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ABSTRACT

This paper documents that the time required to initiate and complete a home foreclosure rose from about 9 months on average prior to the Great Recession to an average of 15 months during the Great Recession and afterward. We refer to these changes as foreclosure delay. We also document that many borrowers who are in foreclosure ultimately exit foreclosure and keep their homes by making up for missed mortgage payments. We analyze the impact of foreclosure delay on the U.S. labor market as an implicit credit line from a lender to a borrower (mortgagor) within a search model. In the model, foreclosure delay provides unemployed mortgagors with additional time to search for a high-paying job. We find that foreclosure delay decreases mortgagor employment by about 0.75 percentage points, nearly doubles the stock of delinquent mortgages, increases the rate of homeownership by about 0.3 percentage points, and increases job match quality, as mortgagors search longer. Severe foreclosure delays, such as those observed in Florida and New Jersey, can depress mortgagor employment by up to 1.3 percentage points. The model results are consistent with PSID and SCF data that show that employment rates rise for delinquent mortgagors once the mortgagor is in the foreclosure process.

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1 Introduction

Prior to the Great Recession, the average time required to initiate and complete the process of home foreclosure in the United States was about 9 months. However, foreclosure time rose substantially in many states beginning in the Great Recession. A combination of housing policies, as well as delays due to the enormous increase in the number of delinquent properties being processed by courts and lenders, considerably increased the time of completing foreclosure. Policies include both state and national foreclosure moratoria, as well as the National Mortgage Settlement (also known as the "robo-signing" settlement) which permanently slowed foreclosures.[1]

On average, the time to foreclose in the United States rose from about 9 months prior to the Great Recession to about 15 months around the time of the Great Recession and continued afterward. As a result of these delays, the probability that a delinquent borrower (hereafter referred to as a delinquent *mortgagor)* received a foreclosure notice, which is the initiation of the foreclosure process, fell by one-third across all U.S. states. Similarly, the probability that a delinquent mortgagor who was already in the foreclosure process was evicted fell by one-third across all U.S. states. We call these changes *foreclosure delay*.

This paper analyzes the impact of foreclosure delay on the U.S. labor market, with a focus on how this delay has qualitatively and quantitatively affected the labor market decisions of unemployed mortgagors. Two sets of statistics, which to our knowledge are new to the literature, motivate this study. One statistic, which is presented and discussed in detail in Sections 2 and 3, is that the employment rate of persistently delinquent mortgagors is very low, but this rate increases when the mortgagors are in foreclosure and thus are at risk of losing their homes. The second statistic, which is presented and discussed in detail in Section 5, is that many of the mortgagors who persistently miss mortgage payments ultimately resolve their delinquency before foreclosure is completed. This resolution is accomplished by the mortgagor making up for previous missed payments and late fees. This process of successfully exiting delinquency/foreclosure is known as *curing*. Although curing has been discussed in the literature (see Adelino et al. [2009]), the relative frequency of curing as well as the transitions out of delinquency to curing have not been documented to our knowledge.

The facts that (i) mortgagor reemployment rises as foreclosure becomes more likely, and that (ii) many persistently delinquent mortgagors ultimately cure lead us to construct a

[1] See Gerardi et al. [2011] and Cordell et al. [2013] for a summary of policies and a discussion of congestion which led to foreclosure delays during the 2007-2009 recession and afterward.

search model of the labor market that includes homeownership, mortgages, and mortgage default with the possibility of curing. We use this model to assess how foreclosure delay has had an impact on the level of employment among mortgagors since the Great Recession. In the model, unemployed households choose their search intensity, which affects the likelihood of receiving a job offer that pays a stochastic wage, and they also choose a reservation wage. Additionally, households choose whether to default on their mortgage payment. In this model, foreclosure delay is an implicit line of credit between the mortgage lender and the borrower. By defaulting on their mortgage payment, mortgagors open an implicit credit line with the lender that has a limited duration that depends on the time it takes to complete foreclosure. The credit line is closed either with the mortgagor curing or with a completed foreclosure. Foreclosure delay thus provides unemployed mortgagors with additional time to search for a high-paying job. However, as foreclosure becomes more likely, mortgagors' choices regarding search intensity and their reservation wage change as they try to cure and avoid eviction. In the past, unemployed mortgagors would use cash-out refinancing to extract equity from their homes to smooth consumption (see Hurst and Stafford [2004]), but the cash-out refinancing market collapsed during the 2007-2009 recession.[2]

The affect of foreclosure delay bears some similarity to the impact of unemployment insurance. Both of these mechanisms allow unemployed mortgagors to smooth consumption while searching for a good match (a high paying job). Unemployment benefits and mortgage foreclosure delay have two key differences, however. One is that the delinquent mortgage payments ultimately must be resolved if the mortgagors are to stay in their homes. The second is that the incentives to find a job near foreclosure for a mortgagor may be stronger than in the case of the expiration of unemployment benefits because of the implications of foreclosure for (i) the cost of leaving the home and living elsewhere, (ii) the decline in credit access, and (iii) the potential deficiency judgment against a foreclosed mortgagor.

We conduct a quantitative experiment with three economies that are identical except for having different foreclosure timelines. Each economy experiences the analogue of the Great Recession with exogenously lower productivity, a higher rate of job destruction, and a lower rate of job creation. One economy has a 9-month timeline to foreclosure, which is the average prior to the Great Recession, another has a 15-month timeline, which is the U.S. average during and after the Great Recession, and another has a 24-month timeline, which is roughly

[2] Hurst and Stafford [2004] estimate that during the recession, there were roughly 100 million homeowners, roughly 31 percent refinanced in 1993, and 18 percent of the homeowners who refinanced were unemployed. These refinances drew down roughly $16,000 of equity on average. Appendix 15 documents the collapse of the cash-out refinancing market.

the average of the 10 longest foreclosure timeline states. We then compute the solution to the three models and measure unemployed mortgagor decisions regarding mortgage default and curing, homeownership rates, delinquency, search intensity, their reservation wage, their employment level, and the average match quality, which is measured using the average wage.

Our main finding is that the increase in foreclosure time had a significant impact on mortgagor employment rates. Specifically, we find that the employment rate for mortgagors is about 1.3 percent lower in the 24-month timeline and is about 0.75 percent lower in the 15-month timeline economy compared with the 9-month timeline economy. This impact of foreclosure delay on employment is roughly comparable to extending employment benefits by 6 months and 4 months, respectively. Foreclosure delays increase the stock of delinquent mortgagors by a factor of 2 but also allow more mortgagors to remain in their homes. As a result homeownership rates rise by .3 percentage points with foreclosure delays. We also find that match quality improves in the delay economies as the average wage rises, reflecting the fact that unemployed mortgagors remain unemployed longer but on average find higher-paying jobs.

The remainder of the paper is organized as follows: Sections 2 and 3 document new facts about employment near foreclosure, Section 4 describes the details of the foreclosure process, Section 5 explains changes in transition rates into and out of default, Section 6 describes the model, Section 7 describes the calibration and steady state results, Section 8 includes the main foreclosure delay experiment, Section 9 discusses the mechanism in light of unemployment insurance and wage ladders, and Section 10 concludes.

2 Mortgagor Employment Rates Rise during Foreclosure

This section presents data that are consistent with our theory by showing that employment rates are higher for delinquent borrowers who are in foreclosure compared with delinquent borrowers who are not yet in foreclosure. We use data from two surveys: the Panel Study of Income Dynamics (PSID) and the Survey of Consumer Finances (SCF). These data allow us to track employment rates among mortgagors over various mortgage delinquency horizons. The data show that employment rates among delinquent borrowers are roughly constant as delinquency duration increases (e.g., delinquency increases from 60 days late to 90 days late), but the employment rate increases considerably when the mortgagor is in foreclosure.

The model economy developed in Section 6 will interpret these data on the duration of delinquency, foreclosure, and employment as follows: unemployed mortgagors will choose to miss mortgage payments to smooth consumption while searching for a job, but they will then lower their reservation wage when losing their home through foreclosure is imminent, and thus their employment rate will rise.

2.1 PSID Evidence

We use data from the 2009-2011 PSID Core/Immigrant sample and the 2009-2011 PSID Housing, Mortgage Distress, and Wealth Supplement to construct data on mortgagor employment rates and mortgage delinquency and foreclosure status. The observations are for all working-age heads of household with mortgages. The PSID collects data on delinquency status as of the survey date and whether the lender initiated the foreclosure process as of the survey date. We then separated these mortgagors into 5 bins according to their reported delinquency status: (1) "No Missed Payments," (2) "30 Days Late," (3) "60 Days Late," (4) "90 or More Days Late," and (5) "In Foreclosure," and within each bin we classify their employment status as either employed or not employed. In Appendix 11, we also consider the employment status of the spouse and find a similar patterns to the heads-only sample.

Table 1 shows employment rates among mortgagors in these 5 mortgage payment statuses for both the 2009 and 2011 PSID. Employment rates are higher for those in foreclosure compared with those 90 or more days late for all categories except for the 2011 sample of mortgagors who are in states in which initiating foreclosure requires a court order, which is known as a "judicial state."

We will show later that there are some statistically significant differences in employment rates between delinquent mortgagors who are in the foreclosure process and thus at risk of losing their home immediately, and delinquent mortgagors who have not yet entered the foreclosure process and thus have no risk of losing their home immediately.

To estimate the impact of these 5 mortgage payment statuses on employment rates, we fit a linear probability model (LPM), a logit model, and a probit model of a {0,1} binary employment indicator on dummy variables for each of the 5 mortgage payment statuses. We also control for variables that are often used in binary employment/unemployment regressions and which are also available in the PSID: previous income (measured as annual gross family income), unemployment duration, and liquid assets to income.[3] In addition, we also estimate regressions that control for compositional demographic differences. Demographic controls include age, sex, marital status, and education. To capture legal differences in the foreclosure process across states, we also control for whether or not the mortgagor is in a judicial state as described earlier, and whether or not they are in a *recourse state*, which is a state in which the borrower may be liable for losses suffered by the lender. We describe the foreclosure process in judicial states and recourse in detail in Section 4. We conduct these compositional corrections using both a random effects and a fixed effects specification.

These three approaches (LPM, logit, probit) are all used frequently in analyzing models with a binary dependent variable. We therefore used all three approaches for completeness. The LPM is cited as performing well in terms of unbiasedness and consistency if there are relatively few predicted probabilities that lie outside of the unit interval (see Wooldridge [2010] and Horrace and Oaxaca [2006]). This is indeed the case in this application, with only 10 percent of predicted probabilities outside of the unit interval, and many of those are indeed very close to one. The logit and probit specifications are also widely used and have the benefit of restricting predicted values to lie in the unit interval. However, the logit and probit specifications face a challenge in that those procedures drop all observations when using fixed effects for households that either never default or remain in default for the entire panel (2007-2009).[4] Since the logit and probit results are very similar, we only report the logit results.

The regression coefficients on the mortgage payment status indicators are used to construct a regression analogue to the data presented in Table 1. Specifically, Figure 1 plots the statistics from that table, along with the regression constant plus the coefficients from the mortgage payment status variables from column (1) of Table 2. We use the random effects model for the compositional correction, as the fixed effects specification results were very similar. Figure 1 shows that employment per capita is lower among defaulters, as one would anticipate. However, note that employment increases for those in foreclosure, compared to the other delinquency states. Specifically, the employment rate for mortgagors in foreclosure is about 17 percentage points higher than it is for those who are 90 or more days late without correcting for demographics, (Table 2, Column (2)), and it is about 11 percentage points higher than it is for those who are 90 or more days late, after controlling for demographic differences, (Table 2, Column (1)).

[3]Here we use the PSID question that asks about checking and savings account balances, money market funds, certificates of deposits, Treasury securities, and other government savings bonds.

[4]If included, those observations would have fixed effects of $\pm\infty$.

Tables 2 and 3 show the linear probability and logit regression statistics. Using the linear probability model, we find that in both the random effects and fixed effects regressions, the employment rate is significantly different for households that are 90 or more days late versus households in foreclosure. Households in foreclosure are more likely to be employed than households that are 90 or more days late, controlling for composition. In the logit specification, employment per capita is significantly different from households that are 90 or more days late versus those households in foreclosure for the fixed effect specification at the 10 percent level. However, the difference in employment in the logit specification with random effects is not significant at the 10 percent level.

2.2 SCF Evidence

We present additional evidence on foreclosure and employment by conducting the same analysis as earlier, but using the 2007-2009 SCF panel. The SCF surveys mortgagors on their delinquency. The responses allow us to classify them into one of three statuses: "30 Days Late," "60 or More Days Late," and "In Foreclosure." The "30 Days Late" and "60 or More Days Late" statuses refer to mortgagors who are in default on any type of debt, including mortgage debt. Thus, we do not know the specifics of their default. However, our hypothesis that homeowners avoid foreclosure by lowering their reservation wage indicates that the SCF mortgagors should also have higher employment in foreclosure, subject to attenuation bias. As in the PSID, the sample is all working-age heads of household with mortgages as of the 2009 survey date.

Figure 2 is analogous to Figure 1, as it plots the compositionally corrected LPM coefficients from the delinquency status indicator variables from the 2009 SCF.[5] In both sets of data, even after controlling for compositional differences, there is a significant increase in employment during foreclosure compared with being delinquent but not in foreclosure. Table 4 shows these results for both the linear probability model (Columns (1) and (2)) and the logit model (Columns (3) and (4)). The result that employment during foreclosure is higher than that in the "60 or More Days Late" category is statistically significant at the 5 percent level in both the linear probability model and the logit model.

[5] Mortgagors in the "30 Days Late" category are defined as those who reported being late on debt payments over the prior year, but never missing two or more months' worth of payments. Those who missed two or more months' worth of payments over the prior year were counted as 60 or more days late. Due to privacy issues, the state of residence is omitted from public use files. Therefore, we are unable to include the controls for judicial/recourse states used in the previous analysis with the PSID.

