, D_t^X} \{O_t^X(k_t, x_t, a_t, y_t), S_t^X(k_t, x_t, a_t, y_t), D_t^X(a_t, y_t)\}.$$

The value of making their mortgage payment and continuing as a homeowner is given by

$$\begin{aligned} O_t^X(k_t, x_t, a_t, y_t) &= \max_{c_t, a_{t+1}^* \geq 0} u(c_t, k_t) + \beta \mathbb{E}_t[\lambda V_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}) \\ &\quad + (1 - \lambda)X(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}) | y_t] \end{aligned}$$

subject to

$$c_t + q_t(k_t, x_t, a_{t+1}^*, y_t)a_{t+1}^* + x_t = y_t - g(x_t, a_t, y_t) + a_t$$

$$k_{t+1} = (1 - \delta_{t+1})k_t, \quad x_{t+1} = \mu x_t, \quad a_{t+1} = a_{t+1}^* - e_{t+1}$$

If instead they choose to sell their home, they receive the proceeds from the sale  $P_t k_t$  less a proportional transaction cost  $\chi_S$ . The household must also repurchase their mortgage contract from the lender for an amount equal to the present value of the promised stream of decaying mortgage payments, discounted at the risk-free interest rate. Recall that a household that sells their home must rent housing space in the current period. The value of selling is then

$$\begin{aligned} S_t^X(k_t, x_t, a_t, y_t) &= \max_{c_t, a_{t+1}^* \geq 0, h_t} u(c_t, h_t) + \beta \mathbb{E}_t[\lambda V_{t+1}(0, 0, a_{t+1}, y_{t+1}) \\ &\quad + (1 - \lambda)X_{t+1}(0, 0, a_{t+1}, y_{t+1}) | y_t] \end{aligned}$$

subject to

$$c_t + q_t(0, 0, a_{t+1}^*, y_t)a_{t+1}^* + R_t h_t = y_t - g(0, a_t, y_t) + a_t + P_t k_t (1 - \chi_S) - \left(1 + \frac{\mu}{r + 1 - \mu}\right) x_t.$$

$$a_{t+1} = a_{t+1}^* - e_{t+1}$$

The household may also decide to default on their mortgage. In this case they are relieved of their mortgage payment but must relinquish their home to the lender and are temporarily excluded from credit markets. They must also rent housing space in the current period. The value of defaulting is

$$D_t^X(a_t, y_t) = \max_{c_t, a_{t+1}^* \geq 0, h_t} u(c_t, h_t) + \beta \mathbb{E}_t[\lambda V_{t+1}(0, 0, a_{t+1}, y_{t+1}) + (1 - \lambda) X_{t+1}(0, 0, a_{t+1}, y_{t+1}) | y_t]$$

subject to

$$c_t + q_t(0, 0, a_{t+1}^*, y_t)a_{t+1}^* + R_t h_t = y_t - g(0, a_t, y_t) + a_t$$

$$a_{t+1} = a_{t+1}^* - e_{t+1}$$

### 3.1.3 Problem of a Renter with Good Credit

Next, consider the decision problem faced by a household that does not own a home and is in good credit standing. This type of household must choose between purchasing housing space ( $O_t^R$ ), continuing to rent ( $L_t^R$ ), and filing for bankruptcy ( $B_t^R$ ). Their optimal choice is the one with the highest value:

$$V_t(0, 0, a_t, y_t) = \max_{O_t^R, L_t^R, B_t^R} \{O_t^R(a_t, y_t), L_t^R(a_t, y_t), B_t^R(y_t)\}.$$

Households can finance the purchase of housing space using a combination of savings and a mortgage. If the household decides to purchase a house of size  $k_t$ , commits to first mortgage payment  $x_t$ , chooses to carry assets  $a_{t+1}^*$  into the following period, and has endowment  $y_t$ , then the lender issues a mortgage with value  $m_t(k_t, x_t, a_{t+1}^*, y_t)x_t$  to the household. We impose that the household must be able to afford the sum of the purchase price  $P_t k_t$ , a proportional moving cost  $\chi_B$ , and their first mortgage payment  $x_t$  without the need to borrow in unsecured credit markets. The value of purchasing a home is thus:

$$O_t^R(a_t, y_t) = \max_{c_t, k_t, x_t, a_{t+1}^*} u(c_t, k_t) + \beta \mathbb{E}_t[V_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})|y_t]$$

subject to

$$c_t + q_t(k_t, x_t, a_{t+1}^*, y_t)a_{t+1}^* + P_t k_t(1 + \chi_B) + x_t = y_t - g(x_t, a_t, y_t) + a_t + m_t(k_t, x_t, a_{t+1}^*, y_t)x_t$$

$$y_t - g(x_t, a_t, y_t) + a_t + m_t(k_t, x_t, a_{t+1}^*, y_t)x_t \geq P_t k_t(1 + \chi_B) + x_t$$

$$P_t k_t \geq m_t(k_t, x_t, a_{t+1}^*, y_t)x_t$$

$$k_{t+1} = (1 - \delta_{t+1})k_t, \quad x_{t+1} = \mu x_t, \quad a_{t+1} = a_{t+1}^* - e_{t+1}$$

where the third constraint restricts the household from taking out a mortgage that exceeds the value of the home.

If the household decides to repay their unsecured debt and continue renting housing space, the value is given by:

$$L_t^R(a_t, y_t) = \max_{c_t, a_{t+1}^*, h_t} u(c_t, h_t) + \beta \mathbb{E}_t[V_{t+1}(0, 0, a_{t+1}, y_{t+1})|y_t]$$

subject to

$$c_t + q_t(0, 0, a_{t+1}^*, y_t)a_{t+1}^* + R_t h_t = y_t - g(0, a_t, y_t) + a_t.$$

$$a_{t+1} = a_{t+1}^* - e_{t+1}$$

Finally, the household can choose to file for bankruptcy subject to the same costs and penalties described above. The value of pursuing this option is

$$B_t^R(y_t) = \max_{c_t, a_{t+1}^* \geq 0, h_t} u(c_t, h_t) - \nu + \beta \mathbb{E}_t[\lambda V_{t+1}(0, 0, a_{t+1}, y_{t+1}) \\ + (1 - \lambda)X_{t+1}(0, 0, a_{t+1}, y_{t+1})|y_t]$$

subject to

$$c_t + q_t(0, 0, a_{t+1}^*, y_t)a_{t+1}^* + R_t h_t = y_t - g(0, 0, y_t) - \omega_t(y_t).$$

### 3.1.4 Problem of a Renter with Bad Credit

Lastly, consider the decision problem of a household that does not own housing space and is excluded from credit markets. To (slightly) simplify our analysis, we restrict this type of household from purchasing a home, and hence they must rent housing space until they regain access to credit markets. The problem of this type

of household is:

$$\begin{aligned}
X_t(0, 0, a_t, y_t) &= \max_{c_t, a_{t+1}^* \geq 0, h_t} u(c_t, h_t) + \beta \mathbb{E}_t[\lambda V_{t+1}(0, 0, a_{t+1}, y_{t+1}) \\
&\quad + (1 - \lambda) X_{t+1}(0, 0, a_{t+1}, y_{t+1}) | y_t]
\end{aligned}$$

subject to

$$c_t + q_t(0, 0, a_{t+1}^*, y_t) a_{t+1}^* + R_t h_t = y_t - g(0, a_t, y_t) + a_t.$$

$$a_{t+1} = a_{t+1}^* - e_{t+1}$$

### 3.2 Financial Intermediaries

We assume that financial intermediaries are risk neutral and competitive. For simplicity, we consider a representative financial intermediary that accepts deposits, lends to households in unsecured credit markets, and sells mortgages to help households finance the purchase of owner-occupied housing space. The financial intermediary can also borrow or lend risk-free at the exogenously given interest rate  $r$ .

For computational tractability, we model mortgage contracts as perpetuities with payments that decay over time. In particular, when taking out a mortgage, the mortgagee agrees to the sequence of payments  $\{x, \mu x, \mu^2 x, \dots\}$ , where  $\mu \in (0, 1)$ , until they either default or sell their home. The decaying nature of mortgage payments allows households to gradually build home equity over time, even with a constant house price.

Consider a mortgage sold to a household planning to purchase a home of size

$k_t$ , with initial payment  $x_t$ , end of period assets  $a_{t+1}$ , and endowment  $y_t$ . The intermediary then disperses the amount  $m_t(k_t, x_t, a_{t+1}, y_t)x_t$  to the household in the current period and receives the first payment  $x_t$ . If the household defaults in the following period, the intermediary takes control of the house and sells it through a foreclosure process, recovering a fraction  $1 - \chi_S$  of its post-depreciation shock market value  $P_{t+1}k_{t+1}$ , where  $\chi_S$  is a proportional transaction cost.