Taken together, data from the PSID and the SCF indicate that employment is higher among foreclosed homeowners than among delinquent homeowners who have not entered foreclosure.

3 Mortgage Delinquency as Implicit Credit

Missing mortgage payments is a costly *implicit credit line*, reflecting late fees that range from 3 percent to 6 percent per month. It is therefore reasonable to expect that unemployed mortgagors who do skip mortgage payments have likely exhausted lower-cost means of smoothing consumption, such as using their other assets.

We indeed find that unemployed mortgagors who are delinquent have little or no liquid assets. Figure 3 shows the PSID's measure of liquid asset holdings relative to income, for all heads of household with mortgages from the 2009-2011 PSID. Liquid assets include checking and savings account balances, money market funds, certificates of deposits, Treasury securities, and other government saving bonds.[6]

The graph splits liquid asset holdings into bins ranging from liquid assets between zero to 5 percent of prior annual gross family income, up to 50 percent or more, and shows liquid assets for unemployed and employed mortgagors. Note that 85 percent of unemployed mortgagors have exhausted or nearly exhausted their liquid assets, which suggests that they are indeed significantly constrained in being able to make their mortgage payment.[7]

4 The Process of Mortgage Delinquency and Foreclosure

Before presenting statistics on mortgage delinquency, foreclosure, and curing, we provide some background information on the actual delinquency and foreclosure process. To our knowledge, the model developed in this paper will include considerably more detail about the actual features of the delinquency and foreclosure process than other papers in the

[6]The PSID definition of liquid assets does not include stocks or bonds outside of federal government bonds. Adding these measures to the PSID's liquid assets does not change these results in any substantive way.

[7]Gerardi et al. [2013] provide additional evidence that mortgagors who default are severely financially constrained.

literature. This detail will be qualitatively and quantitatively important for this study.

A *delinquent borrower* means that a borrower is 30 or more days late. A *notice of default* begins the process of foreclosure and is typically given to borrowers who are 90 or more days late. A *foreclosure sale* is conducted by auction, and a *notice of sale* is given one month prior to the auction. A borrower is *evicted* from the home after the sale. A foreclosed borrower may be liable for a *deficiency judgment* if the sales price is less than the mortgage balance. A foreclosed borrower is ineligible for government-backed loans for 7 years (see Lowrey [2010]).

There are two main types of foreclosures in the United States: judicial and nonjudicial (see Ghent and Kudlyak [2011] for state classifications). To complete a judicial foreclosure, the bank that owns the mortgage must sue the person living in the home in a state court. A judge is required to rule on the case before a foreclosure sale can occur.

A nonjudicial foreclosure, also known as a *foreclosure by power of sale*, allows the bank to sell the house without a court's approval. A notice of default is sent to the mortgagor which explains that the bank intends to sell the property. Typically, a sale will not take place for at least a month after receiving this notice. Additional details about the foreclosure process are presented in Appendix 17.

4.1 Interest on Missed Payments

Mortgage payments are usually due on the first day of the month, and a late fee is typically assessed if the payment is not received within the first two weeks of the month. The late fee is a fraction of the payment amount. If the scheduled payment is $1,000 and the late fee is 3 percent, then the mortgagor must pay $1,030 in the following month. Most late fee interest rates fall in the range of 3 percent to 6 percent per month (see Goodman [2009]).

5 Time to Foreclose and Transitions In and Out of Delinquency

In nearly all models with limited commitment and mortgages, missing even a single mortgage payment means that the mortgagor is evicted (see Garriga and Schlagenhauf [2009], Corbae and Quintin [2009], Campbell and Cocco [2011], Chatterjee and Eyigungor [2011], and

Hatchondo et al. [2012]).[8] This common modeling assumption about the foreclosure process, however, stands in contrast to two facts that will be relevant for analyzing the impact of foreclosure time on labor market actions: (1) default is protracted and typically involves a borrower repeatedly missing payments without being evicted, and (2) mortgagors often successfully exit the delinquency and foreclosure process by making up for missed mortgage payments.[9]

This section presents data that highlight two features of the actual foreclosure process. One is that many mortgagors who are in default *self-cure,* which means that the borrower makes up for missed payments plus penalties. In fact, even mortgagors who miss enough payments to enter the foreclosure process self-cure about as often as foreclosure is completed (see Pennington-Cross [2010]). The other key feature of these data is that the time to complete foreclosure was much longer after 2009 than before.

Figure 5 presents data that summarizes the evolution of default, which includes missing payments, the foreclosure process, self-cure, and foreclosure completion. These data are from Lender Processing Services, Inc. (hereafter called LPS – see Elul [2015] for a full description of the data), which has compiled detailed mortgage data on roughly 2/3 of U.S. mortgages. LPS is one of two standard datasets that are used in mortgage analyses.[10]

Figure 5 is a transition matrix which describes how mortgagors transit across mortgagor payment states. The possible states are "current," "60 Days Late," "90 or More Days Late," "In Foreclosure," two measures of completed foreclosure ("Real Estate Owned" [REO] and "Liquidated"), and "Paid Off," which means that the mortgagor sold the home.[11] The rows are the beginning states, and the columns are the ending states. The period is one month. The table includes two sets of entries: the black entries refer to the transition matrix calculated from 2009-2011 data, in which foreclosure was significantly delayed, and

[8] Our model is also related to Karahan and Rhee [2011], Hedlund [2011], and Head and Lloyd-Ellis [2012], who incorporate search in a model with housing, Herkenhoff [2013] and Athreya et al. [2014] who consider the way unsecured debt interacts with labor markets, and Benjamin and Wright [2009] and Benjamin and Mateos-Planas [2011], who consider debt renegotiation.

[9] The standard assumption that eviction is immediate also makes it difficult for models to match actual default rates. Several authors use a period length of 2-4 years so that the discount rate is effectively small enough to generate default.

[10] We use a sample of around 470,000 mortgages per year from LPS. This is a larger sample than used in other analyses of mortgages who use Core Logic, Inc., which typically range from 130,000 mortgages to 400,000 mortgages (see Elul et al. [2010] among others).

[11] We eliminated the "30 Days Late" state, since this state includes mortgagors who miss a payment simply as an error. These errors include forgetting to send in a payment, mailing the payment late, the payment being lost in the mail, the payment being returned due to insufficient funds in a checking account, so on.

the red underlined entries are for the 2001-2003 data. Figure 5 presents the following:[12]

1. Delinquency is often temporary, with frequent transitions from delinquent to current (current means up-to-date on payments) and transitions resulting in a mortgagor becoming closer to being current (i.e., the lower triangular entries for the states "30 Days Late," "60 Days Late," and "90+ Days Late" are nonsparse).

2. Foreclosure, which we define as the time between the delivery of the default notice and eviction, is often temporary. This means that there are frequent transitions out of the foreclosure into curing. Specifically, the probability that a mortgagor will successfully exit foreclosure is about the same as the probability that a mortgagor who is in foreclosure will suffer a completed foreclosure.

3. Entry into foreclosure is slow, and became slower after 2008. Specifically, loans that were "90 or More Days Late" were in that category for 3.2 months on average during the 2001-2003 period and 6.2 months on average during the 2009-2011 period. The unconditional monthly hazard rate of receiving a foreclosure notice, after being 90 or more days late, dropped by 40 percent between the 2001-2003 survey and the 2009-2011 survey, declining from 8.3 percent to 4.8 percent.

4. Foreclosure is a slow process, and became slower after 2008. Specifically, conditional on reaching foreclosure, mortgagors remained in foreclosure on average for 4.0 months during the 2001-2003 period, and for 8.3 months in the 2009-2011 period. Consequently, the unconditional monthly hazard of having a completed foreclosure, either as a bank-owned property, or as a liquidated property, dropped by 36 percent, declining from 8.6 percent in 2001-2003 to 5.5 percent in 2009-2011. The increase in time to foreclose is concentrated among a group of states in which foreclosure delay rose substantially. These states include California, Florida, Illinois, Indiana, Maryland, Massachusetts, New Jersey, New York, Oklahoma, Pennsylvania, and Wisconsin. Some other states, including Alabama, Arizona, Georgia, Iowa, Missouri, North Carolina, Oregon, Texas, Virginia, and Washington, did not experience a large increase in time to foreclose.[13]

5. The *self-cure probabilities*, which we define as the lower triangular entries of the matrix, decreased in every single entry between 2001-2003 and 2009-2011.

[12]This is a transition matrix, so in order to read this table, the rows are the starting state at the beginning of the month and the columns are the possible states next month. For instance, in a given month the probability of moving from being current to 30 days late is 1.7 percent during the 2009-2011 period.

[13]See RealtyTrac [2012] for a detailed foreclosure timeline report and ranking of states.

In summary, these data show that (1) there is considerable movement of mortgagors across different levels of delinquency, (2) mortgagors typically spend considerable time in mortgage delinquency before entering foreclosure, (3) foreclosure takes considerable time, (4) delinquent mortgagors often self-cure, and (5) the time spent in "90 or More Days Late" and "In Foreclosure" categories rose considerably in the 2009–2011 period, and the self-cure probabilities declined during this period. The model in the following section features a delinquency and foreclosure process that is tailored to capture these features described earlier, and is used to conduct an experiment comparing 2001-2003 with 2009-2011.

6 Search Model with Persistent Mortgage Default and Curing

This section describes a model that features a labor search process with a reservation wage for unemployed agents and a housing market in which mortgagors can persistently default as well as exit default or exit foreclosure through repaying their delinquent balances. The model is decision-theoretic in that the prices in the model are exogenous. This simplification allows us to include substantial heterogeneity in the model in terms of individual employment histories, asset histories, and mortgage histories, while at the same time keeping the model tractable. The analysis thus quantifies how the labor market is affected by changes in the time to foreclose, given prices.[14]

Unlike other papers in the literature, this paper allows mortgagors to self-cure by making up for missed payments, including late fees and accumulated interest. To our knowledge, this is the first analysis that is consistent with the fact that delinquent mortgagors can self-cure within a model featuring mortgage finance and job search.

Time, indexed by $t = 0, 1, 2, 3, \ldots$, is discrete and runs forever. The model economy is populated by a heterogeneous mass of risk-averse and finitely lived agents who are subject to both idiosyncratic and aggregate shocks. In each period, agents may participate in three markets: the labor market, the asset market, and the housing market.

The labor market features search frictions similar to those in Ljungqvist and Sargent [1998] and Krueger and Mueller [2010]. Unemployed agents exert a search effort s_t at a

[14] It would be interesting to try to extend this to a general equilibrium environment. However, this would complicate the solution of the model enormously, particularly in terms of the pricing of mortgages in conjunction with general equilibrium search and matching in the labor market. We leave this to future work.

utility cost $x(s_t)$ to increase the probability of receiving a wage offer. Wage offers are drawn from an exogenous and stationary distribution $F(\cdot)$, and agents can reject or accept offers. This gives rise to a reservation wage profile $w^*(\cdot)$, which is a function of the state space of the agent. Once an offer is accepted and the agent is employed, we consider two wage processes: one in which the wage is constant for the duration of the match and one in which the wage follows a Markov process. The job match continues until it is terminated by an exogenous and stochastic job destruction shock, in which the agent becomes unemployed and then searches as described earlier.

In the asset market, agents can save ($a_t > 0$) at a fixed risk-free rate $\bar{r}$ in order to smooth their consumption.[15]

In the housing market, homeowners can sell their homes, but once agents become renters, they are renters for the remainder of their lives as in Corbae and Quintin [2009]. Homeowners receive a flow utility from housing services given by z_h and renters receive a flow utility of housing given by z_r where $z_r < z_h$. In our model and similar to the model in Chatterjee and Eyigungor [2009], every homeowner has a mortgage perpetuity and must either make the required payment or default. The key difference in this model from existing models in the literature is that both mortgage default and foreclosure are protracted and potentially reversible events, both of which influence job search and consumption decisions.[16]

Agents maximize discounted expected utility, in which preferences are defined over the expected stream of consumption of a nondurable good, c, housing services, z_i, where $i_t \in \{h, r\}$ (h denotes homeowner, and r denotes renter), and search effort (if unemployed), s, in which $x(s)$ is the disutility of searching and x is weakly increasing and is convex in s. We define $\widehat{\beta} = (1 - p_d)\beta$ as the death-adjusted discount factor where p_d is the probability of an agent dying and β is the household discount factor. The household objective function is given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \widehat{\beta}^t \big(u(c_t, z_{i_t}) - x(s_t)\big).$$

The model includes an aggregate shock that allows us to analyze the impact of foreclosure delay during the Great Recession. We define θ_t to be the aggregate state at date t, where

[15] It is standard in defaultable debt models to take the risk-free savings rate as exogenously given (see Eaton and Gersovitz [1981] or Benjamin and Wright [2009]).

[16] This model is of the same general type explored in an earlier paper (Herkenhoff and Ohanian [2011a]) where mortgage default does not necessarily lead to eviction.

θ_t follows a two-state Markov process, in which it can be either high (H) or low (L). As described in detail later, the aggregate state governs the job-finding rate, the job destruction rate, and house prices.

While unemployed, agents search for a job with search intensity, s_t, and their search disutility is given by $(x(s_t))$. The probability of obtaining an offer, which we hereafter call the job-finding probability, is a function of the aggregate state. This is denoted as $\pi(s_t, \theta_t)$ and is increasing and concave in s_t. Note that $\pi(s_t, H) > \pi(s_t, L)$ for all s_t. If the agent finds a job, the wage offer is drawn from a stationary distribution $F(w)$. The agent can either accept or reject the job offer, which gives rise to a reservation wage profile $w^*(\cdot)$ that is a function of the state vector of the agent. We denote $\delta(\theta_t)$ as the state-contingent probability of a job being destroyed, in which $\delta(H) < \delta(L)$.