If the household decides to sell, they must repurchase their mortgage contract from the lender for an amount equal to the present value of the promised stream of decaying mortgage payments, discounted at the risk-free interest rate, or  $(1 + \mu/(r + 1 - \mu))x_{t+1}$ .

If the household declares bankruptcy, their unsecured debt obligations are discharged in exchange for temporary exclusion from credit markets, a one-time utility cost, and either a one-time endowment cost or the forced sale of their home.<sup>12</sup> If the home is liquidated as part of the bankruptcy proceedings, the intermediary receives the present value of the mortgage discounted at the risk-free interest rate. From the intermediary's perspective, bankruptcy in this case is equivalent to the sale of the home. On the other hand, if the household is allowed to keep their home, the intermediary receives the continuation value of the mortgage conditional on the household's choice of assets, realized endowment, depreciation shock, expense shock, and inability to borrow in unsecured credit markets.

If the household neither defaults, sells, nor declares bankruptcy, the intermediary receives the continuation value of the mortgage conditional on the household's choice

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<sup>12</sup>We will discuss the details pertaining to the U.S. bankruptcy code and its treatment of homeownership in the following section.



of assets, realized endowment, depreciation shock, and expense shock in the following period.

Let  $\mathbb{D}_t(k_t, x_t, a_t, y_t)$  be an indicator function equal to 1 if a household with these characteristics finds it optimal to default at time  $t$  and 0 otherwise. Likewise, let  $\mathbb{S}_t(k_t, x_t, a_t, y_t)$  be an indicator function equal to 1 if a household with these characteristics sells their home (either because they find it optimal to sell or because their home is liquidated during bankruptcy) and 0 otherwise, and similarly define  $\mathbb{B}_t(k_t, x_t, a_t, y_t)$  for a household that declares bankruptcy but is not forced to sell their home. The zero profit condition for this mortgage contract is then:

$$\begin{aligned}
& m_t(k_t, x_t, a_{t+1}, y_t)x_t = x_t \\
& + \frac{1}{1+r+\alpha_t} \mathbb{E}_t \left[ \underbrace{\mathbb{D}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}) P_{t+1} k_{t+1} (1 - \chi_S)}_{\text{Value if household defaults}} \right] \\
& + \underbrace{\mathbb{S}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}) \left( 1 + \frac{\mu}{r+1-\mu} \right) x_{t+1}}_{\text{Value if house is sold}} \\
& + \underbrace{\mathbb{B}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}) m_{t+1}^X(k_{t+1}, x_{t+1}, a_{t+2}, y_{t+1}) x_{t+1}}_{\text{Continuation value of mortgage after bankruptcy}} \\
& + (1 - \mathbb{D}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})) (1 - \mathbb{S}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})) \\
& \underbrace{(1 - \mathbb{B}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})) m_{t+1}(k_{t+1}, x_{t+1}, a_{t+2}, y_{t+1}) x_{t+1}}_{\text{Continuation value of mortgage without bankruptcy}} | y_t
\end{aligned}$$

where  $\alpha_t$  is a time-varying credit wedge and the expectation is taken over the realization of the household's next period endowment, depreciation shock, and expense shock.

Since the value of a mortgage today depends on its continuation value tomorrow if the household files for bankruptcy and is allowed to keep their home, creditors must also price mortgages to households that are excluded from credit markets even though such a mortgage is never actually sold in equilibrium.<sup>13</sup> A household that is excluded from credit markets, owns a home of size  $k_t$ , and has a mortgage with payment  $x_t$  will never file for bankruptcy (since they will not have any unsecured debt), but they may choose to sell their home or default on their mortgage. In addition, the household is allowed to reenter credit markets with probability  $\lambda$  each period. Let  $\mathbb{D}_t^X(k_t, x_t, a_t, y_t)$  and  $\mathbb{S}_t^X(k_t, x_t, a_t, y_t)$  be indicator functions analogous to those described above but specific to households that are excluded from credit markets. The value of this mortgage contract is then

$$\begin{aligned}
& m_t^X(k_t, x_t, a_{t+1}, y_t)x_t = x_t \\
& + \frac{1}{1+r+\alpha_t} \mathbb{E}_t[(1-\lambda) \underbrace{\{\mathbb{D}_{t+1}^X(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})P_{t+1}k_{t+1}(1-\chi_S)\}}_{\text{Value of remaining excluded and defaulting}} \\
& \quad + \underbrace{\mathbb{S}_{t+1}^X(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}) \left(1 + \frac{\mu}{r+1-\mu}\right) x_{t+1}}_{\text{Value of remaining excluded and selling}} \\
& \quad + (1 - \mathbb{D}_{t+1}^X(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}))
\end{aligned}$$

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<sup>13</sup>We assume that households which are excluded from unsecured credit markets are also excluded from mortgage markets, and hence this type of mortgage is never sold to households in our model. Given our assumption of competitive financial intermediaries, though, one can think of an active secondary mortgage market in which this type of mortgage, along with all other active mortgages, are traded. It is this market in which the continuation value, or price, of mortgages such as this one are determined.

$$\begin{aligned}
& \underbrace{(1 - \mathbb{S}_{t+1}^X(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}))m_{t+1}^X(k_{t+1}, x_{t+1}, a_{t+2}, y_{t+1})x_{t+1}}_{\text{Value of remaining excluded and continuing mortgage}} \\
& + \lambda \underbrace{\{\mathbb{D}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})P_{t+1}k_{t+1}(1 - \chi_S)\}}_{\text{Value of reentering credit markets and defaulting}} \\
& + \underbrace{\mathbb{S}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}) \left(1 + \frac{\mu}{r + 1 - \mu}\right) x_{t+1}}_{\text{Value of reentering credit markets and selling}} \\
& + (1 - \mathbb{D}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})) \\
& \underbrace{(1 - \mathbb{S}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}))m_{t+1}(k_{t+1}, x_{t+1}, a_{t+2}, y_{t+1})x_{t+1}}_{\text{Value of reentering credit markets and continuing mortgage}} \Big| y_t]
\end{aligned}$$

Together, these functional equations determine the profit maximizing, equilibrium mortgage contract pricing schedules  $m_t(k_t, x_t, a_{t+1}, y_t)$  and  $m_t^X(k_t, x_t, a_{t+1}, y_t)$ .

The financial intermediary also offers one-period, unsecured, pure discount bonds which households cannot commit to repay. Suppose, for example, a household with house size  $k_t$ , mortgage payment  $x_t$ , and endowment  $y_t$  promises to repay an amount  $a_{t+1}$  in the following period. The intermediary then disperses the amount  $q_t(k_t, x_t, a_{t+1}, y_t)a_{t+1}$  to the household in the current period. If the household does not declare bankruptcy in the following period, then the intermediary is repaid the amount  $a_{t+1}$  in full. On the other hand, if the household declares bankruptcy, the intermediary recovers an amount  $\psi_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})$  which depends on the household's characteristics and the current bankruptcy laws in place. The zero profit condition for this type of loan is:

$$q_t(k_t, x_t, a_{t+1}, y_t)a_{t+1} = \frac{1}{1+r} \mathbb{E}_t \left[ \underbrace{(1 - \mathbb{B}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1}))a_{t+1}}_{\text{Value of repaying loan}} \right]$$

$$+ \underbrace{\mathbb{B}_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})\psi_{t+1}(k_{t+1}, x_{t+1}, a_{t+1}, y_{t+1})}_{\text{Value of declaring bankruptcy}} |y_t].$$

Since a household that chooses  $a_{t+1} \geq 0$  will never file for bankruptcy, it follows that:

$$q_t(k_t, x_t, a_{t+1}, y_t) = \frac{1}{1+r}$$

for all  $k_t$ ,  $x_t$ , and  $y_t$  whenever  $a_{t+1} \geq 0$ . Hence, the equilibrium net interest rate paid by the financial intermediary on household deposits is  $r$ .

### 3.3 Government

There is also a government that levies income taxes on households. We include a government in our model to capture two of the primary financial benefits of homeownership in the U.S.: (1) the implicit rental income from homeownership is not taxed and (2) mortgage interest payments are tax deductible. While the former induces high income households to purchase rather than rent their housing space, the latter gives an incentive for homebuyers to finance their purchase with debt rather than equity. For simplicity, we assume that government consumption does not provide any benefit to households and that tax revenues are not rebated to households.

The tax  $g$  levied on each household is modeled after the U.S. tax code. A household's taxable income  $i$  is the sum of their current endowment and interest on deposits less the greater of (i) their mortgage interest payment  $\mu r x_t / (r + 1 - \mu)$  and (ii) the standard deduction  $s$ :

$$i(x_t, a_t, y_t) = y_t + r \max\{a_t, 0\} - \max\left\{\frac{\mu r x_t}{r + 1 - \mu}, s\right\}.$$

We assume that the tax rate  $\tau(i(x_t, a_t, y_t))$  is increasing in the household's taxable income. The tax levied on a household is then:

$$g(x_t, a_t, y_t) = \int_0^{i(x_t, a_t, y_t)} \tau(w) dw$$

and their after-tax income is given by  $y_t - g(x_t, a_t, y_t)$ .

### 3.4 Market Clearing

Let  $\Phi_t(k_t, x_t, a_t, y_t, cs_t)$  represent the distribution of households over owner-occupied housing space, mortgage payments, assets, endowments, and credit statuses ( $cs_t$ ) entering period  $t$ . The prices  $P_t$  and  $R_t$  adjust each period so that the aggregate demands for owner-occupied and rental housing space equal their exogenous supplies:

$$K_t = \int k_t(k_t, x_t, a_t, y_t) d\Phi_t(k_t, x_t, a_t, y_t, cs_t)$$

$$H_t = \int h_t(k_t, x_t, a_t, y_t) d\Phi_t(k_t, x_t, a_t, y_t, cs_t)$$

### 3.5 Equilibrium

An equilibrium in this economy is a sequence of prices  $\{P_t, R_t, q_t, m_t, m_t^X\}$ , ex-

ogenous sequences of owner-occupied and rental housing stocks  $\{K_t, H_t\}$ , sequences of household decision rules, and a sequence of distributions of households over states  $\{\Phi_t\}$ , such that, taking prices, the bankruptcy code, housing supplies, and the initial distribution of households over states  $\Phi_0$  as given, at each date  $t$ :

1. Households optimally solve their decision problems.
2. Creditors maximize profits.
3. Markets for owner-occupied and rental housing clear.

## 4 The BAPCPA

Prior to the BAPCPA, most households with significant unsecured debt obligations could benefit by filing for bankruptcy. Households who did not own a home were able to have all of their unsecured debt obligations extinguished in exchange for having a bankruptcy flag on their credit report for a period of 10 years.<sup>14</sup> We model this penalty as a one-time utility cost and temporary exclusion from credit markets, during which time households can neither borrow in unsecured credit markets nor purchase a home.<sup>15</sup> There are no other costs associated with declaring bankruptcy in this case, and unsecured creditors do not recover anything (i.e.  $\omega_t(y_t) = 0$  and  $\psi_t(k_t, x_t, a_t, y_t) = 0$ ).

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<sup>14</sup>The presence of a bankruptcy flag on a household's credit report has been shown to severely restrict their access to credit (see [Musto \(2004\)](#)).

<sup>15</sup>The one-time utility cost is meant to capture the social stigma attached to bankrupts discussed extensively in the literature (see [Fay, Hurst, and White \(2002\)](#) and [Gross and Souleles \(2002\)](#)).

The U.S. bankruptcy code provides exemptions which households can use to protect certain assets from seizure by creditors. The largest and most commonly used is the homestead exemption which allows homeowners to keep their home equity up to a prespecified limit known as the homestead exemption. Homeowners with home equity less than the homestead exemption were allowed to keep their home and file under Chapter 7. Homeowners with home equity greater than the homestead exemption, on the other hand, were forced to sell their home and transfer all home equity in excess of the homestead exemption (non-exempt home equity) to their unsecured creditors.

In terms of our model, define the home equity of a household with house size  $k_t$  and payment  $x_t$  at time  $t$  as

$$HE_t(k_t, x_t) \equiv P_t k_t - \left(1 + \frac{\mu}{r + 1 - \mu}\right) x_t$$

and let  $\zeta$  be the homestead exemption. Prior to the BAPCPA, a homeowner with  $HE_t(k_t, x_t) \leq \zeta$  would be allowed to keep their home, while a homeowner with  $HE_t(k_t, x_t) > \zeta$  would be forced to sell, raising an amount  $P_t k_t$ . Out of these funds, the mortgage lender would receive the present value of the promised stream of decaying mortgage payments, discounted at the risk free interest rate, or  $[1 + \mu/(r + 1 - \mu)]x_t$ , the household would keep an amount equal to the homestead exemption  $\zeta$ , and unsecured creditors would be paid all non-exempt home equity up to the original

loan amount:

$$\psi_t(k_t, x_t, a_t, y_t) = \min \{|a_t|, \max \{HE_t(k_t, x_t) - \zeta, 0\}\}.^{16}$$

The BAPCPA made it more costly for households to declare bankruptcy. It raised the average total bankruptcy filing costs under both Chapter 7 and Chapter 13, capped the homestead exemption for households who have owned their home for less than 3 -1/2 years, increased the number of years before a household could refile from six to eight, and introduced means testing that severely restricted high income households' ability to benefit from bankruptcy. While all of these reforms clearly affect a homeowner's decision to file, we focus our attention on the effects of means testing as it is likely to have the largest impact on household behavior.

To illustrate the impact of means testing introduced under the BAPCPA, consider a household that either does not own a home or has home equity below the homestead exemption. The first step is to convert the household's income over the previous six months to an annualized basis and then compare it to the median income in their home state. If their income is less than the median, they are permitted to file under Chapter 7 and are unaffected by the reform. Conversely, if their income is above the median, the household may be forced to file under Chapter 13 and commit to a repayment plan.<sup>17</sup> In this case, the household's unsecured debt is discharged, but

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<sup>16</sup>The fact that non-exempt home equity is seized by unsecured creditors during bankruptcy should lead to lower interest rates on borrowing in unsecured credit markets for these borrowers. We find this to be a quantitatively important benefit of homeownership which was reduced by the BAPCPA.

<sup>17</sup>This occurs if their income in excess of their exempt income, where exempt income includes the funds required for housing and transportation costs and personal expenses as well as additional amounts for their mortgage and car payments, exceeds \$2,000. See [Li et al. \(2011\)](#) for a detailed



they are required to pay all non-exempt income to their creditors for a period of five years. For simplicity, we model this penalty as a one-time endowment cost. Specifically, if  $\bar{y}$  is median income, then a household that declares bankruptcy, does not own a home, and has endowment  $y_t > \bar{y}$ , is required to repay an amount

$$\omega_t(y_t) = \kappa(y_t - \bar{y})$$

in the current period to their unsecured creditors, in addition to facing the same one-time utility cost and temporary exclusion from credit markets discussed above. It follows in this case that,

$$\psi_t(k_t, x_t, a_t, y_t) = \min \{|a_t|, \kappa(y_t - \bar{y})\},$$

where the creditor's recovery amount is bounded above by the initial loan amount.

Now consider a household that owns their home and has home equity in excess of the homestead exemption. If the household's non-exempt home equity is greater than five times their annualized income in excess of the state's median income (non-exempt income), then the household is forced to sell their home and pay all non-exempt home equity to their unsecured creditors. Otherwise, the household is allowed to keep their home, but must pay all non-exempt income to their creditors for a period of five years. In both cases the household is subject to the same one-time utility cost and temporary exclusion from credit markets discussed above. In terms of our 

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description of how a household's non-exempt income is computed.

model, if

$$HE_t(k_t, x_t) - \zeta > 5(y_t - \bar{y})$$

then the household is forced to sell their home, raising an amount  $P_t k_t$ . Out of these funds, the mortgage lender receives the present value of the promised stream of decaying mortgage payments, discounted at the risk free interest rate, or  $[1 + \mu/(r + 1 - \mu)]x_t$ , the household receives an amount equal to the homestead exemption  $\zeta$ , and unsecured creditors are paid all non-exempt home equity up to the original loan amount:

$$\psi_t(k_t, x_t, a_t, y_t) = \min \{|a_t|, \max \{HE_t(k_t, x_t) - \zeta, 0\}\}.$$

On the other hand, if

$$HE_t(k_t, x_t) - \zeta \leq 5(y_t - \bar{y})$$

the household is required to repay an amount

$$\omega_t(y_t) = \kappa(y_t - \bar{y}),$$

in the current period to their unsecured creditors, in addition to facing the same one-time utility cost and temporary exclusion from credit markets discussed above.