In the housing market, mortgages are modeled as perpetuities, which helps keep the model tractable. When agents die, they are replaced by newborns, who are endowed with zero liquid assets and who are randomly assigned to homeownership, with fraction f_m being endowed with a home (and a mortgage). Newborn agents begin with wages and benefits drawn from $F(w)$. A fraction $1 - u$ begin employed with $u = .06$.

Mortgages have a constant payment per period, c_h, which is denoted in units of the nondurable consumption good. The house price $(p(\theta_t))$ is governed by the aggregate state such that $p(L) \leq p(H)$. In the high state, the price of a home is given as $p(H) = \frac{c_h}{r_b}$, where r_b is the fixed mortgage interest rate. In the low state, we allow potentially for underwater homeowners, $p(L) \leq \frac{c_h}{r_b}$, but in the baseline parameterization we will assume that $p(H) = p(L) = \frac{c_h}{r_b}$ is constant.[17]

6.1 Homeowner Delinquency and Foreclosure

This section describes the model details regarding mortgagor decisions on their mortgage payment and whether they choose to sell the home. Consider a mortgagor at date t. Mortgagors are either *current*, which means that they are not delinquent on past payments, or they are in *default*, which means that they are delinquent on at least one previous mortgage payment. We denote the number of periods of delinquency at date t as n_t.

[17] As Mian et al. [2011] show, foreclosures may lead to house price declines, and thus foreclosure intervention may prevent negative equity. We note that (i) since foreclosure delays may mitigate house prices drops, in order to avoid overstating the mechanism, we study delays in an environment in which house prices remain constant throughout the Great Recession and no agents are under water, and (ii) closing the housing market would require closing the mortgage market, and either of these tasks makes the problem intractable.

A mortgagor who is current chooses to either (i) make the date t mortgage payment c_h, (ii) miss the date t mortgage payment c_h, or (iii) sell the house. A mortgagor who is in default chooses to either (i) make the two most delinquent payments, including penalties, (ii) continue in default by missing the date t payment, or (iii) sell the house. A mortgagor who is delinquent risks foreclosure, which means that the mortgagor is evicted from the home. A delinquent mortgagor can temporarily stop foreclosure by making two delinquent payments, including the penalty interest payment. If a delinquent mortgagor does this in period t, but has remaining unpaid mortgage payments in period $t+1$, the mortgagor must make another two mortgage payments in $t+1$ in order to stop the foreclosure process for date $t+1$.

For simplicity, the mortgagor must pay the *two longest outstanding mortgage payments with penalty interest* $((1+r_b)^{n-1}c_h + (1+r_b)^n c_h)$, where r_b is the penalty interest rate. This feature of the model is consistent with the fact that the empirical transitions in Figure 5 show that homeowners slowly transit out of delinquency, rather than curing immediately by making good on all missed payments and penalties. Moreover, the assumption in our model that initiation of mortgagor self-curing stops the foreclosure process is consistent with the fact that lenders prefer receiving late fees to foreclosure (see Thompson [2010]).

A delinquent mortgagor is able to smooth consumption by missing a payment, but risks foreclosure. The time to foreclosure is governed by the function $\lambda_F(n_t)$, which denotes the probability of foreclosure as a function of the number of missed payments by the mortgagor. As the time spent in default (n_t) increases, the probability of foreclosure increases: $\lambda_F(n) \leq \lambda_F(n') \quad \forall n' > n$ (see Figure 4 for the foreclosure probability for (A) the 9-month timeline, (B) the 15-month timeline, and (C) the 24-month timeline). If the homeowner sells or is foreclosed upon, they become permanent renters. The mortgage payment is greater than the rental payment $(c_h > c_r)$, but the utility flow from owning a home strictly dominates the utility flow from renting $(z_h > z_r)$. The rental payment is set to zero such that the renter with the lowest possible unemployment benefits given by $\underline{b}$ can consume at least $\underline{c} = \underline{b}$, where $\underline{c}$ is subsistence consumption.

To model the possibility of a deficiency judgment against a foreclosed mortgagor, a foreclosed house is sold at a discount of $1-\chi$. For example, if $\chi = .95$, this corresponds to a 5 percent discount and the house is sold for $\chi \cdot p(\theta_t)$. For homes sold at a loss, $G(\cdot)$ is a function which describes the potential deficiency judgment owed by the ex-homeowner as a function of the proceeds of the sale.

The unique focus of this model is that prolonged mortgage default will have an impact on the labor market by affecting the reservation wage and search effort of an unemployed homeowner. Specifically, initial default will be associated with a low foreclosure probability, which means that agents will have a relatively high reservation wage and may also economize on their search effort. As foreclosure becomes more likely, search effort will rise and the reservation wage will decline.

6.2 Employed Discrete Choices

We focus on the recursive representation of the maximization problems for the agents, so we will now drop time subscripts and use primes to denote the date $t+1$ value. We denote value functions associated with a discrete choice with a tilde, e.g., $\widetilde{W}$. We begin with employed agents. The value function for the discrete choice faced by an employed homeowner with wage w, liquid assets a, with no late payments ($n = 0$), and in aggregate state θ is $\widetilde{W}_h(w, a, 0; \theta)$. This agent chooses among the following options: pay the mortgage ($W_h^g(w, a, 0; \theta)$), default and face the risk of foreclosure ($W_h^d(w, a, 0; \theta)$), or sell the home ($W_h^s(w, a, 0; \theta)$). Thus, the value of entering the period in current standing is

$$\widetilde{W}_h(w, a, 0; \theta) = \max_{\textit{Pay, Default, Sell}} \big\{ W_h^g(w, a, 0; \theta), W_h^d(w, a, 0; \theta), W_h^s(w, a, 0; \theta) \big\}.$$

When $n \geq 1$, the mortgagor has missed n payments and owes the lender a minimum of two payments plus penalties to stop foreclosure. The delinquent mortgagor chooses between paying to stop foreclosure ($W_h^p(w, a, n; \theta)$), missing another payment, which means that foreclosure occurs with probability $\lambda_F(n)$, or selling the property ($W_h^s(w, a, n; \theta)$). The value for the employed homeowner who has missed at least one payment ($n \geq 1$) is given as

$$\begin{aligned} \widetilde{W}_h(w, a, n; \theta) = \max_{\textit{Pay Twice, Default, Sell}} \big\{ & W_h^p(w, a, n; \theta),\ \lambda_F(n) W_h^f(w, a, n; \theta) \\ & + (1 - \lambda_F(n)) W_h^d(w, a, n; \theta),\ W_h^s(w, a, n; \theta) \big\}. \end{aligned}$$

Let $D_h(b, a, n; \theta)$ summarize the discrete choice decision for homeowners.

6.3 Employed Value Functions

We begin with renters. An employed renter with wage w and liquid assets a has value function $W_r(w, a; \theta)$. The only choice made by an employed renter is next period's liquid asset holdings a'. At the end of the period, with probability $\delta(\theta')$, an employed renter is laid off and receives unemployment benefits of $b(w)$. The flow utility from renting is z_r, the rental payment is c_r, $\widehat{\beta}$ is the death adjusted discount factor, and $\bar{r}$ is the return on savings. Thus, the problem solved by an employed renter is as follows

$$W_r(w, a; \theta) = \max_{a'} \; u(c, z_r) + \widehat{\beta}\mathbb{E}\big[(1 - \delta(\theta'))W_r(w', a'; \theta') + \delta(\theta')U_r(b(w), a'; \theta')\big],$$

such that

$$c + c_r + a' = w + (1 + \bar{r})a.$$

An employed homeowner with wage w, liquid assets a, current payments $n = 0$, and aggregate state θ that pays on time has a value function $E^g_h(w, a, 0; \theta)$. The mortgage payment is c_h consumption units, z_h is the flow utility from living in the house, and $\delta(\theta)$ is the aggregate state contingent job destruction probability.

$$E^g_h(w, a, 0; \theta) = \max_{a'} \; u(c, z_h) + \widehat{\beta}\mathbb{E}\big[(1 - \delta(\theta'))\widetilde{W}_h(w', a', 0; \theta') + \delta(\theta')\widetilde{U}_h(b(w), a', 0; \theta')\big],$$

such that

$$c + c_h + a' = w + (1 + \bar{r})a.$$

An employed mortgagor in default ($n > 0$) with wage w and liquid assets a who chooses to miss an additional payment solves the following problem:

$$W^d_h(w, a, n; \theta) = \max_{a'} \; u(c, z_h) + \widehat{\beta}\mathbb{E}\big[(1 - \delta(\theta'))\widetilde{W}_h(w', a', n+1; \theta') + \delta(\theta')\widetilde{U}_h(b(w), a', n+1; \theta')\big],$$

such that

$$c + 0 + a' = w + (1 + \bar{r})a.$$

Since the household missed an additional payment, the delinquency indicator becomes $n' = n + 1$.

A mortgagor can temporarily stop the foreclosure process by making two payments plus penalties ($W^p_h(w, a, n; \theta)$). In this case, the delinquency indicator transitions to $n' = n - 1$. To reduce the size of the statespace, the mortgagor must pay the two longest outstanding mortgage payments plus penalties: $((1 + r_b)^{n-1}c_h + (1 + r_b)^n c_h)$. The full problem is written as follows:

$$W_h^p(w,a,n;\theta) = \max_{a'} \; u(c,z_h) + \widehat{\beta}\mathbb{E}\big[(1-\delta(\theta'))\widetilde{W}_h(w',a',n-1;\theta') + \delta(\theta')\widetilde{U}_h(b(w),a',n-1;\theta')\big],$$

such that

$$c + (1+r_b)^{n-1}c_h + (1+r_b)^n c_h + a' = w + (1+\bar{r})a.$$

An employed homeowner who sells has value function ($W_h^s(w,a,n;\theta)$). A seller must pay all late interest penalties ($\sum_{i=1}^n (1+r_b)^i c_h$), and these penalties are collected directly from the sale of the home (see Thompson [2010]):

$$W_h^s(w,a,n;\theta) = \max_{a'} \; u(c,z_h) + \widehat{\beta}\mathbb{E}\big[(1-\delta(\theta'))W_r(w',a';\theta') + \delta(\theta')U_r(b(w),a';\theta')\big],$$

such that

$$c + a' = w + (1+\bar{r})a + p(\theta) - \frac{c_h}{r_b} - \sum_{i=1}^{n}(1+r_b)^i c_h.$$

In the event of foreclosure, $\chi < 1$ is the foreclosure discount on the house price, so the sales price is given by $\chi p(\theta)$. Late fees ($\sum_{i=1}^n (1+r_b)^i c_h$) are also collected directly from the sale proceeds. As discussed in Section 4, a foreclosure may also involve a deficiency judgment against the mortgagor. Recall that $G(\cdot)$ is the function that governs the deficiency judgment. The deficiency judgment is limited to wages and assets in excess of subsistence consumption. We define subsistence consumption as $\underline{c}$.

An employed homeowner that is foreclosed upon solves the following problem:

$$W_h^f(w,a,n;\theta) = \max_{a'} \; u(c,z_h) + \widehat{\beta}\mathbb{E}\big[(1-\delta(\theta'))W_r(w',a';\theta') + \delta(\theta')U_r(b(w),a';\theta')\big],$$

such that

$$c + a' = \max\Big\{w + (1+\bar{r})a + G\Big(\chi p(\theta) - \frac{c_h}{r_b} - \sum_{i=1}^{n}(1+r_b)^i c_h\Big), \underline{c}\Big\}.$$

6.4 Unemployed Discrete Choices

The problem for the unemployed is similar to the employed. The main difference is that the unemployed choose their search intensity, s, which influences their job finding probability, $\pi(s;\theta)$. Unemployed agents receive unemployment benefits, b, which are described in detail later.

An unemployed mortgagor who is current (n=0) chooses to either pay the mortgage, default, or sell the home:

$$\widetilde{U}_h(b,a,0;\theta) = \max_{Pay,\ Default,\ Sell} \big\{U_h^g(b,a,0;\theta), U_h^d(b,a,0;\theta), U_h^s(b,a,0;\theta)\big\}.$$

For $n \geq 1$, the unemployed mortgagor is in default and owes the lender past mortgage payments and penalties. The mortgagor must choose to either make two payments (including penalties), miss another payment and continue in default, or sell the home:

$$\begin{aligned}\widetilde{U}_h(b,a,n;\theta) = \max_{Pay\ Twice,\ Default,\ Sell} \big\{&U_h^p(b,a,n;\theta),\ \lambda_F(n)U_h^f(b,a,n;\theta) \\ &+ (1-\lambda_F(n))U_h^d(b,a,n;\theta),\ U_h^s(b,a,n;\theta)\big\}.\end{aligned}$$

6.5 Unemployed Value Functions

An unemployed renter must choose their search intensity, s, which has a convex utility cost $x(s)$. The job-finding probability $\pi(s;\theta)$ is weakly concave, which ensures an interior solution to the search choice. The variable b is the current unemployment benefit, a is liquid assets, and $\hat{w}$ is the wage drawn from $F(\hat{w})$. The wage is drawn, and then the unemployed renter can choose to accept the offer $\hat{w}$ or reject the offer and keep benefits b', which stochastically expire. Let p_b be the probability that benefits expire, and if benefits expire, agents are given a minimum benefit amount $\underline{b}$,

$$\begin{aligned}U_r(b,a;\theta) = \max_{a',s}\ u(c,z_r) - x(s) + \widehat{\beta}\mathbb{E}\Big[&(1-\pi(s;\theta'))U_r(b',a';\theta') \\ &+ \pi(s;\theta')\int_{\hat{w}} \max\big\{W_r(\hat{w},a';\theta'),\ U_r(b',a';\theta')\big\}dF(\hat{w})\Big],\end{aligned}$$

such that

$$c + c_r + a' = b + (1+\bar{r})a.$$

The max operator implies a reservation wage for which an agent accepts or rejects a wage $w_r^*(b,a';\theta')$, in which w_r^* indicates this is a reservation wage, and the subscript indicates the renter status. We assume the upper bound for the support of w is $\bar{w}$, and therefore the reservation wage is determined as follows:

$$\int_{\hat{w}} \max\big\{W_r(\hat{w}, a'; \theta'),\ U_r(b', a'; \theta')\big\} dF(\hat{w})$$
$$= U_r(b', a'; \theta') F(w_r^*(b', a'; \theta')) + \int_{w_r^*(b', a'; \theta')}^{\bar{w}} W_r(\hat{w}, a'; \theta') dF(\hat{w}).$$

An unemployed homeowner with benefits b, liquid assets a, no late payments ($n = 0$), and who pays the current mortgage payment solves the following problem:

$$U_h^g(b, a, 0; \theta) = \max_{a', s} u(c, z_h) - x(s) + \widehat{\beta}\mathbb{E}\Big[(1 - \pi(s; \theta'))\widetilde{U}_h(b', a', 0; \theta')$$
$$+ \pi(s; \theta') \int_{\hat{w}} \max\big\{\widetilde{W}_h(\hat{w}, a', 0; \theta'),\ \widetilde{U}_h(b', a', 0; \theta')\big\} dF(\hat{w})\Big],$$

such that

$$c + c_h + a' = b + (1 + \bar{r})a.$$

An unemployed homeowner who is in default ($n \geq 1$) and who makes no payments has their number of months late transition upward to $n' = n + 1$.