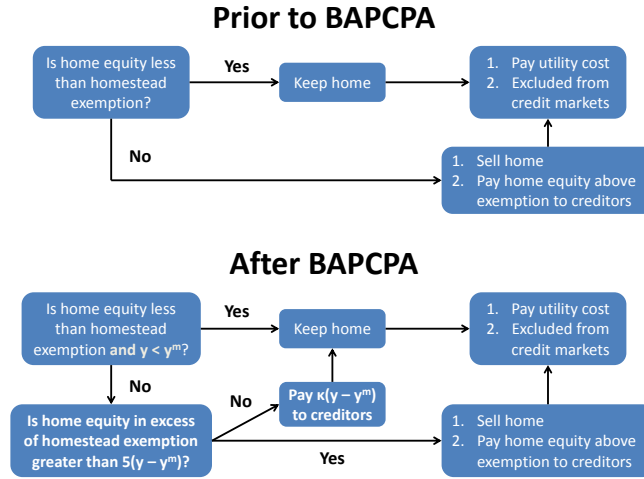
It follows in this case that,

$$\psi_t(k_t, x_t, a_t, y_t) = \min \{|a_t|, \kappa(y_t - \bar{y})\},$$

where, again, the creditor's recovery amount is bounded above by the initial loan amount.

Importantly, in this case the creditor’s recovery amount only depends on the household’s income and is independent of the household’s homeownership status. While this household would have benefited from owning a home through lower interest rates on unsecured debt prior to the BAPCPA, this benefit is no longer available under the BAPCPA. Consequently, homeowners that currently have negative home equity and expect to have high income in the future, perceive a reduced benefit to future homeownership. This lower future benefit may induce some homeowners to default on their mortgage instead of staying in their home. Understanding this mechanism is important when discussing the effects of the BAPCPA on households’ incentives to default.

**Figure 2. Implementation of BAPCPA**



The effects of means testing implemented under the BAPCPA on the costs of bankruptcy faced by households in our model is depicted in Figure 2. Clearly, bankruptcy reform made filing for bankruptcy much more costly for high income

households. In the following sections we calibrate our model and quantify the effects of BAPCPA on the recent housing crisis.

## 5 Parameterization

We assume that each period in our model corresponds to one year. Many of our model parameters are common in the literature and can therefore be set outside of the model. We first discuss how these parameters are chosen and then describe how we calibrate the remaining model parameters.

The parameters governing households' stochastic first-order autoregressive endowment process are set to  $\rho = 0.97$  and  $\sigma = 0.129$ , which are consistent with the findings of [Storesletten, Telmer, and Yaron \(2004\)](#). We discretize this process with a 17-state Markov chain using [Tauchen and Hussey \(1991\)](#)'s method.

We assume that a household's flow utility at date  $t$  is given by:

$$u(c_t, h_t) = \frac{(c_t^{1-\theta} h_t^\theta)^{1-\gamma}}{1-\gamma}$$

where  $\gamma$  is a proxy for risk aversion and  $\theta$  determines the share of income spent on housing space.<sup>18</sup> We set  $\gamma = 2$  which is a standard value for this parameter used in the literature. Empirical work by [Davis and Ortalo-Magne \(2011\)](#) indicates that household's spend approximately 24% of their income on housing services, so we set  $\theta = 0.24$ .

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<sup>18</sup>Cobb-Douglas preferences imply that a renting household will choose to spend constant fractions of their wealth on non-durable consumption and housing services. Note that households do not derive any direct utility benefit from owning versus renting their housing space in this model.

The parameters related to the housing sector that are determined outside of our model are  $(\chi_B, \chi_S, \bar{\delta}, \zeta)$ . The proportional transaction costs for buying and selling are set to  $\chi_B = 0.025$  and  $\chi_S = 0.070$ , respectively, which are in line with the values reported by [Gruber and Martin \(2003\)](#). [Pennington-Cross \(2006\)](#) find that the value received from the sale of a foreclosed home is about 78% of the market value for a similar non-foreclosed home.<sup>19</sup> Since in our model a household that chooses to default on their mortgage also often has incurred the housing depreciation shock, we set  $\bar{\delta}$  such that creditors receive 78% of the value of the pre-depreciation shock home after selling transaction costs. This implies that  $\bar{\delta} = 0.15$ .<sup>20</sup> Since our model is intended to represent the U.S. economy, we compute the average homestead exemption across states, where each state is weighted by its share of U.S. households.<sup>21</sup> Using data collected by [Mitman \(2011\)](#), we find the weighted average homestead exemption to be 1.10 times median household income. We normalize median income in our model to 1 and therefore set  $\zeta = 1.10$ .

The risk-free interest rate is set to 4% as is standard in the literature. The positive value for the expense shock  $\bar{e}$  is set to 3.33 times median income, which is consistent with the findings of [Livshits et al. \(2007\)](#). The probability of reentering credit markets after declaring bankruptcy or defaulting on a mortgage  $\lambda$  is set to 12%, implying that, on average, an excluded household reenters credit markets after 8.5 years. Although households that declared bankruptcy during the pre-reform period

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<sup>19</sup>This finding is in line with estimates from other work, including [Shilling, Benjamin, and Sirmans \(1990\)](#), who find values that range in 22%-24%.

<sup>20</sup>More formally, the value to the creditor of a foreclosed home that received the depreciation shock is  $(1 - \bar{\delta})(1 - \chi_S)P_t k_t = 0.85(0.925)P_t k_t = 0.786P_t k_t$ , matching the empirical literature.

<sup>21</sup>We exclude states with an infinite homestead exemption from this calculation.

were only restricted from refiling for 6 years, there is empirical evidence that filing for bankruptcy impacts a household’s credit market status for as long as their credit score is adversely affected. Moreover, underwriting standards by the government-sponsored enterprises over this period suggest that access to mortgage markets is also similarly restricted after a bankruptcy or default.<sup>22</sup>

Finally, we calibrate the tax schedule. As in [Chatterjee and Eyigungor \(2011b\)](#) we assume that a household in our model files their taxes as married filing separately and calibrate the model’s income tax schedule to match that of the U.S. economy in 1998. Table 1 presents the implied tax schedule and we set the standard deduction  $s = 0.1116$ .

Table 1. Model Income Tax Brackets

Taxable Income ( $i$ )	Tax Rate ( $\tau$ )
0 – 0.64	0.15
0.64 – 1.55	0.28
1.55 – 2.37	0.31
2.37 – 4.23	0.36
4.23 – $\infty$	0.396

The remaining parameters to be calibrated are the discount factor  $\beta$ , the utility cost of bankruptcy  $\nu$ , the rate of decay for mortgage payments  $\mu$ , the probability the household receives a depreciation shock  $\phi$ , and the probability a household receives an expense shock  $\xi$ . These parameters are jointly calibrated to match the unsecured

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<sup>22</sup>For example, [Musto \(2004\)](#) finds that households that declare bankruptcy face restricted access to credit markets at potentially prohibitively tough terms for 10 years after they file – at which point the bankruptcy flag is removed from their credit report. Defaulting on a mortgage also negatively impacts a household’s credit score and thus their ability to borrow in unsecured credit markets (see [Christie \(2010\)](#) and [Brevoort and Cooper \(2010\)](#)).

debt-to-income ratio, bankruptcy filing rate, percentage of homeowners with less than 30% home equity, mortgage default rate, and bankruptcy rate among new homeowners in the stationary distribution of the model prior to the BAPCPA.

Since these statistics are intended to capture a steady state in the U.S. housing market prior to the BAPCPA, we choose targets that predate the substantial rise in homeownership rates and house prices that corresponded with the housing boom in the mid-2000's. The target bankruptcy filing rate is set to 1.4%, which was the total bankruptcy filing rate in 2004 as reported by [Li and White \(2009\)](#). The percentage of homeowners with home equity less than 30% is taken from [Chatterjee and Eyigungor \(2011b\)](#), who in turn compute this number from the 1998 Survey of Consumer Finances. This value is set to 23.0%. The annual foreclosure rate according to the Mortgage Banker's Association was about 1.0%. However, using data from LPS Analytics between 2001 and 2003, [Herkenhoff and Ohanian \(2012\)](#) find that roughly 15% of homeowners entering the foreclosure process self-cure and remain in their home. Since defaulting on a mortgage is synonymous with losing the home through a foreclosure process in our model, we exclude such households from our target statistic, implying a mortgage default rate of 0.85%. The target bankruptcy rate for new homeowners is set to 0.57%, as reported in [Li et al. \(2011\)](#). The target unsecured debt-to-income ratio is set to 9.6%. This statistic is computed by constructing a revolving debt-to-income ratio measure from the Flow of Funds Accounts and adjusting this series with the historical spread between the unsecured and revolving debt-to-income ratios implied by [Livshits et al. \(2010\)](#). Finally, we choose to target a homeownership rate of 66.4%, which matches the ten-year average in the U.S.

economy prior to 2003.

The joint calibration of these five parameters ( $\beta, \nu, \mu, \phi, \xi$ ) is achieved by conducting a grid search over the parameters, computing the stationary distribution of the economy for each set of parameters, and choosing the combination that minimizes a weighted sum of squared residuals between the empirical and model values for the target statistics.<sup>23</sup> Table 2 summarizes the parameter values.

Table 2. Parameterization

Parameter	Value	Source/Target
$\gamma$	2.0	Standard
$\theta$	0.24	Davis and Ortalo-Magne (2011)
$\rho$	0.97	Storesletten et al. (2004)
$\sigma$	0.129	Storesletten et al. (2004)
$r$	0.04	Standard
$\chi_B$	0.025	Gruber and Martin (2003)
$\chi_S$	0.070	Gruber and Martin (2003)
$\bar{\delta}$	0.15	Pennington-Cross (2006)
$\zeta$	1.10	Mitman (2011)
$\lambda$	0.12	Average Exclusion Period of 8.5 yrs
$\bar{e}$	3.33	Livshits et al. (2007)
$\beta$	0.936	Unsecured Debt-to-Income Ratio = 9.6%
$R/P$	0.052	Homeownership Rate = 66.4%
$\nu$	1.6	Bankruptcy Filing Rate = 1.4%
$\mu$	0.966	Fraction of HO with < 30% HE = 23.0%
$\phi$	0.005	Mortgage Default Rate = 0.85%
$\xi$	0.004	New HO Bankruptcy Rate = 0.57%

Table 3 presents the calibration results and other relevant model statistics in the pre-reform stationary distribution of the model. The model is able to match the

<sup>23</sup>See Appendix A for a detailed description of our algorithm to solve for the model's stationary distribution.



Table 3. Steady State Results

Statistic	Data	Model
Homeownership Rate*	66.4%	71.0%
Bankruptcy Filing Rate*	1.4%	1.7%
New Homeowner Bankruptcy Filing Rate*	0.57%	0.65%
Aggregate Mortgage Default Rate*	0.85%	0.90%
Homeowners with < 20% Equity	13.7%	8.6%
Homeowners with < 25% Equity	19.0%	16.5%
Homeowners with < 30% Equity*	23.0%	23.7%
Average Home Equity Ratio	64.0%	50.3%
Average Loan-to-Value at Origination	?	83.5%
Average Income of Homeowners to Renters	2.02	1.77
Average Annual Home Sales	4.3%	4.8%
Loan-to-Income Ratio	3.9	3.6
Unsecured Debt-to-Income Ratio*	9.6%	11.5%

\* = Calibration Target

pre-reform empirical moments for the statistics targeted in our calibration exercise reasonably well. It also performs well in replicating several relevant statistics that are not targeted by our calibration exercise. Notably, the model replicates the home equity distribution rather well, only slightly underpredicting the fraction of homeowners with home equity less than 20 and 25 percent, in addition to matching the fraction of homeowners with less than 30 percent home equity. Matching this region of the home equity distribution is particularly important because it suggests that the fraction of homeowners that are pushed underwater on their mortgage by a drop in house prices similar to the recent housing crash is the same in the model and the data – a necessary feature of a model that quantitatively evaluates the effects of an unexpected housing crash.

The initial stationary distribution of the model is also consistent with the fact that homeowners have higher income, on average, than renters. The average income of homeowners relative to renters is 1.77 in our model, compared to 2.02 in the data.

Moreover, the pre-crisis stationary distribution is consistent with several statistics regarding the relative size of mortgages. In particular, our model matches the empirical loan-to-income value rather well and generates a loan-to-value at origination of 83.5%. Although we were unable to locate an analog to this statistic in the data, this value seems reasonable. Finally, the model implies that 4.8% of all owner-occupied houses are sold each year, which is in line with the ten-year average prior to 2003 as reported by the National Association of Realtors.

Now that we have calibrated the model and determined that it is able to match key empirical statistics in the pre-BAPCPA stationary distribution, we turn to the primary quantitative objective of this paper: assessing the impact of the BAPCPA on the U.S. economy during the recent housing crisis. The next section details how we use the model to make such an assessment and describes our quantitative results.

## 6 Quantitative Results

In this section we detail the quantitative experiment that we run to assess the impact of the BAPCPA on the housing market crash. The experiment is based on the economy experiencing two shocks: a bankruptcy reform shock in 2005 and a housing crisis in 2007. We then compute the perfect foresight transition path of the economy in response to the following sequences of events assuming each event is unanticipated

by the agents in our model:

1. *Actual Timeline*: The U.S. economy experiences an unexpected change to the bankruptcy code in 2005 that mimics the BAPCPA and then suffers a housing crisis in 2007.<sup>24</sup>
2. *Counterfactual*: The U.S. bankruptcy code is not altered in 2005 but the economy does experience a housing crisis in 2007.

The ability to run counterfactual exercises that incorporate general equilibrium effects through housing, mortgage, and unsecured debt prices, to isolate the impact of the BAPCPA on the subsequent housing crisis is a key benefit of constructing a quantitative model like that presented in this paper.

We model the BAPCPA shock as an unexpected and permanent change to the U.S. bankruptcy code as outlined in Section 4: an introduction of the income and asset means testing consistent with this reform. Following [Chatterjee and Eyigungor \(2011b\)](#) we model the housing crisis as an unexpected increase in the owner-occupied housing supply in 2007. Unlike these authors, however, we assume that this shock is temporary and dissipates over time, which implies that the housing market eventually returns to a state consistent with the initial stationary distribution.<sup>25</sup> We find that a 4% shock to the supply of owner-occupied housing produces a decline in house prices

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<sup>24</sup>The fact that we model bankruptcy reform as unexpected in 2005 seems reasonable given our annual calibration. Although this act was originally introduced in Congress in 1998, it gained little political support until Republican majorities increased in Congress in 2004. It was ultimately passed by the U.S. Congress on April 14, 2005 and signed into law by President Bush on April 20th of that same year. Its provisions affected bankruptcy filings on or after October 17, 2005.

<sup>25</sup>In particular, we assume that the owner-occupied housing supply remains elevated between 2007 and 2012 and then declines to its original value by 2020.

similar in magnitude to the decline in the S&P Case-Shiller 20-City Home Price Index between January 2007 and January 2009. The size of our housing supply shock is also in line with the empirical estimates of excess housing supply reported by McNulty (2009).

In order to capture the fact that housing prices remain below their peak in 2006, we also include an exogenous credit wedge that increases the cost of issuing mortgages in the periods immediately following the housing market crash. A substantial rise in credit spreads during this period is documented in Hall (2011), who finds increases in various spreads on the order of 1.0-3.7%. In particular, we model this wedge as an additional spread – above the risk-free rate – that the creditor requires, represented by  $\alpha_t$ . Under this interpretation, the right-hand side of the mortgage pricing equations are now multiplied by  $1/(1+r+\alpha_t)$  instead of  $1/(1+r)$ . To match the upper-end of Hall (2011)’s estimates, we set  $\alpha_t = 0.035$  for  $t = 2008, \dots, 2012$ , and then allow this wedge to slowly decline back to zero by 2020. In sum, these modeling assumptions imply that the housing supply and credit markets return to their initial standing by 2020.

While solving the counterfactual perfect foresight transition path is relatively straightforward – given that the economy only experiences one unexpected shock – solving the transition under the actual timeline is more complicated. To solve for this transition, we have to compute two different transitions, and then combine the results from each to form the actual sequence of events. First, we compute a transition path of our economy starting from the pre-BAPCPA stationary distribution that experiences a bankruptcy reform-only shock in 2005, and then transitions to the

post-BAPCPA steady state from there. This transition gives us the model statistics for 2005 and 2006 as well as the distribution of households over states entering 2007. The second transition starts with this distribution and subjects the economy to an unexpected 4% increase in the owner-occupied housing supply. The transition from this shock to the steady state for the post-BAPCPA economy with an owner-occupied housing supply consistent with the initial stationary distribution is then computed. This transition provides us with the statistics for the economy from 2007 onward. Appendix A presents a more detailed description of our model solution, including solving for the economy's stationary distribution given a fixed set of parameters, and also computing the perfect foresight transitions described in this section.

Prior to computing the transitions, we have to determine the value for  $\kappa$ , which controls the cost of filing for bankruptcy for high income households that pass the income means test after bankruptcy reform. Recall that a household that files for bankruptcy and is forced into a repayment plan due to their high income must pay  $\kappa(y_t - \bar{y})$  in the current period, where  $\bar{y}$  is the economy's median income. We choose  $\kappa$  to match [Li et al. \(2011\)](#)'s findings that, on impact, bankruptcy reform increased the default probability of households that owned their home for less than three years by 21.6%.<sup>26</sup> To compute this statistic, we have to solve the entire perfect foresight transition of the economy in response to only the BAPCPA shock in 2005. We then find the value of  $\kappa$  that produces an increase in the mortgage default probability of new homeowners of 21.6%. A value of  $\kappa = 1.0$  most closely matches this statistic.