A defaulting nonpayer solves the following problem:

$$U_h^d(b, a, n; \theta) = \max_{a', s} u(c, z_h) - x(s) + \widehat{\beta}\mathbb{E}\Big[(1 - \pi(s; \theta'))\widetilde{U}_h(b', a', n + 1; \theta')$$
$$+ \pi(s; \theta') \int_{\hat{w}} \max\big\{\widetilde{W}_h(\hat{w}, a', n + 1; \theta'),\ \widetilde{U}_h(b', a', n + 1; \theta')\big\} dF(\hat{w})\Big],$$

such that

$$c + 0 + a' = b + (1 + \bar{r})a.$$

The reservation wage $w_d^*(b, a', n + 1; \theta')$ (where the subscript $_d$ indicates default) is a key function to characterize, and we will characterize this reservation wage below both theoretically and numerically. The reservation wage is the point at which the value of taking a job during default is just equal to the value of continuing in default while unemployed:

$$\widetilde{W}_h(w_d^*(b', a', n + 1; \theta'), a', n + 1; \theta') = \widetilde{U}_h(b', a', n + 1; \theta').$$

An unemployed homeowner in default that begins to pay current is not subject to foreclosure. As before, the mortgagor must pay the two most delinquent mortgage payments

$((1+r_b)^{n-1}c_h + (1+r_b)^n c_h)$. The value function is as follows:

$$U_h^p(b,a,n;\theta) = \max_{a',s} u(c,z_h) - x(s) + \widehat{\beta}\mathbb{E}\Big[(1-\pi(s;\theta'))\widetilde{U}_h(b',a',n-1;\theta') + \pi(s;\theta')\int_{\hat{w}} \max\big\{\widetilde{W}_h(\hat{w},a',n-1;\theta'),\ \widetilde{U}_h(b',a',n-1;\theta')\big\}dF(\hat{w})\Big],$$

such that

$$c + (1+r_b)^{n-1}c_h + (1+r_b)^n c_h + a' = b + (1+\bar{r})a.$$

An unemployed homeowner that sells becomes a renter after that. They receive the state contingent house price $p(\theta)$, but they must pay off the remaining mortgage $\frac{c_h}{r_b}$ and the outstanding late payments $\sum_{i=1}^{n}(1+r_b)^i c_h$. Thus an unemployed agent that sells solves the following problem:

$$U_h^s(b,a,n;\theta) = \max_{a',s} u(c,z_h) - x(s) + \widehat{\beta}\mathbb{E}\Big[(1-\pi(s;\theta'))U_r(b',a';\theta') + \pi(s;\theta')\int_{\hat{w}} \max\big\{W_r(\hat{w},a';\theta'),\ U_r(b',a';\theta')\big\}dF(\hat{w})\Big],$$

such that

$$c + a' = b + (1+\bar{r})a + p(\theta) - \frac{c_h}{r_b} - \sum_{i=1}^{n}(1+r_b)^i c_h.$$

As stated earlier, χ is the discount on the house price $p(\theta)$ if foreclosed upon and $G(\cdot)$ reflects the institutional details of foreclosure sales. Thus, an unemployed homeowner who is foreclosed upon solves the following problem:

$$U_h^f(b,a,n;\theta) = \max_{a',s} u(c,z_h) - x(s) + \widehat{\beta}\mathbb{E}\Big[(1-\pi(s;\theta'))U_r(b',a';\theta') + \pi(s;\theta')\int_{\hat{w}} \max\big\{W_r(\hat{w},a';\theta'),\ U_r(b',a';\theta')\big\}dF(\hat{w})\Big],$$

such that

$$c + a' = \max\Big\{b + (1+\bar{r})a + G\Big(\chi p(\theta) - \frac{c_h}{r_b} - \sum_{i=1}^{n}(1+r_b)^i c_h\Big), \underline{c}\Big\}.$$

6.6 Equilibrium

An equilibrium in this economy is a set of policy functions for (i) the savings decision $\{a_i^{j\prime}(b,a,n;\theta)\}_{i=h,r \quad j=E,U}$, (ii) search intensity for the unemployed $\{s_i(b,a,n;\theta)\}_{i=h,r}$, (iii) the reservation wage, $\{w_i^*(b,a,n;\theta)\}_{i=h,r}$, and (iv) beginning-of-period pay, default, or sell decisions for homeowners $\{D_h^j(b,a,n;\theta)\}_{j=E,U}$ that solve the households' dynamic programming problem, where households take as given the parametric wage distribution $F(w)$, the interest rates $\bar{r}$ and r_b, house prices $p(\theta)$, and the law of motion for the aggregate state.

We solved the model by iterating on the value functions. The details of the model solution are in Appendix 13. After solving the model, we simulated the model for 25,000 households for 240 periods, and then we repeated this procedure until the model moments stabilized.[18] We report steady state results by averaging outcomes over this period and by discarding the first 100 periods.

6.7 Theoretical Characterization

This section provides a characterization of how foreclosure delay affects the reservation wage and search intensity. Lemma 6.1 shows how the reservation wage falls as protection increases, and Lemma 6.2 shows how search effort declines as protection increases.

Lemma 6.1. *Define $\psi(n) = 1 - \lambda_F(n)$ as the degree of default protection (the probability of not being foreclosed upon). Let θ be constant, let δ be the constant job destruction rate, and let b be the constant benefit rate. Suppose that the domain of the household dynamic programming problem is convex and the return function $u(c,z) - x(s)$ is concave, then the optimal reservation wage $w_i^*(b,a,n;\theta), \quad i \in \{h,r\}$ is increasing in the degree of protection for any interior points of the state space.*

Proof. See Appendix 14. □

Lemma 6.2. *Consider a version of the model that satisfies the hypothesis of Lemma 6.1. Under the additional assumptions that the disutility of search is increasing and strictly convex in search effort, $x'(s) > 0$ and $x''(s) > 0 \;\; \forall s > 0$, and $\pi(s,\theta)$ is linear in s with $\partial\pi(s,\theta)/\partial s =$*

[18] We anticipated needing to repeat this procedure many times, but since we have so many agents in the economy, we found that the model moments were changed very little after 2 replications. We therefore terminated repeating the procedure at 5 replications. We also found that 240 model periods per simulation was sufficient. Specifically, since the initial draw was from the ergodic age distribution, we found the stationary distribution typically by 100 periods.

α_s, then the optimal search effort $s_h^*(b, a, n; \theta)$ is decreasing in the degree of protection for any interior point in the state space.

Proof. See Appendix 14. □

Lemmas 6.1 and 6.2 are at the heart of the quantitative mechanism. In both cases, foreclosure protection is a form of debtor protection that allows delinquent mortgagors to smooth consumption while searching for higher-paying jobs less intensely.

7 Calibration and Steady State Results

7.1 Calibration

The period length is one month, which is the payment period for most mortgages. Krueger and Mueller [2010] take a similar labor market model to time-use survey data (their model abstracts from asset accumulation and home ownership), and we use the same preferences for nondurable consumption and the cost of searching:

$$\textbf{Preferences for Consumption}: \; u(c, z) = \log(c) + \log(z)$$

$$\textbf{Disutility of Search}: \; x(s) = \alpha_s s^2$$

Agents have a 42-year working life; thus the monthly probability of death, p_d, is set to .002 as in Ljungqvist and Sargent [1998]. The functional form for the probability of receiving an offer is also taken from Krueger and Mueller [2010], but we extend their specification to incorporate a state contingent coefficient to model cyclical changes in job finding:

$$\pi(s; \theta) = \alpha_f(\theta)s.$$

The aggregate state is governed by a transition matrix based on NBER business cycle dates (see Appendix 13, the top row of the matrix corresponds to the high state), and the matrix is given as follows:

$$\theta_{Transition} = \begin{bmatrix} 0.9854 & 0.0146 \\ 0.0833 & 0.9167 \end{bmatrix}.$$

In the high state, $\alpha_f(H) = 1$, which ensures that maximum search effort results in an offer with probability 1 (although there is limited data on offers, both Krueger and Mueller [2010] and Ljungqvist and Sargent [1998] demonstrate that such an assumption is necessary to deliver plausible job finding rates). Shimer [2005] reports that the average job-finding rate declines by about 24 percent in recessions, therefore, the offer rate is multiplied by .761 in the low state so that $\alpha_f(L) = .761$. This means that the maximum search effort results in an offer with probability .761 during a recession.

The job destruction rate is calibrated using data on layoffs from the Job Openings and Labor Turnover Survey (JOLTS), which yields $\delta(L) = .015$ and $\delta(H) = .013$. As in Campbell and Cocco [2011], the price of a house, $p(\theta)$, is exogenously determined. We allow the price of the house to potentially be a function of the aggregate state, but in the baseline calibration we set it to be the discounted sum of all future mortgage payments in every state of the world, $p(\theta) = \frac{c_h}{r_b}, \quad \forall \theta$.[19]

To calibrate the wage offer distribution $F(w)$, we follow Jolivet et al. [2006] and build a transformation between the observed wages of employed households and the unobserved offer distribution.[20] Wages in the model lie in the interval $[\underline{w}, 1]$, where we normalize $\underline{w} = .1$. Once employed, we consider two cases for wage dynamics: (i) fixed wage contracts, as in Chetty [2008] and Krueger and Mueller [2010], which is our benchmark case, and (ii) wage ladders as in Ljungqvist and Sargent [1998] and Hornstein et al. [2007]. To discipline the wage ladder case, we use information on monthly wage transition rates for employed households from Survey of Income and Program Participation (SIPP). Section 9 contains more details.

The unemployment benefit replacement rate is 50 percent of the wage, which is taken from the OECD database on U.S. Benefits and Wages.[21] To keep the model tractable and also allow for benefit expiration, we specify a monthly benefit expiration probability of .165, which implies a 6-month expected duration of unemployment insurance. Upon benefit expiration, households receive the lowest benefit, $\underline{b}$. The unemployment benefit formula is given by $b(w) = \max\left\{\underline{b}, \frac{1}{2}w\right\}$. We normalize the lowest unemployment benefits and the associated consumption level so that agents never earn below $\underline{w}$, i.e. $\underline{b} = \underline{c} = .1$. This value is taken from Krueger and Mueller [2010] and corresponds to a payment that is about a 13 percent replacement rate.

[19] In the previous version of this paper, we allowed for underwater homeowners during the crisis, $p(L) < \frac{c_h}{r_b} < p(H)$. This does not significantly change the results.

[20] See Appendix 13 for more details.

[21] See OECD "Table 3.2. Net replacement rates and unemployment insurance benefit duration in 26 OECD countries, 2004." http://www.oecd.org/about/publishing/36965805.pdf.

The flow utility of renting, z_r, can be normalized and is set to one. The cost of renting is set to zero, $c_r = 0$, to avoid negative consumption. The flow utility to owning, z_h, and the consumption cost of owning, c_h, are set to match the transition rate from moving from 90 or more days late to 60 days late, and to match the average debt-to-income (DTI) ratios observed for defaulters in the PSID. The DTI statistics are described in detail later.

The foreclosure completion probability function $\lambda_F(n)$ is piecewise linear, which allows us to approximate the distribution of actual foreclosures. Specifically, this function captures the fact that time to foreclose is stochastic and becomes certain after a sufficient number of periods have passed:

$$\lambda_F(n) = \begin{cases} f_c, & \text{if } n \leq N \\ 1, & \text{if } n > N. \end{cases}$$

Specifically, households are evicted with probability f_c between period n and N, which is chosen to match the transition rate from the process of foreclosure to completed foreclosure in Figure 5. After month N, households are evicted with certainty. In addition to matching the foreclosure completion transition rate, this process also captures other empirical features of the delinquency and foreclosure process which is described later.

We analyze three specifications of foreclosure time. The first has a foreclosure timeline of 9 months ($N = 9$), which corresponds to the modal number of days from default to foreclosure sale as outlined by Fannie Mae and Freddie Mac.[22] In addition, a few foreclosures occur before N periods, so f_c will be about 3 percent in order to capture this fact. The second foreclosure timeline is 15 months ($N = 15$), which is a nationally representative foreclosure timeline from LPS data for 2009-2011 (see Figure 5). The third foreclosure timeline is based on the most extreme observed foreclosure delays, which is about 24 months in Florida and New Jersey. Although the foreclosure completion probability function $\lambda_F(n)$ is stylized, it enables the model to roughly approximate many of the observed transitions across mortgage payment states.

The foreclosure discount on the sale price of the home is 22 percent ($\chi = .22$), which corresponds to the average reported by Pennington-Cross [2006]. A deficiency judgment on foreclosed homes is equal to the amount owed times the observed deficiency enforcement rate.