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<sup>26</sup>We compute this number from their findings that the probability of defaulting on a prime mortgage – which represented 81% of outstanding mortgages – increased by 23.4%, and the probability of defaulting on a subprime mortgage increased by 13.9%.

The next two sections present the main quantitative results of this paper.

## 6.1 BAPCPA and the Housing Crisis

We first consider the effect of the BAPCPA on the U.S. economy on impact when it was introduced in 2005. We compare the model implied statistics in 2005 to the statistics taken from the pre-reform stationary distribution. Table 4 depicts the percentage change in each of these statistics from the pre-reform stationary distribution in response to bankruptcy reform.

Table 4. Bankruptcy Reform on Impact

Statistic	Change
P	0.0%
R	-0.5%
Bankruptcy Rate	-1.0%
Mortgage Default Rate	25.5%

Upon implementation, the BAPCPA reduces the bankruptcy rate and produces a higher mortgage default rate, which is consistent with the empirical literature. In particular, the bankruptcy filing rate falls by 1.0% and the mortgage default rate increases by 25.5%. However, the BAPCPA had minimal impact on house and rental prices. The price of owner-occupied housing is unchanged and the rental price only declines by 0.5% in response to the reform.

We now turn to the primary quantitative question of this paper: To what extent did the BAPCPA impact the housing market crash? We begin by assessing the ability of our model to match the severity of the housing crisis. The model statistics

in 2007 are presented in Table 5.<sup>27</sup>

Table 5. The Housing Crisis

Statistic	Initial Steady State	Value in 2007
P	1.00	0.75
R	0.052	0.044
Bankruptcy Rate	1.7%	3.3%
Mortgage Default Rate	0.9%	4.5%
R/P	5.2%	5.9%
Unsecured Debt-to-Income	11.5%	10.4%

Evident from this table is that our model produces a housing crash that looks very much like the data. Specifically, the unexpected supply shock generates a substantial decline in house prices, by 25.5%, and a quintupling in the mortgage default rate – from 0.9% in the pre-crisis steady state to 4.5% in 2007 – which remains elevated for several years following the crash. By comparison, the S&P Case-Shiller 20-City Home Price Index fell by 27.6% between January 2007 and January 2009, while the adjusted annual foreclosure rate reported by the Mortgage Bankers Association reached 4.2% in 2008. Moreover, this crash is accompanied by a pronounced rise in bankruptcy filing rates and a severe and protracted decline in unsecured borrowing relative to income similar to those observed in the data during this period.

The model also captures the empirical fact that the rent-price ratio rose during the housing crash.<sup>28</sup> Our model predicts a 13.5% increase in this statistic from 2004 to 2007. Thus, to clear both the owner-occupied and rental housing markets in response to the housing supply shock, the owner-occupied house price must decline

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<sup>27</sup>See Appendix B for graphs depicting the transitions for relevant model statistics.

<sup>28</sup>See [Davis, Lehnert, and Martin \(2008\)](#) for quarterly data on this ratio.

more relative to the rental price.

The fact that our model has quantitative predictions that are consistent with *both* [Li et al. \(2011\)](#)'s findings that bankruptcy reform caused mortgage default rates to rise by 21.6% for new homeowners *and* the response of the housing and unsecured debt markets to the recent housing crisis, gives us confidence in its implications for the impact of the BAPCPA on the severity of the housing crisis. To analyze this question, we compare the implications of our model under the actual and counterfactual timelines.

Table 6 compares the economy with bankruptcy reform to the counterfactual economy by contrasting the statistics in 2007 between the two simulations.

Table 6. Bankruptcy Reform and the Housing Crisis

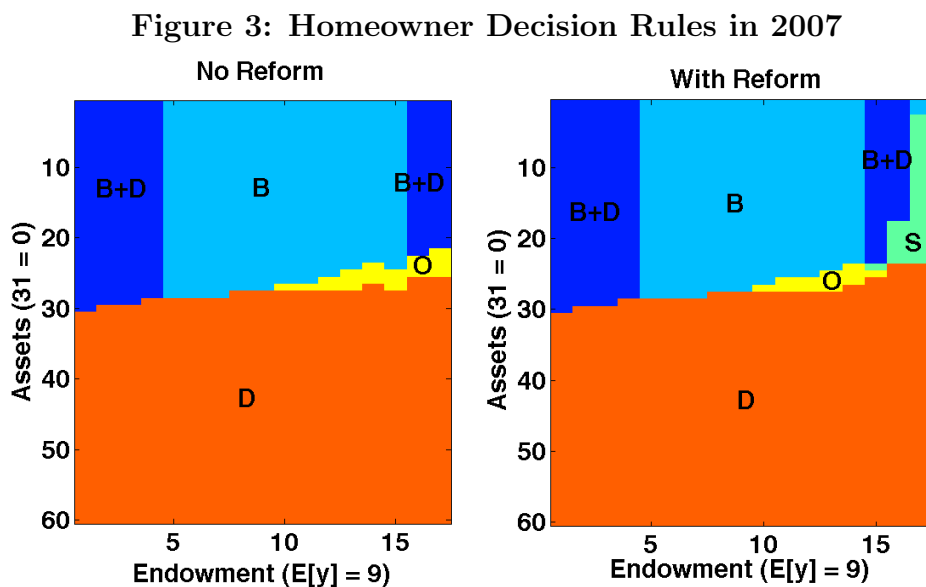
Statistic	Actual Relative to Counterfactual
P	0.0%
R	1.1%
Bankruptcy Rate	1.4%
Mortgage Default Rate	2.7%
R/P	1.1%
Unsecured Debt-to-Income Ratio	-1.2%

These results suggest that bankruptcy reform had little impact on the severity of the housing crisis, producing only modestly higher bankruptcy and mortgage default rates in 2007. The aggregate mortgage default rate is 2.7% higher in the economy that underwent bankruptcy reform in 2005. However, the BAPCPA had little impact on the aggregate prices for owner-occupied and rental housing. In the next section we discuss some intuition for these findings.



## 6.2 Discussion

Figure 3 depicts decision rules for a homeowner during the housing crisis in 2007 that is underwater on their mortgage both with (right figure) and without (left figure) the reform. This figure displays these decision rules fixing a household's house size and mortgage payment presented in the endowment (x-axis) - asset (y-axis) space. The x-axis represents the household's current endowment, and the y-axis depicts the assets with which the household enters the period.<sup>29</sup>



There are several facts about the impact of the BAPCPA on homeowner decisions that are evident from this figure. First, reform reduces the region in which continuing to own is optimal (yellow). With reform, the household now finds it optimal to default on their mortgage (orange) or to sell their home (green) in several regions where they

<sup>29</sup>Note that the y-axis is inverted, with the level of unsecured debt increasing as you move upward along that axis.

find it optimal to continue to own their home in the absence of reform. Second, the introduction of the BAPCPA leads to a reduction in the region where it is optimal to only declare bankruptcy (the light blue region) for high-income households. By decreasing the probability the homeowner files for bankruptcy, the BAPCPA causes unsecured creditors to reduce interest rates on their lending, leading to an increase in risky lending for which bankruptcy-only and bankruptcy and default are non-trivial decisions. We now discuss these features in further detail.

### 6.2.1 Reduced Benefits to Homeownership

Prior to the BAPCPA, a homeowner with positive non-exempt home equity was able to borrow against that home equity in unsecured credit markets, as it served as collateral for unsecured debt in the event of bankruptcy. Consequently, homeowners with non-exempt home equity experienced a benefit of being able to borrow in unsecured credit markets at more favorable interest rates. This changed with the implementation of the BAPCPA and reduced the benefits of homeownership for some homeowners.

Consider a homeowner with income above the median ( $y_t > \bar{y}$ ) and home equity above the exemption such that  $5(y_t - \bar{y}) > HE_t(k_t, x_t, \delta_t) - \zeta > 0$ . Table 7 depicts the amount recovered by creditors in the event of bankruptcy for a household with these characteristics if they are a homeowner or renter. Prior to the introduction of the BAPCPA, this household directly benefits by facing lower interest rates on unsecured borrowing by being a homeowner since, in the event of bankruptcy, the creditor recovers their non-exempt home equity (up to the face value of the bond).

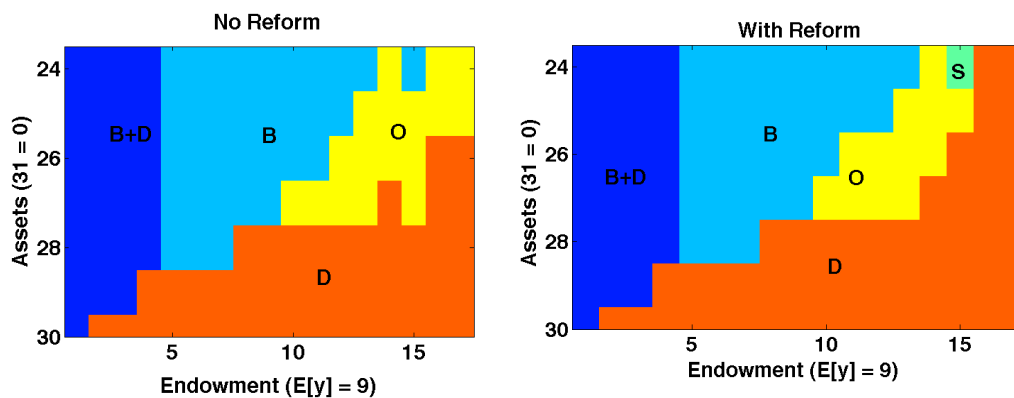
Following the introduction of the BAPCPA, creditor recovery no longer varies with the household's homeownership status, eliminating the benefit to this household of borrowing at lower interest rates because they own a home.

Table 7. Creditor Recovery and the BAPCPA

	Before Reform	After Reform
Homeowner	$HE_t(k_t, x_t, \delta_t) - \zeta$	$\kappa(y_t - \bar{y})$
Renter	0	$\kappa(y_t - \bar{y})$

This reduction in the benefit of homeownership is acute for homeowners with specific characteristics: relatively low current levels of home equity, expectations of high future income, and a desire to borrow in unsecured credit markets. We should expect to see households with these characteristics substituting away from homeownership in response to the BAPCPA. This intuition is reinforced by the decision rules depicted in Figure 4, as we see that homeowners with a higher current endowment now prefer to default on their mortgage (orange) or sell (green) as a result of the reform rather than continuing owning (yellow).

Figure 4: Homeowner Decision Rules in 2007



Thus, because the BAPCPA decreased the relative benefit of homeownership by reducing the dependence of unsecured interest rates on a household's homeownership status, underwater homeowners who would otherwise have decided to remain in their home now prefer to default on their mortgage. This effect tends to increase the mortgage default rate during the housing crisis.

### 6.2.2 Looser Unsecured Credit Lending Standards

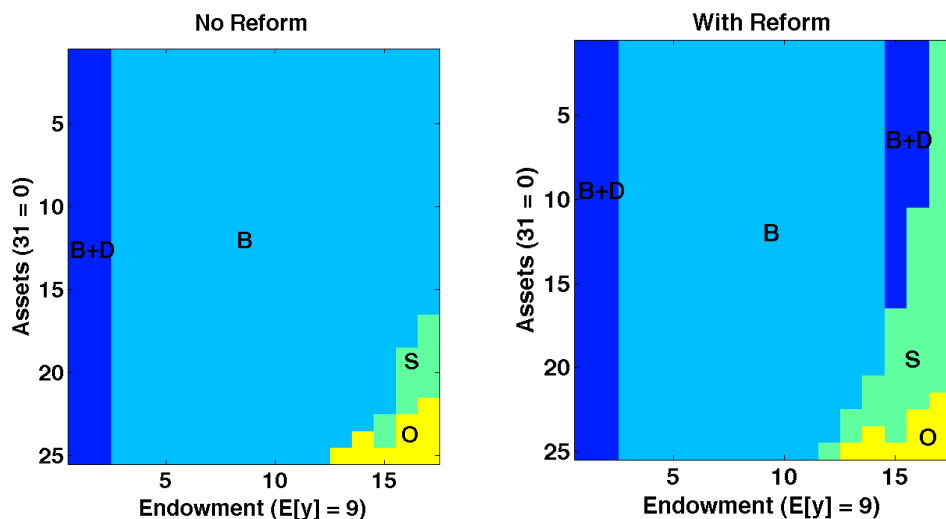
The BAPCPA significantly increased the cost of filing for bankruptcy for high income households. This led to a dramatic reduction in the region in which households find it optimal to declare bankruptcy as seen in Figure 5 which depicts decision rules for a homeowner in 2005 in the case with and without bankruptcy reform. Prior to the BAPCPA, this household would declare bankruptcy with near certainty (i.e. across all endowments) for large amounts of debt. This high probability of default leads to prohibitively high interest rates for households that desire to borrow that amount of debt. As a result, it is unlikely that households would choose to borrow an amount that causes them to declare bankruptcy and default.

With the implementation of the BAPCPA, the probability that a high income household declares bankruptcy falls dramatically. Unsecured creditors thus expect to be repaid in full with a higher probability after the reform, leading to lower interest rates and increased lending to high income households in regions in which they may declare bankruptcy and default on their mortgage in the following period (dark blue).<sup>30</sup>

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<sup>30</sup>Recall that the creditor is repaid in full if the household sells their home. A reduction in the area in which households find it optimal to declare bankruptcy and an increase in the optimal sell

Figure 5. Increase in Risky Lending



An increase in the degree of lending for levels of debt where households are more likely to get mapped into a region where they find it optimal to simultaneously declare bankruptcy and default leads to higher mortgage default rates. Quantitatively, we find that this effect is not as sizable as the higher default rates caused by the lower benefit of homeownership just discussed. Nevertheless, an increase in risky lending as a result of the BAPCPA contributes to higher mortgage default rates in the aggregate.

### 6.2.3 Tighter Mortgage Lending Standards

An important feature of our model is how bankruptcy and default incentives are fully reflected in the terms at which households can borrow in credit markets. In response to the increased incentive for households to default on their mortgage or

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region implies higher expected returns for the creditor.

sell, mortgage lenders expect to receive a lower return on loans to new home buyers.<sup>31</sup> To continue to break even in expectation despite these changing incentives, mortgage lenders must tighten their lending standards which in our model is accomplished by raising interest rates on those households which are now more likely to either default or sell in the future as a result of the reform.

Table 8. Change in Mortgage Lending Standards in Response to BAPCPA

Statistic	Direction
House Size	↓
Income	↓
LTI	↓
LTV	↓
MTI	↓

Table 8 depicts how several characteristics of new home buyers change in response to the introduction of the BAPCPA. Most of these metrics move in very intuitive directions and imply a tightening of mortgage lending standards. For example, the average house size, initial loan-to-income, loan-to-value and mortgage payment-to-income ratios all decline. Although the fact that the average income of new homeowners declines may at first appear to contradict a tightening of mortgage lending standards, this result is also intuitive. Since high income households experience the higher incentive to default on their mortgage, in equilibrium, mortgage lenders tighten standards for high income households relatively more in response to the BAPCPA, leading to lower average income for new homeowners.

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<sup>31</sup>More specifically, lenders face higher credit and prepayment risk after the BAPCPA.

Tighter mortgage lending standards tend to reduce the probability households will find it optimal to default on their mortgage after the BAPCPA, offsetting some of the increased incentives homeowners have to default on their mortgage. On net, these effects nearly offset each other, implying a relatively small role for the BAPCPA in the severity of the housing crisis.

## 7 Conclusion

This paper investigates whether the recent housing crisis was exacerbated by the BAPCPA of 2005 in the context of a quantitative-theoretic, equilibrium model of unsecured debt and mortgage markets. We conclude that, although the BAPCPA did produce higher mortgage default rates, it had minimal effect on the severity of the housing crisis, and virtually no effect on house prices.

Understanding how unsecured debt and mortgage prices respond to new incentives to declare bankruptcy and default in response to reform is key to our findings. In particular, the BAPCPA increased homeowner incentives to default by reducing the benefit homeowners derived from borrowing against their non-exempt home equity in unsecured credit markets, leading marginal homeowners to switch from owning to defaulting on their mortgage. Moreover, a rise in risky unsecured lending brought about by a reduction in the likelihood of bankruptcy for high income households, increased the probability that a homeowner enters a region in which they find it optimal to declare bankruptcy and default. These incentives that tend to increase the mortgage default rate were offset by the fact that mortgage lenders tightened lend-

ing standards for new homeowners by requiring the household to purchase a smaller home and/or undertake a mortgage with a lower loan-to-income, loan-to-value or mortgage payment-to-income ratio. Tighter mortgage standards, in turn, reduce the likelihood that households will find themselves in a position in which they prefer to default on their mortgage. On net, these incentives tend to offset, implying that the BAPCPA had a small impact on the severity of the housing crisis.

Given our analysis in this paper, a natural question is what reform could have been enacted that would have *reduced* the severity of the housing crisis. In other words, what type of policy should be implemented given joint goals of reducing the ability of high-income households to declare bankruptcy *and* insulating the housing market against potential crises. We view this as a natural next step in our analysis that we plan to undertake.