[22] Fannie Mae, "Foreclosure Time Frames and Compensatory Fee Allowable Delays." https://www.fanniemae.com/content/guide_exhibit/foreclosure-timeframes-compensatory-fees-allowable-delays.pdf

Fannie Mae's observed deficiency enforcement rate is .1181. Specifically, Fannie Mae reports that 35,231 out of 298,327 foreclosures were pursued for a deficiency (see Inspector General [2012]). The function that governs the deficiency judgment $G(\cdot)$ based on the statistics provided earlier is given by the following:

$$G(x) = .1181 \cdot x \cdot \mathbb{I}(x < 0) + x \cdot \mathbb{I}(x > 0).$$

The model deficiency judgment does not distinguish between recourse and nonrecourse states. This is because states that are often considered to be nonrecourse states can have recourse on some mortgages. For example, in California all refinanced loans are recourse and subject to deficiency judgments (see Ghent and Kudlyak [2011]).

In terms of the remaining parameters, we set the discount factor β, the fixed mortgage payment c_h, the flow utility from housing z_h, the bank interest rate r_b, the savings rate $\bar{r}$, the fraction of newly born agents endowed with a mortgage f_m, the stochastic foreclosure probability f_c, and the disutility of search coefficient α_s for the model to capture the following targets: the 60 days late delinquency rate from LPS data from 2001 to 2003, the average back-end debt-to-income ratio for defaulters and nondefaulters in the PSID, the cure rate for 60 days late mortgagors, the cure rate for 90 days late mortgagors, the fraction of defaulting and nondefaulting mortgagors with a ratio of liquid assets to income between 0 and 5 percent, the mortgagor rate, the liquidation rate, and the homeowner as well as the economy-wide unemployment rate. Note that there are more targets than parameters, so the model will not match these targets exactly. We report how well the model matches these targets in Section 7.2.

To specify the mortgagor rate, we use 2007 census data, which is just prior to the Great Recession. These data indicate a homeownership rate of about 68.2 percent and that 64.4 percent of households have a mortgage.[23] Therefore, the mortgagor rate is 43.91 percent.

To measure debt, we calculate average back-end debt-to-income ratios in the PSID. The back-end debt-to-income ratio captures the fact that households have other obligated payments in addition to their mortgage payments, including insurance and other debt payments. Since these other obligations are not in our model, but since they do impact ability to pay, we deal with these by removing those payments out of the PSID incomes. We do this by

[23]The data on the number of mortgages are from Census Table 963. "Mortgage Characteristics – Owner – Occupied Units: 2007", which provides data on nearly 76 million owner-occupied housing units. The data on homeownership is from Census Table 5. "Homeownership Rates for the United States and Regions: 2006 to 2012".

applying the NBER's TAXSIM program to the 2009 PSID dataset to generate after-tax income.[24] From the after-tax income, we further subtract insurance expenses, lease outlays, and an imputed unsecured debt service flow equal to 14.31 percent of the stock of unsecured debt (14.31 percent is the average credit card interest rate taken from the 2009 Flow of Funds). The ratio of mortgage payments, including first and second mortgages, to this adjusted after-tax income number is what we will call the back-end debt-to-income ratio. Table 5 tabulates these ratios.[25]

The ergodic unemployment rate that we will target is 6.5 percent.[26] The cure rates are taken to be the lower triangular entries in Figure 5, summed across columns to yield a model-equivalent measure. We target the cure rate from 60 days late (DL) to current and from 90 days late to 60 days late. Liquid assets are measured as in Section 3 and depicted in Figure 3. We target the fraction of homeowners with liquid assets to annual income between 0 and 5 percent.

7.2 Model Statistics Compared with Data Targets

Since the model has more targets than parameters, we chose parameters by minimizing the sum of squared deviations between the model and the data statistics. Table 6 shows that the calibration does reasonably well in approximating these targets. Defaulters have back-end debt-to-income ratios in line with the data, and the mortgagor unemployment rate is identical to the data. Defaulters also have similar liquid asset holdings as in the data.

As is standard in any default model, it is necessary to have a high discount rate: the β in the model corresponds to an annual discount rate of roughly 16 percent.[27] The bank interest rate corresponds to an annual rate of 5.8 percent, and the savings rate corresponds to an annual yield of 1.08 percent. These interest rates primarily determine the cure rate and the fraction of liquid assets held by homeowners, respectively. The cure rate is quite high in the data, even during the recession, and thus the bank fees must be low. Note that by omitting mortgage modifications, we may be biasing downward the bank penalty rate, since a large

[24] TAXSIM is a program made by the NBER specifically for computing tax liabilities. As in any tax return, TAXSIM takes as inputs the marital status in filing, exemptions, and deductions, including mortgage deductibles, etc. TAXSIM then yields the federal and state tax liabilities of households.

[25] In the event that a household had negative income after these adjustments, we dropped them from the sample, thus understating the burden of mortgage debt.

[26] Our model has no participation margin and thus the unemployment rate in our model corresponds to a number more like U6.

[27] The discount rate cannot be too high since it also shifts the asset distribution.

number of homeowners have had their mortgages modified or had late fees forgiven.[28]

In this calibration, the model does not generate home sales except through foreclosure. However, this feature of the calibration may not be important, as home sales were very low during this period, falling by a factor of eight (see Figure 5). The search disutility parameter is set to match the 6.5 percent ergodic unemployment rate; however, the disutility of search parameter also indirectly affects the mortgagor rate and cure rates.

8 Impact of Foreclosure Delay during Great Recession

This section quantifies the impact of the large increased time to foreclosure that occurred during the Great Recession.[29] Our approach is as follows. We take three identical economies with the 9-month foreclosure timeline and which had been in the high aggregate state for the preceding 12 months. All three economies next enter the low state, θ=L, and remain in that state for 18 months, which is about the length of the Great Recession as defined by the NBER (December 2007 to June 2009). At the onset of the low state, one economy continues with the 9-month foreclosure timeline, and we call this the "no delay economy." The foreclosure timeline in the second of the economies increases to 15 months, which corresponds to the national average, and we call this the "foreclosure delay economy." The foreclosure timeline in the third of the economies increases to 24 months, which is roughly the average foreclosure time for the 10 most delayed states, such as Florida, California, and New York. We call this the "long foreclosure delay economy." Thus, the only difference between the three economies is that one has a 9-month foreclosure timeline, one has a 15-month foreclosure timeline, and one has a 24-month foreclosure timeline.

Figure 4 plots how the probability of foreclosure depends on the number of months in default. In the no delay economy, there is a constant foreclosure rate of 3.02 percent for borrowers who are delinquent between 1 and 8 months, and certain eviction occurs in the 9th month. Recall that we chose the 3.02 percent eviction rate to account for the small number of early foreclosures that do occur in the data. In the delay economy, there is also a constant foreclosure rate of 3.02 percent for borrowers who are delinquent between 1 and 14

[28]In a working paper version of the model we include modifications as a random event that competes with foreclosure. Including means tested modifications distorts job taking behavior even more. See Mulligan [2008] and Herkenhoff and Ohanian [2011a] for more.

[29]This experiment relates to work by Mulligan [2008, 2010, 2011] and Herkenhoff and Ohanian [2011b] who study the way various government housing policies, including mortgage modifications, have increased unemployment by distorting incentives to find and accept jobs.

months, and certain eviction occurs in the 15th month. There is an analogous process for the long foreclosure delay economy, with certain eviction in the 24th month.

The job-finding rate and the job destruction rate during the Great Recession were quite different from those in previous, milder recessions. We therefore adjust the model's job-finding and job destruction rates, using data from JOLTS. We find that the job-finding rate fell by about 37 percent and that the job destruction rate rose by about 27 percent between 2007 to 2009. Table 7 summarizes the impact of the 2007-2009 recession on job-finding and layoff rates in the data. To capture the severity of the Great Recession, we unexpectedly reduce job offers and increase job destruction rates during the 18 months for which the economy is in the low aggregate state. Specifically, the job-finding rate in the low state is adjusted down from $\alpha_f(L) = .76$ to .64. Similarly, the job destruction rate in the low state, $\delta(L)$, is adjusted from 1.5 in the low state to 1.7.[30]

At the end of 18 months in the low state, both economies enter the high state, which continues thereafter, and in which job destruction and job creation rates return to their high state levels, and the time to foreclose continues.

The main experiment is summarized as follows:

- Both economies are identical, including the 9-month foreclosure timeline, had been in the aggregate high state for the previous 12 months, and before that had been in the ergodic steady state.
- Date t
  - Both economies enter the low state for 18 months. The job destruction rate and the job creation rate are modified as described earlier to capture the job destruction and job creation that occurred between 2007 and 2009.
  - One economy introduces default protection through a 15-month foreclosure timeline, which we call the foreclosure delay economy, whereas the other economy maintains a 9-month foreclosure timeline, which we call the no delay economy.

[30] We choose to set the Great Recession job destruction and job creation rates as unexpected events based on forecasts that the economy would recover much more quickly than it did. Specifically, Romer [2009] forecast a relatively quick recovery in the labor market. Sahm [2015] documents economic forecasts during the Great Recession and finds that FOMC forecasts significantly overpredicted GDP growth in 2009 and 2010. Specifically, she reports that the forecasted GDP growth for 2009 and 2010 was much stronger than actual growth, and that unemployment would be in the range of 6.6 percent to 7.5 percent in 2011 (see Sahm [2015] and http://www.federalreserve.gov/monetarypolicy/files/FOMC20090128SEPcompilation.pdf).

- Date $t+18$: Both economies enter the high aggregate state ($\theta = H$) and remain there. Each economy maintains its time to foreclose.

8.1 Model Transitions In and Out of Delinquency and Foreclosure

To illustrate how foreclosure delay affects defaulting and curing, Figure 6 presents the transition matrix across mortgage payment states for the no delay economy and for the foreclosure delay economy from this experiment. The black numbers are for the foreclosure delay economy, and the red underlined numbers are for the no-delay economy and are thus interpreted as the counterfactual. For simplicity, note that the model transition matrix does not include as many states as the empirical transition matrix from Figure 5.

We focus on two features of these model statistics. The first is that the model approximately captures the impact of foreclosure delay, as the probability of a borrower who is in foreclosure and who remains in foreclosure is about 89 percent in the data for 2009-2011 and is about 88 percent in the model for this period. The second is that foreclosure delay results in a lower foreclosure rate. The model foreclosure rate is 9.9 percent for the no delay economy and is 4.5 percent for the foreclosure delay economy. Although there is no empirical analogue for comparison, given that the no delay economy is a counterfactual, it is interesting to note, however, that the actual foreclosure rate drops from 8.6 percent in 2001-2003 to 5.5 percent in 2009-2011.

Foreclosure delay also has an impact on borrowers' decisions to default and to cure. Specifically, borrowers default more frequently and cure more slowly with foreclosure delay. The model predicts that the monthly default rate is about 0.3 percentage points (.0105-.0077) higher when there is a 15-month foreclosure timeline (this is roughly a third higher relative to the 9-month foreclosure timeline). Similarly, the cure rate from 90 or more days late to 60 days late in the 15-month foreclosure economy drops by about 0.8 percentage points (.1762-.1685). Since more borrowers default and also remain in the 90 or more days late category longer, they experience more foreclosures. Thus, with foreclosure delay the foreclosure rate rises roughly 3.8 percentage points (.1063-.0675), which represents a 57 percent increase compared with the economy with no delays.

8.2 Quantitative Impact of Foreclosure Delay

Figures 7 to 11 illustrate the time paths of mortgagor employment, aggregate employment, the stock of homes with delinquent mortgages, and the fraction of households with mortgages (the mortgagor rate) in the three economies during the experiment. The main finding is that foreclosure delay considerably affects borrower decisions to default and cure. This in turn depresses employment but improves match quality as unemployed mortgagors have additional time to search, which results in higher wages. As we describe later, the impact from foreclosure delay on employment is equivalent to extending unemployment benefits between about 4 months, which is for the average foreclosure delay across all states, to about 6 months, which is for the states with the longest delays.

8.2.1 Impact of Foreclosure Delay on Employment

Figure 7 plots employment per capita among mortgagors in the three economies. We find that mortgagor employment in the economy with the 24-month foreclosure timeline, which characterizes the increase in foreclosure delays that occurred in Florida, New York, New Jersey, California, and several other large states, is about 1.3 percentage points lower than in the no delay economy. In levels, the employment rate is about 89.5 percent in the economy with a 9-month foreclosure timeline and about 88.2 percent in the economy with the 24-month foreclosure timeline. Aggregate employment in these states, which combines mortgagor employment with employment of renters and of homeowners without mortgages, is about 0.5 percentage points lower, which reflects the fact that those with mortgages make up roughly 43 percent of the model economy's agents. The employment rate among mortgagors in the economy with the 15-month foreclosure timeline, which captures the average increase that occurred for all states, and which includes several states with little if any foreclosure delay, is about 0.75 percentage points lower than in the economy with the 9-month foreclosure timeline, and aggregate employment is about 0.3 percentage points lower.

Figure 8 plots the differences in mortgagor employment rates for the three economies in order to highlight these differences. Lemmas 6.1 and 6.2 indicate why employment is lower when time to foreclose rises. Specifically, the self-insurance provided by mortgage default results in lower employment as the foreclosure timeline becomes longer. Thus, longer foreclosure delay means greater default protection, which in turn means a larger difference in employment between these economies. Foreclosure delay is a de facto implicit line of credit from the lender to the mortgagor, and by extending the duration of this credit line with foreclosure delays, this extra self-insurance has an impact on unemployed worker search decisions and reservation wages. To gauge the model relative to the data, we note that mortgagor employment among PSID respondents drops by about 6 percent between 2007 and 2009, which is of similar magnitude to our experiment. Appendix 16 shows that the drop in employment per capita among mortgagors in the model is consistent with the data. Averaging across states with delays and without delays, Figure 9 plots the difference in aggregate employment per capita, which includes both mortgagors and nonmortgagors in each model economy.

To assess whether our model produces a reasonable quantitative impact of foreclosure delay on employment, we measure the impact of changes in unemployment insurance in this model, given that this topic has been studied considerably. We do this as in Nakajima [2012], who constructs a Mortensen-Pissarides model with risk aversion and asset heterogeneity to assess the impact of unemployment insurance (UI) extensions on unemployment during the 2007-2009 recession. We find that our model produces an *unemployment benefit elasticity* of .43, which is defined as the increase in unemployment durations in weeks resulting from a 10 percent increase in the benefit replacement rate for a regular 6-month duration of UI. Unemployment benefit elasticity is commonly referenced in the empirical literature on unemployment insurance. Card et al. [2015] provide a summary of this literature and report that this same elasticity measure varies from 0.3 to 2 in U.S. data across several studies. Card et al. [2015] also report measures of this elasticity from data during the Great Recession, which range from 0.65 to 0.9. Our model therefore produces a response of employment to unemployment benefit changes that is on the lower end of existing estimates.

Since the topic of foreclosure delay and its impact on employment has not been previously studied, we next place our quantitative estimates in context by calculating the equivalent impact on employment within our model that results from extending unemployment benefits. Specifically, we calculate how many additional months of unemployment benefits would result in 0.5 percent lower aggregate employment, which is the employment decline in the 24-month timeline economy, and 0.3 percent lower aggregate employment, which is the employment decline in the 15-month timeline economy.[31] We find that the employment decline resulting from the 24-month foreclosure timeline is equivalent to the impact of about a 6-month extension of unemployment benefits, and that the employment decline from the 15-month foreclosure timeline is equivalent to about a 3.7-month benefit extension.

[31] A 24-month UI policy increases the unemployment rate by 1.9 percent. We simply scale this ratio of UI duration to UR to arrive at our estimates in the paper of the impact of foreclosure delay on unemployment.

The employment declines resulting from foreclosure delay are the consequence of different levels of search intensity and reservation wages, both of which depend on delinquency status. Specifically, reservation wages are about 4 percent higher with the 24-month foreclosure timeline compared with the 9-month foreclosure timeline economy at a mortgage payment delinquency ranging between 1 to 4 months. Near foreclosure, however, reservation wages in both the 9-month timeline economy and the 24-month timeline economy drop by roughly 10 percent, and search effort increases as households attempt to find a job quickly in order to prevent eviction.

Although foreclosure delay does not account for the majority of the decline in U.S. employment observed since 2008, its relative quantitative impact appears to be similar to several other factors that have been studied. This includes analyses of mismatch employment (Karahan and Rhee [2011], Şahin et al. [2012]), structural changes in the labor market (Charles et al. [2013]), and uncertainty (Schaal [2012]). All of these papers find that these factors account for only a modest amount of the recent change in employment. Fratto and Uhlig [2014] study the impact of several shocks within a single model framework, including monetary shocks, government spending shocks, preference shocks, technology shocks, and wage/price markup shocks, and find that no single factor accounts for more than 2-3 percentage points of the recent change in employment.

Figure 10 plots the fraction of mortgagors in default in the model economy. The stock of mortgages in default reaches its maximum 6 quarters after the recession begins. The delinquent stock declines thereafter as the economy switches back to the high state. In the economy with the 24-month foreclosure timeline, delinquencies peak at about 14.2 percent of the total stock of mortgages, which is roughly equal to the delinquent stock among the 10 most delayed states.[32] The economy with a 15-month foreclosure timeline has a peak delinquency stock of 11.2 percent, which is modestly higher than the national average of about 10.57 percent.[33] The economy with the 9-month foreclosure timeline, which is the counterfactual, has a peak delinquency stock of about 6 percent. These large differences in the stock of delinquencies are driven by households' choices to default more frequently and cure more slowly with foreclosure delay. Empirical work by Pace and Zhu [2011] has demonstrated a similarly strong link between delays and default. The consumption smoothing motive of default is also consistent with evidence in Baker and Yannelis [2015] and Gelman et al. [2015], and it is in line with Guiso et al. [2010] and Gerardi et al. [2013], who both find

[32] See McBride [2011] for delinquency rates by state.

[33] Based on LPS data, see McBride [2012] for details.

very limited roles for strategic default.[34]

Figure 11 illustrates the fraction of households with mortgages in each economy. In the economy with the 24-month foreclosure timeline, homeownership (with mortgages) drops by about 0.5 percentage points, from 42.5 percent to 42.0 percent, 6 quarters after the onset of the recession, whereas homeownership drops to 41.7 percent over this same time period in the counterfactual economy with the 9-month foreclosure delay timeline. Thus, foreclosure delay results in fewer foreclosures and more ultimate curing.

8.2.2 Employment and Foreclosure Across States

The model experiments involving a 24-month timeline, which corresponds to the longest delay states, a 15-month timeline, which corresponds to the U.S. average, and a 9-month timeline, which corresponds to no delay and which is consistent with many states such as Arizona, Georgia, Iowa, Texas, and Washington, predict that foreclosure delay reduces employment. This section uses the Current Population Survey (CPS) to assess the model's quantitative results. To exploit the variation in foreclosure times across states, we categorize households according to their state and conduct a difference-in-difference analysis. Specifically, we compare employment rates across renters and homeowners in slow and fast foreclosure states, controlling for a host of individual characteristics. We rank states based on the speed at which homeowners transition from foreclosure to liquidation (including REO). Table 9 includes our classification of slow and fast foreclosure states. We then isolate the top 10 fastest and top 10 slowest foreclosure states in the 2001 through 2013 March Supplement CPS surveys. We then compare employment status of homeowners and renters in fast and slow foreclosure states, splitting the sample before and after the large increase in foreclosure delays.

Table 10 presents these results. The dependent variable is a dummy variable if the household is employed, and we include demographic, occupation, and industry controls. Columns (1) and (2) of Table 10 show that homeowners, as compared with renters, have a lower employment rate in states with slow foreclosure processes as compared with states with fast foreclosure processes. The magnitude of this effect ranges between a 0.4 percent to a 0.8 percent reduction in employment per capita depending on the control set, which is consistent with the results of our structural model presented Section 6. Columns (3) and (4) of Table 10 split the sample between pre-2007 and post-2007. We see that the impact

[34]Evidence in Dobbie and Song [2013] about earnings outcomes and debt protection is consistent with our mechanism.

of foreclosure delay is weaker in the 2003-2007 period, which is consistent with the fact that there was much less variation in foreclosure time across states in 2003-2007.[35]

8.2.3 Impact of Foreclosure Delay on Wages

Foreclosure delay also affects the quality of jobs that are accepted by the unemployed, as well as the economy's wage bill. Table 8 shows that foreclosure delays result in wages that are higher by about 0.2 percent to about 0.3 percent. The extra self-insurance provided by the default protection has two effects: (i) fewer people are working, which results in a lower employment rate, but those who are working have higher wages. Table 8 indicates that the improved match quality (higher average wages) more than offsets the effect of fewer workers.

This result is consistent with a large literature that includes Ehrenberg and Oaxaca [1976], Feldstein and Poterba [1984], Addison and Blackburn [2000], and Hagedorn et al. [2013], who have found that unemployment insurance extensions improve wage outcomes. In our model, we find that unemployed defaulters find jobs that pay 0.8 percent greater in a stochastic steady state with the 15-month foreclosure timeline relative to the 9-month foreclosure timeline. As noted earlier, the 15-month foreclosure timeline is roughly equivalent to the 4 month benefit extension, which implies that our wage gains from foreclosure delay are at the lower end of estimates from U.S. data.[36] Some studies based on European data such as Schmieder et al. [2013] find mixed evidence regarding wage outcomes, but other studies such as Nekoei et al. [2013], who use Austrian data, find that a UI extension of 9 weeks raises re-employment wages by 0.5 percent, which is consistent with our findings.[37]

Herkenhoff et al. [2015] provide additional support for the wage findings in this paper. They merge US credit reports and census employment histories to study the impact of credit access on non-employment durations and replacement wages of displaced workers. They find that credit access is an important source of self-insurance for unemployed households. They

[35] We thank Sam Schulhofer-Wohl for suggesting this analysis.

[36] Addison and Blackburn [2000] provide a comprehensive survey of the literature, showing that the majority of studies that consider the impact of unemployment benefits on re-employment earnings find significant and positive impacts of UI on wages. The magnitudes vary, and the units of analysis vary, but the general consensus of the literature is that unemployment insurance improves wage outcomes.

[37] The results in Schmieder et al. [2013] are not particularly informative for our study because of large differences in the asset positions of the households we study, and of the 40-42 year old German workers studied in Schmieder et al. [2013]. Specifically, the OECD reports that the German household private savings rate is 10 percent, which suggests that the German households have a significant buffer stock of assets, whereas we documented that the delinquent mortgagors we study have no buffer stock. Thus, our theory indicates that the impact of UI extensions will be very different across these two different groups.

find that households with greater amounts of unsecured credit, and thus more insurance, take longer to find jobs, and find higher wage jobs that are in line with the estimates presented here.

8.3 Employment, Delinquency, and Foreclosure: Model and Data

Figure 12 shows the model's employment per capita by delinquency status for the 15-month timeline economy. Employment rises in the model as delinquencies rise, with borrowers raising their search intensity and reducing their reservation wages. The mortgagor employment rate in the model rises by about 5 percent between being 60 days late and being in the foreclosure process. This increase in the model's mortgagor employment rate is smoother than the increase in the data, in which the latter is characterized by an increase that primarily occurs for mortgagors who are in the foreclosure process. The increase in the employment rate in the actual data is about 10 percent.

There are two likely reasons why the model employment increase is smoother than the increases displayed in Figures 1 and 2 from the PSID and the SCF, and is also not as large as in those data. One reason is that our model, like all standard search models, does not produce as many long-term unemployed as in the data. This is because unemployment in standard search models is Markovian. This means that search models generate very few individuals who are unemployed for long periods of time (e.g., more than a few months), whereas 45 percent of the unemployed between 2009 and 2011 were unemployed for longer than 6 months. We are unaware of any models that are capable of producing this share of long duration unemployed.

Another reason is that there is no heterogeneity in the flow utility derived from housing in our model. This means that the opportunity cost of eviction is identical for all borrowers. However, it is likely that there are some households who are very strongly attached (well matched) to their homes, and who choose to prevent eviction even at a very high cost. This is not included in this model.

9 Sensitivity Analyses: Wage Ladders and Extended Unemployment Insurance

This section considers the sensitivity of the results to two changes to the benchmark model: (i) wage ladders as in Ljungqvist and Sargent [1998] and (ii) unemployment insurance extensions.

9.1 Wage Ladders

This section reports findings for the case of a wage ladder, rather than the fixed wage contract. The impact of foreclosure delay is similar to that with fixed wages. Figure 13 shows the difference in employment per capita between the economy with a 15-month foreclosure timeline and the economy with a 9-month foreclosure timeline under different assumptions about on-the-job wage growth. From SIPP data, we calculate that the probability of a wage increase of at least $1 per month is about 4.66 percent.[38] This measure includes transitory wage changes, so we take this as an upper bound on the rate at which a worker may climb the wage ladder. Prior studies such as Ljungqvist and Sargent [1998] indirectly inferred this parameter, and if we use their values for wage growth, the model results remain largely unchanged. As Figure 13 shows, the difference in employment rates between the 24-month foreclosure timeline relative to the 9-month foreclosure timeline is about 0.1 percentage points smaller with wage ladders.

9.2 Extended Unemployment Benefits

Next, to assess the relative importance of foreclosure delays in an environment with extended unemployment benefits, we compare our benchmark model with a model in which unemployment insurance lasts for 2 years (in expectation). The impact on the *steady state* of the economy from a 2-year permanent benefit extension is to raise the unemployment rate by 1.9 percent. This increase in unemployment is nearly identical to that found in Nakajima

[38] See Appendix 13 for the full transition matrix. We use the SIPP-constructed wage rate "*wage*," which is described as the "Hourly rate this month" deflated by the CPI. The gross probability reported earlier is the average probability of transiting up the wage ladder by $1 or more in any given month. If we calculate net wage increases, i.e. we subtract from this measure the probability of going down at least $1 or more, the transition probability is 1.36 percent. If we further isolate permanent changes, this number declines further and the fixed contract model becomes a closer approximation to the wage ladder model.

[2012] (Table 4 of his paper) who also considers a 2-year permanent benefit extension but in a Mortensen-Pissarides style model. As Nakajima [2012] discusses, this magnitude response is consistent with UI studies such as Katz and Meyer [1990], Chetty [2008], Rothstein [2011] and Hagedorn et al. [2013]. To complete the sensitivity analysis, Figure 14 demonstrates that the impact of foreclosure delay on employment in the economy with a 2-year benefit extension is only about 0.05 percentage points weaker than under the baseline case.

10 Summary and Conclusion

This paper documents the fact that mortgage default as well as the home foreclosure process are persistent and reversible states, as homeowners who enter mortgage default often remain in default for a long period of time, and that these same homeowners often exit default or cure even when they have entered the foreclosure process. To our knowledge, the persistence of default and foreclosure, and the frequent curing from these states, are absent from the literature. We also present evidence from the PSID and the SCF that mortgage default is associated with job acceptance, as the employment rate among delinquent mortgagors in foreclosure is higher than that for delinquent mortgagors who have yet to enter foreclosure.