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## 8 Appendix A: Solution Algorithm

In this appendix we detail the solution algorithm for our model. We begin by describing how to solve for the steady state and then discuss how we solve for the perfect foresight transition paths of our economy under the actual sequence of events and the counterfactual sequence in which there is no bankruptcy reform.

### 8.1 Solving for the Stationary Distribution

Solving for the initial stationary distribution (i.e. prior to bankruptcy reform and the housing shock) of our economy entails fixing prices for owner-occupied and rental housing and solving the following fixed point problem in our economy without bankruptcy reform. To do so we first set  $P = 1.0$  and  $R = 0.052$ , which is in line with the historical rental price to owner-occupied ratio in the U.S. economy from 1960 to 1995 documented in [Davis et al. \(2008\)](#). The solution algorithm is as follows:

1. Guess initial values for  $V(k, x, a, y)$ ,  $X(k, x, a, y)$ ,  $q(k, x, a, y)$ ,  $m(k, x, a, y)$ , and  $m^X(k, x, a, y)$ . Denote this initial guess with a 0 subscript.
2. Taking these guesses as given, compute household optimal decision rules. From these optimal decisions, compute the implied values for  $V_1(k, x, a, y)$ ,  $X_1(k, x, a, y)$ ,  $q_1(k, x, a, y)$ ,  $m_1(k, x, a, y)$ , and  $m_1^X(k, x, a, y)$  from the functional equations outlined in Section 3.
3. Compute the maximum of the absolute value of the differences between the initial guesses for these functions (denoted 0) and the implied values for these

functions (denoted 1) given the initial guesses. If this maximum absolute difference is less than a pre-specified tolerance level, stop value function iteration, and we have found the fixed point of the operator. Conversely, if the maximum absolute difference exceeds the tolerance level, use the implied values computed in this step as the initial guess in step 2.

4. Iterate on 2 and 3 until the maximum difference is less than the tolerance level.
5. Once value function iteration is completed, we use the resulting household optimal decision rules to simulate an economy of 30 million households over 500 periods to compute the stationary distribution. The initial supplies for owner-occupied and rental housing are determined by setting these values equal to their respective demands implied by this initial stationary distribution. Label these initial housing supplies as  $K_0$  and  $H_0$  respectively.

Now we have the pre-reform, pre-housing shock stationary distribution of our economy. To compute the stationary distribution under changes in the bankruptcy code, we first set the supply of owner-occupied and rental housing equal to our desired values. Then, given initial guesses for  $P$  and  $R$ , we solve for the implied demand for both types of housing using the five steps just outlined. We then adjust  $P$  and  $R$  until both housing markets clear.

## 8.2 Solving for the Perfect Foresight Transition

This section details how we solve for the perfect foresight transition in our economy under both the actual sequence of events and the counterfactual sequence of

events in which the economy experiences a housing crisis in 2007 – mimicked by an unanticipated increase in the supply of owner-occupied housing – but did not implement bankruptcy reform in 2005. We begin with the actual sequence of events, as this transition is more complicated than the counterfactual.

### 8.2.1 Actual Sequence of Events

Under this transition the economy experiences an unexpected change to the bankruptcy code in 2005 and an unexpected shock to the owner-occupied housing supply in 2007. In the first few years following the housing crash, mortgage lenders experience a credit wedge that raises the cost of issuing mortgages. To compute the perfect foresight transition under this sequence of events, we must actually compute two different transitions and then combine the results from each. Recall that we assume the following timeline:

1. 2004: Economy is in pre-bankruptcy reform steady state with housing supplies given by  $K_0$  and  $H_0$ .
2. 2005: An unexpected and permanent change to the bankruptcy code occurs.
3. 2007: An unexpected increase in the supply of owner-occupied housing occurs, such that the supply of owner-occupied housing becomes  $\tilde{K} = 1.04K_0$  in 2007. This elevated housing supply persists until 2012 and then slowly returns to its initial value by 2020.
4. 2008: A credit wedge equal to 0.035 raises the cost of issuing new mortgages. Like the housing supply shock, this wedge persists until 2012 and then returns

to zero by 2020.

Thus, to correctly compute the economy's transition given this sequence of events, we must solve for two perfect foresight transitions. The first is for an economy that begins in the pre-bankruptcy reform steady state with housing supplies given by  $K_0$  and  $H_0$  and experiences an unexpected and permanent change to the bankruptcy code in 2005. From this transition we derive the relevant statistics for this economy in 2005 and 2006 in addition to the distribution of households entering 2007.

Next, we compute the transition for the post-bankruptcy reform economy that experiences a housing shock in 2007, beginning from the distribution implied by the bankruptcy reform-only transition in 2007, to the steady state for the post-bankruptcy reform economy with housing supplies equal to their initial values  $K_0$  and  $H_0$ .

We now detail how we compute each of these transitions.

### **Reform-Only Transition**

We assume that the economy takes  $T = 40$  years to transition to its new steady state after experiencing an unexpected shock.<sup>32</sup> The steps for computing this transition are then:

1. Using the algorithm outlined in Section 8.1, solve for the steady states of the economy both pre- and post-bankruptcy reform with the housing supplies equal

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<sup>32</sup>This assumption is confirmed if the economy has successfully transitioned to the terminal steady state in 40 years. If this is not the case, we increase  $T$ .



to their initial values  $K_0$  and  $H_0$ .

2. Set the terminal values (period  $T$ ) for  $V_T(k, x, a, y)$ ,  $q_T(k, x, a, y)$ ,  $X_T(k, x, a, y)$ ,  $m_T(k, x, a, y)$ , and  $m_T^X(k, x, a, y)$  equal to their values in the post-reform steady state.
3. Set  $K_t = K_0$  and  $H_t = H_0$  for all  $t$ .
4. Guess a sequence of owner-occupied house prices and rental prices  $\{P_t, R_t\}_{t=1}^{39}$ .
  - (a) Use the decision rules and pricing functions from the post-reform steady state to back out the  $t = 39$  pricing functions from the functional equations defining these pricing functions outlined in Section 3. Given these pricing functions and the guessed house prices, compute optimal household decisions for  $t = 39$  under the assumption that bankruptcy reform is in place.
  - (b) Repeat this step from  $t = 38$  to  $t = 1$ , documenting household decision rules at each point in time along the transition, to compute the sequence of decision rules and pricing functions along the way.
5. Next, starting from the stationary distribution defined by the pre-bankruptcy reform economy, simulate the distribution of people each period given the sequences of decision rules determined in (b) from  $t = 1$  to  $t = 40$ .
6. From the distribution of people, compute demand for owner-occupied and rental housing for each period, and compute excess demand for both types of housing at each point in time.

7. If excess housing demand and supply are below some pre-specified threshold for both owner-occupied and rental housing at each point in time along the transition, then we have successfully solved for the perfect foresight transition. If not, adjust  $P_t$  and  $R_t$  along the transition, increasing (decreasing) each slightly if the excess demand (supply) for that form of housing is too high at period  $t$ . Return to 4 with this new guess for the sequences of prices.

This algorithm gives us the perfect foresight transition of the economy under the assumption that the economy only experienced bankruptcy reform but no housing crisis. We use the statistics from the first two periods of this transition, corresponding to 2005 and 2006, in the final transition under the actual sequence of events.

## **Full Transition**

To compute the full transition, however, the economy must experience a housing supply shock in 2007. To compute the statistics along the transition during and after the housing supply shock, we follow the algorithm just outlined, but use the value and pricing functions from the post-reform steady state as the terminal values (period  $T$ ) and the distribution that is implied from the second period of the reform-only transition as the initial distribution entering 2007.

### **8.2.2 Counterfactual**

The counterfactual experiment assumes the following timeline:

1. 2004-2006: Economy is in pre-bankruptcy reform steady state with housing supplies given by  $K_0$  and  $H_0$ .
2. 2007: An unexpected increase in the supply of owner-occupied housing occurs, such that the supply of owner-occupied housing becomes  $\tilde{K} = 1.04K_0$  in 2007. This elevated housing supply persists until 2012 and then slowly returns to its initial value by 2020.
3. 2008: A credit wedge equal to 0.035 raises the cost of issuing new mortgages. Like the housing supply shock, this wedge persists until 2012 and then returns to zero by 2020.

To solve for the counterfactual transition we follow the detailed transition algorithm outlined in the preceding section, but use the steady state corresponding to an economy that does not undergo bankruptcy reform for the terminal values for value and pricing functions. The initial distribution of households is taken as the pre-reform stationary distribution with housing supplies given by  $K_0$  and  $H_0$ .

## 9 Appendix B: Transitions