We construct a labor search model with homeownership that structurally interprets these facts as unemployed households using mortgage default as a means to help smooth consumption and search for a high-paying job, and who accept jobs to exit foreclosure when eviction is imminent. Our main finding is that the large increase in time to foreclose in some U.S. states in which foreclosure required about two years, including New York, New Jersey, and Florida (among others), reduced the employment rate of homeowners with mortgages by 1.3 percent and reduced total employment within these states by about 0.5 percent. To assess the plausibility of this impact, we conducted a difference-in-difference estimate of employment rates between homeowners and renters across states and find that homeowner employment rates were between 0.4 percent to 0.8 percent lower. The model also predicts that foreclosure delay of 15 months (the national average) increases the stock of delinquent loans by 45 percent, resulting from longer foreclosure processing time and slower mortgagor curing. To put the model's prediction in context, our results indicate that a 15-month increase in the foreclosure timeline has an impact on the aggregate economy roughly equal to a 6-month unemployment benefit extension.

The model also predicts an increase in match quality, as foreclosure delay results in longer unemployment spells, which allows the unemployed to wait for higher-wage jobs. We find that the wage bill in the economy with foreclosure delay rises by about 0.3 percent. This positive analysis of foreclosure delay provides an input to policymaking discussions on alternative approaches in providing additional insurance to homeowners during periods of substantial job loss and mortgage default.

References

John T Addison and McKinley L Blackburn. The effects of unemployment insurance on postunemployment earnings. *Labour Economics*, 7(1):21–53, 2000.

M. Adelino, K. Gerardi, and P.S. Willen. Why don't lenders renegotiate more home mortgages? redefaults, self-cures and securitization. Technical report, National Bureau of Economic Research, 2009.

Kartik Athreya, Juan M Sánchez, Xuan S Tam, and Eric R Young. Labor market upheaval, default regulations, and consumer debt. *Federal Reserve Bank of St. Louis Working Paper Series*, (2014-002), 2014.

Scott R Baker and Constantine Yannelis. Income changes and consumption: Evidence from the 2013 federal government shutdown. *Available at SSRN 2575461*, 2015.

D. Benjamin and X. Mateos-Planas. Formal and informal default in consumer credit. 2011.

D. Benjamin and M.L.J. Wright. Recovery before redemption: A theory of delays in sovereign debt renegotiations. *Unpublished Paper, University of California at Los Angeles*, 2009.

J.Y. Campbell and J.F. Cocco. A model of mortgage default. Technical report, National Bureau of Economic Research, 2011.

David Card, Andrew Johnston, Pauline Leung, Alexandre Mas, and Zhuan Pei. The effect of unemployment benefits on the duration of unemployment insurance receipt: New evidence from a regression kink design in missouri, 2003-2013. Technical report, National Bureau of Economic Research, 2015.

Kerwin Kofi Charles, Erik Hurst, and Matthew J Notowidigdo. Manufacturing decline, housing booms, and non-employment. Technical report, National Bureau of Economic Research, 2013.

S. Chatterjee and B. Eyigungor. *Foreclosures and House Price Dynamics: A Quantitative Analysis of the Mortgage Crisis and the Foreclosure Prevention Policy.* Federal Reserve Bank of Philadelphia, 2009.

S. Chatterjee and B. Eyigungor. A quantitative analysis of the us housing and mortgage markets and the foreclosure crisis. 2011.

R. Chetty. Moral hazard vs. liquidity and optimal unemployment insurance. Technical report, National Bureau of Economic Research, 2008.

D. Corbae and E. Quintin. Mortgage innovation and the foreclosure boom. *n Unpublished paper, University of Texas at Austin*, 2009.

Larry Cordell, Liang Geng, Laurie Goodman, and Lidan Yang. The cost of delay. 2013.

Will Dobbie and Jae Song. Debt relief and debtor outcomes: Measuring the effects of consumer bankruptcy protection. Technical report, working paper, 2013.

J. Eaton and M. Gersovitz. Debt with potential repudiation: Theoretical and empirical analysis. *The Review of Economic Studies*, pages 289–309, 1981.

Ronald G Ehrenberg and Ronald L Oaxaca. Unemployment insurance, duration of unemployment, and subsequent wage gain. *The American Economic Review*, pages 754–766, 1976.

R. Elul, N. Souleles, S. Chomsisengphet, D. Glennon, and R. Hunt. What'triggers' mortgage default? *FRB of Philadelphia Working Paper No. 10-13*, 2010.

Ronel Elul. Securitization and mortgage default. *Journal of Financial Services Research*, pages 1–29, 2015.

Martin Feldstein and James Poterba. Unemployment insurance and reservation wages. *Journal of Public Economics*, 23(1):141–167, 1984.

Chiara Fratto and Harald Uhlig. Accounting for post-crisis inflation and employment: A retro analysis. Technical report, National Bureau of Economic Research, 2014.

C. Garriga and D.E. Schlagenhauf. Home equity, foreclosures, and bailouts. *Manuscript, Federal Reserve Bank of St. Louis*, 2009.

Michael Gelman, Shachar Kariv, Matthew D Shapiro, Dan Silverman, and Steven Tadelis. How individuals smooth spending: Evidence from the 2013 government shutdown using account data. Technical report, National Bureau of Economic Research, 2015.

K. Gerardi, P. Willen, and L. Lambie-Hansen. Do foreclosure delays improve borrower outcomes?, 2011.

K.S. Gerardi, K.F. Herkenhoff, L.E. Ohanian, and P.S. Willen. Is it strategic? employment, wealth, and equity of defaulters. *In Progress*, 2013.

A.C. Ghent and M. Kudlyak. Recourse and residential mortgage default: evidence from us states. *Review of Financial Studies*, 24(9):3139–3186, 2011.

P.S. Goodman. Lucrative fees may deter efforts to alter troubled loans. *NY Times, July*, 30, 2009.

Luigi Guiso, Paola Sapienza, and Luigi Zingales. The determinants of attitudes towards strategic default on mortgages. *Forthcoming Journal of Finance*, 2010.

Marcus Hagedorn, Fatih Karahan, Iourii Manovskii, and Kurt Mitman. Unemployment benefits and unemployment in the great recession: the role of macro effects. Technical report, National Bureau of Economic Research, 2013.

J.C. Hatchondo, L. Martinez, and J. Sanchez. Mortgage defaults. 2012.

A. Head and H. Lloyd-Ellis. Housing liquidity, mobility and the labour market. *The Review of Economic Studies*, 2012.

A. Hedlund. Illiquidity and foreclosures in a directed search model of the housing market. 2011.

K.F. Herkenhoff. The impact of consumer credit access on unemployment. *Manuscript*, 2013.

K.F. Herkenhoff and L.E. Ohanian. Labor market dysfunction during the great recession. Technical report, National Bureau of Economic Research, 2011a.

Kyle Herkenhoff, Gordon Phillips, and Ethan Cohen-Cole. How credit cosntraints impact job finding rates, sorting, & aggregate output. *Manuscript*, 2015.

Kyle F Herkenhoff and Lee E Ohanian. Labor market dysfunction during the great recession. *The Cato Papers on Public Policy 2011*, 1:173, 2011b.

Andreas Hornstein, Per Krusell, and Giovanni L Violante. Frictional wage dispersion in search models: A quantitative assessment. Technical report, National Bureau of Economic Research, 2007.

William C Horrace and Ronald L Oaxaca. Results on the bias and inconsistency of ordinary least squares for the linear probability model. *Economics Letters*, 90(3):321–327, 2006.

E. Hurst and F. Stafford. Home is where the equity is: mortgage refinancing and household consumption. *Journal of Money, Credit and Banking*, pages 985–1014, 2004.

Federal Housing Finance Agency Office of Inspector General. Fhfas oversight of the enterprises efforts to recover losses from foreclosure sales. *Audit Report: AUD-2013-001*, 2012.

G. Jolivet, F. Postel-Vinay, and J.M. Robin. The empirical content of the job search model: Labor mobility and wage distributions in europe and the us. *European Economic Review*, 50(4):877–907, 2006.

F. Karahan and S. Rhee. Housing and the labor market: The role of migration on aggregate unemployment. *University of Pennsylvania, mimeo*, 2011.

Lawrence F Katz and Bruce D Meyer. Unemployment insurance, recall expectations, and unemployment outcomes. *The Quarterly Journal of Economics*, 105(4):973–1002, 1990.

A. Krueger and A. Mueller. Job search and job finding in a period of mass unemployment: Evidence from high-frequency longitudinal data. Technical report, Princeton University, Department of Economics, Industrial Relations Section., 2011.

A.B. Krueger and A. Mueller. Job search and unemployment insurance: New evidence from time use data. *Journal of Public Economics*, 94(3-4):298–307, 2010.

W. Li and M.J. White. Mortgage default, foreclosure, and bankruptcy. Technical report, National Bureau of Economic Research, 2009.

L. Ljungqvist and T.J. Sargent. The european unemployment dilemma. *Journal of Political Economy*, 106(3):514–550, 1998.

A. Lowrey. Strategic default penalties threaten struggling homeowners. *Washington Independent*, 2010.

M. Luzzetti and S. Neumuller. Bankruptcy reform and the housing crisis. *Available at SSRN 2001777*, 2012.

Bill McBride. Mortgage delinquencies by state: Percent and number, 2011. URL http://www.calculatedriskblog.com/2011/05/mortgage-delinquencies-by-state-percent.html.

Bill McBride. Lps: Mortgage delinquencies decreased slightly in july, 2012. URL http://www.calculatedriskblog.com/2012/09/lps-mortgage-delinquencies-decreased.html.

Atif Mian, Amir Sufi, and Francesco Trebbi. Foreclosures, house prices, and the real economy. Technical report, National Bureau of Economic Research, 2011.

K. Mitman. Macroeconomic effects of bankruptcy & foreclosure policies. 2011.

C.B. Mulligan. A depressing scenario: Mortgage debt becomes unemployment insurance. Technical report, National Bureau of Economic Research, 2008.

C.B. Mulligan. Aggregate implications of labor market distortions: The recession of 2008-9 and beyond. Technical report, National Bureau of Economic Research, 2010.

C.B. Mulligan. Means-tested subsidies and economic performance since 2007. Technical report, National Bureau of Economic Research, 2011.

Makoto Nakajima. A quantitative analysis of unemployment benefit extensions. *Journal of Monetary Economics*, 59(7):686–702, 2012.

Arash Nekoei, Andrea Weber, et al. Does extending unemployment benefits improve job quality? Technical report, mimeo, Harvard University, Cambridge, MA, 2013.

RK Pace and S. Zhu. The influence of foreclosure delays on borrower's default behavior, 2011.

A. Pennington-Cross. The duration of foreclosures in the subprime mortgage market: a competing risks model with mixing. *The Journal of Real Estate Finance and Economics*, 40(2):109–129, 2010.

Anthony Pennington-Cross. The value of foreclosed property. *Journal of Real Estate Research*, 28 (2):193–214, 2006.

RealtyTrac. 2011 year-end foreclosure report: Foreclosures on the retreat, 2012. URL http://www.realtytrac.com/content/news-and-opinion/2011-year-end-foreclosure-market-report-6984.

Christina D Romer. From recession to recovery: The economic crisis, the policy response, and the challenges we face going forward. *Testimony before the Joint Economic Committee*, 2009.

J. Rothstein. Unemployment insurance and job search in the great recession. Technical report, National Bureau of Economic Research, 2011.

Ayşegül Şahin, Joseph Song, Giorgio Topa, and Giovanni L Violante. Mismatch unemployment. Technical report, National Bureau of Economic Research, 2012.

Claudia Sahm. Forecasts of economic activity in the great recession, 2015. URL http://www.federalreserve.gov/econresdata/notes/feds-notes/2015/forecasts-of-economic-activity-in-the-great-recession-20150501.html.

Edouard Schaal. Uncertainty, productivity and unemployment in the great recession. *Federal Reserve Bank of Minneapolis, mimeo*, 2012.

Johannes Schmieder, Till Von Wachter, and Stefan Bender. The causal effect of unemployment duration on wages: Evidence from unemployment insurance extensions. Technical report, National Bureau of Economic Research, 2013.

R. Shimer. The cyclical behavior of equilibrium unemployment and vacancies. *American economic review*, pages 25–49, 2005.

D.E. Thompson. Problems in mortgage servicing from modification to foreclosure. *Manuscript*, 2010.

Jeffrey M Wooldridge. *Econometric analysis of cross section and panel data*. MIT press, 2010.

Figure 1: Employment Per Capita among Mortgagors by Delinquency Status (Source: 2009-2011 PSID)

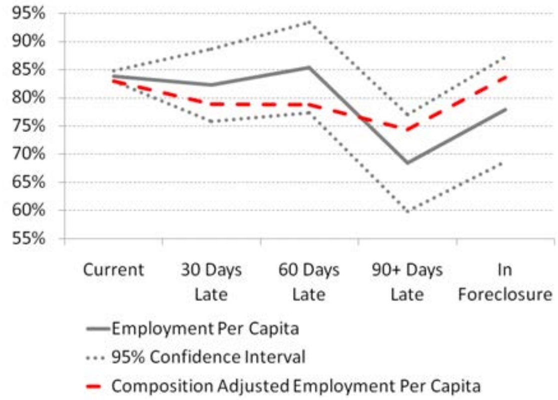


Figure 2: Employment Per Capita among Mortgagors by Delinquency Status (Source: 2009 SCF)

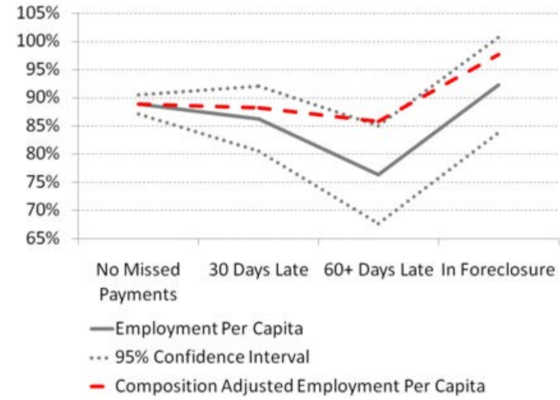


Figure 3: Histogram of Liquid Assets to Income (Source: 2009-2011 PSID)

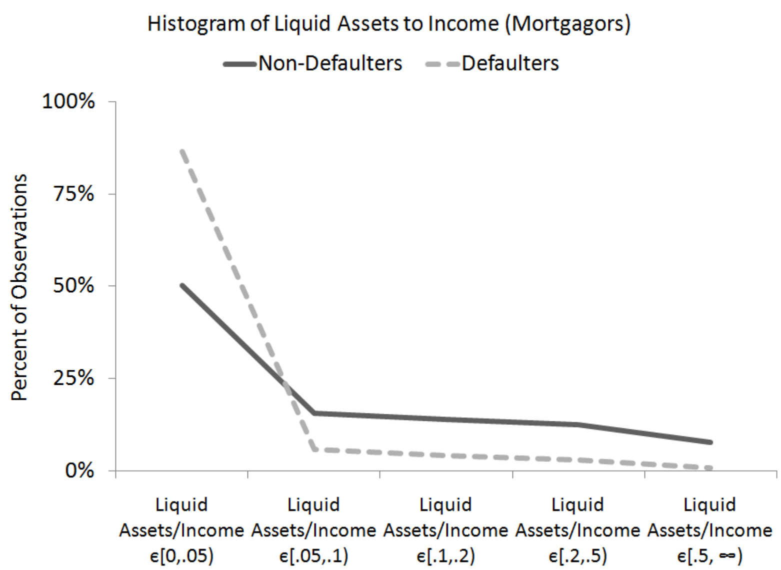


Figure 4: Transition Experiment: Foreclosure Probability $\lambda_F(n)$

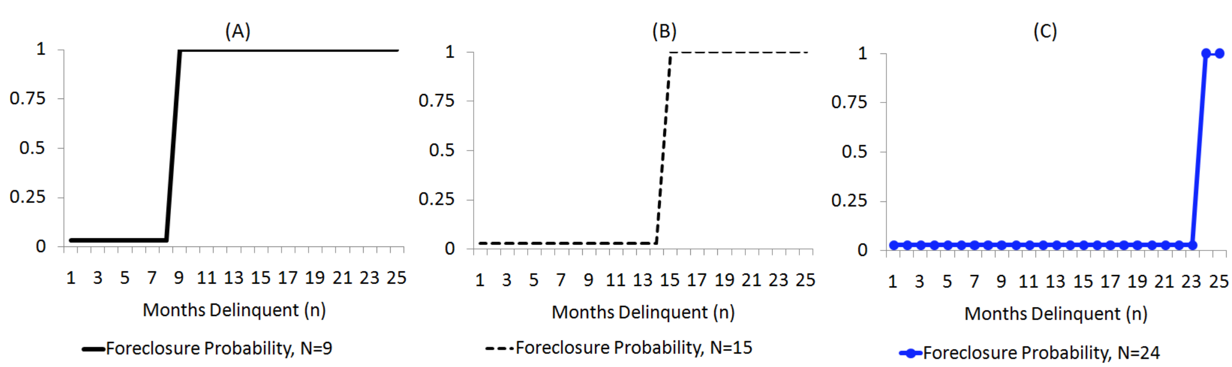


Figure 5: Homeowner Transitions 2009-2011 (Black), Homeowner Transitions 2001-2003 (Red and Underlined) (Source: LPS)

	Current	60 Days Late	90+ Days Late	In Foreclosure	REO	Paid Off	Liquidated
Current	97.01 97.79	0.45 0.9	0.01 0.01	0 0	0 0	2.52 1.3	0 0
60 Days Late	39.67 20.4	24.72 36.63	30.44 41.17	2.64 1.4	0 0.02	2.52 0.26	0 0.12
90+ Dates Late	10.47 4.26	4.71 1.83	68.4 83.9	14.58 8.56	0.45 0.27	1.29 0.39	0.1 0.79
In Foreclosure	6.37 1.59	0.14 0.07	7.77 4.68	75.16 87.9	8.26 4.82	1.96 0.28	0.35 0.66
REO	0 0	0 0	0 0	0 0	100 100	0 0	0 0
Paid Off	0 0	0 0	0 0	0 0	0 0	100 100	0 0
Liquidated	0 0	0 0	0 0	0 0	0 0	0 0	100 100

Figure 6: Model Homeowner Transitions, (No Delay Economy=Red Underlined Entries, Delay Economy= Black Entries)

	Current	60DL	90DL	FC	Renter
Current	0.9923 0.9895	0.0077 0.0105	0 0	0 0	0 0
60DL	0.454 0.4444	0 0	0.5296 0.5409	0 0	0.0163 0.0148
90DL	0 0	0.1762 0.1685	0.6533 0.6527	0.1539 0.1615	0.0166 0.0173
FC	0 0	0 0	0.1118 0.0667	0.7891 0.888	0.0992 0.0452
Renter	0 0	0 0	0 0	0 0	1 1

Figure 7: Transition Experiment: **Mortgagor** Employment Rate (%)

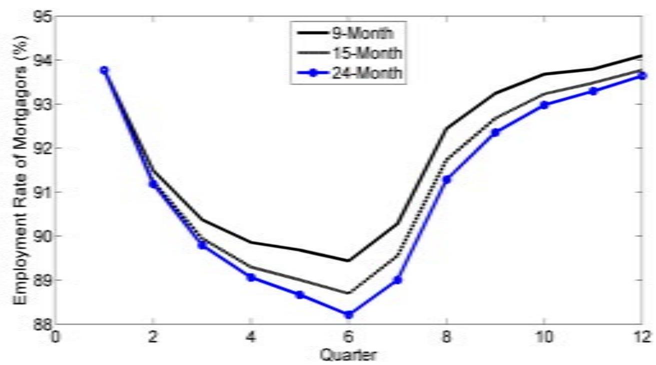


Figure 8: Transition Experiment: Difference in **Mortgagor** Employment Rate across Economies

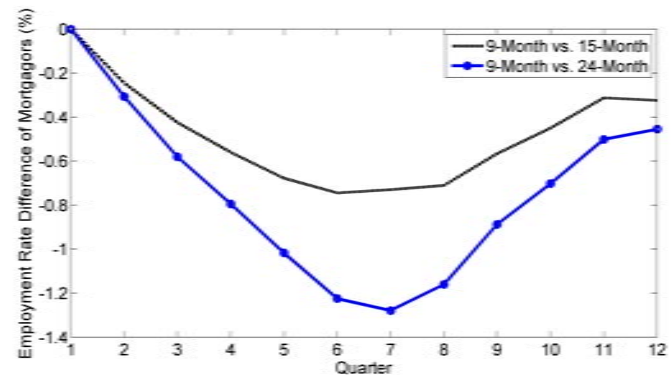


Figure 9: Transition Experiment: Difference in Employment Rate across Economies, All Agents

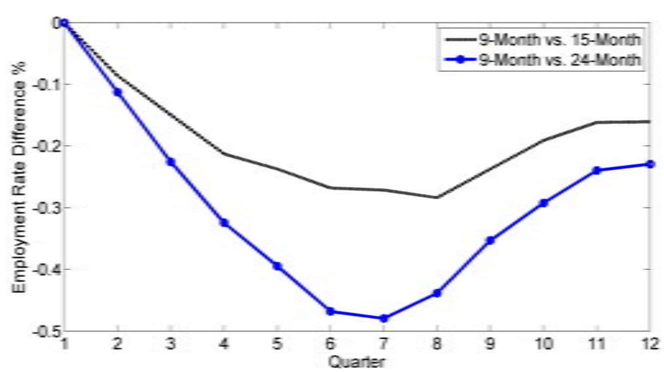


Figure 10: Transition Experiment: Delinquency Stock

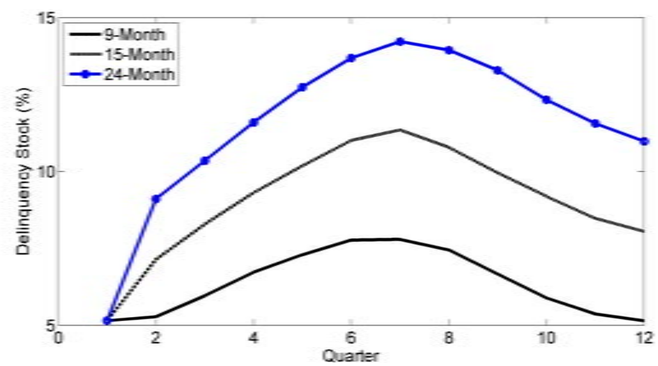


Figure 11: Transition Experiment: Homeownership

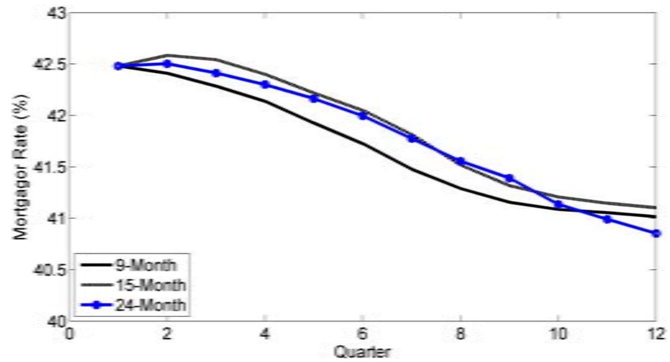


Figure 12: Transition Experiment: Employment Rate by Delinquency Status

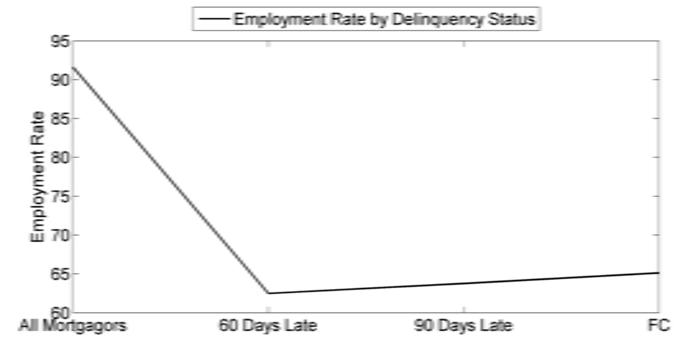


Figure 13: Transition Experiment: Difference in Unemployment Rates across Economies with and without Wage Ladders.

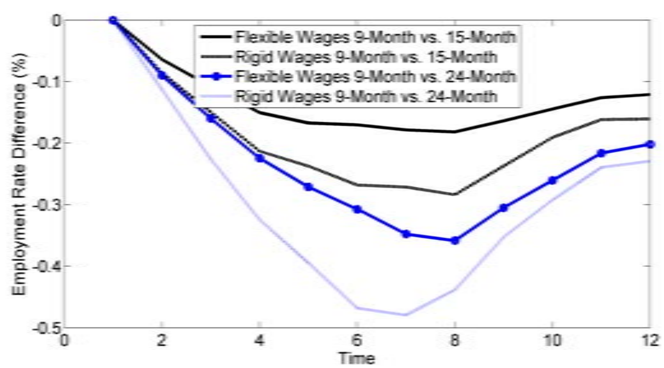


Figure 14: Transition Experiment: Difference in Employment Per Capita across Economies with Regular UI (6-month duration) vs. Extended UI (2-year duration).

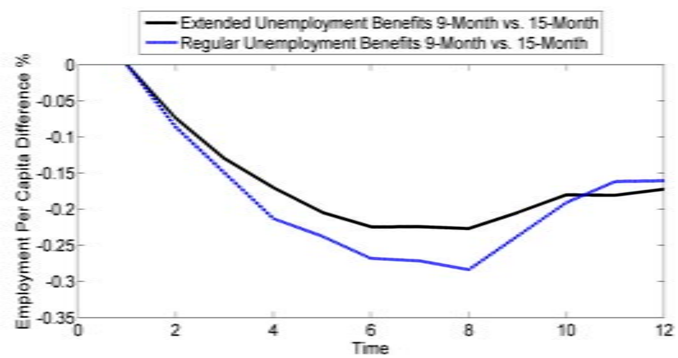


Table 1: Summary of Employment Per Capita, 2009 and 2011

Employment Per Capita, 2011					
	No Missed Payments	30 Days Late	60 Days Late	90+ Days Late	In Foreclosure
All Mortgagors, 2011	0.88	0.89	0.88	0.78	0.83
Judicial State Mortgagors, 2011	0.88	0.88	0.92	0.71	0.67
Nonjudicial State Mortgagors, 2011	0.88	0.89	0.85	0.84	0.92
	Observations				
All Mortgagors, 2011	2718	54	33	94	40
Judicial State Mortgagors, 2011	1058	26	12	42	15
Nonjudicial State Mortgagors, 2011	1626	28	20	50	25

Employment Per Capita, 2009					
	No Missed Payments	30 Days Late	60 Days Late	90+ Days Late	In Foreclosure
All Mortgagors, 2009	0.87	0.80	0.83	0.61	0.75
Judicial State Mortgagors, 2009	0.88	0.74	0.85	0.42	0.69
Nonjudicial State Mortgagors, 2009	0.86	0.84	0.82	0.72	0.79
	Observations				
All Mortgagors, 2009	3036	80	46	72	32
Judicial State Mortgagors, 2009	1173	31	13	26	13
Nonjudicial State Mortgagors, 2009	1854	49	33	46	19

Note: Sample includes 2009-2011 PSID mortgagor heads.

Table 2: Panel Regression Dependent Variable is Employment Indicator. OLS Coefficients Reported.

	(1)	(2)	(3)	(4)	(5)	(6)
30 Days Late (d)	-0.041	-0.039	-0.009	-0.003	-0.046	-0.050
	(-1.52)	(-1.36)	(-0.24)	(-0.10)	(-1.58)	(-1.52)
60 Days Late (d)	-0.042	-0.022	0.009	0.013	-0.069*	-0.050
	(-1.17)	(-0.59)	(0.18)	(0.26)	(-1.76)	(-1.16)
90+ Days Late (d)	-0.086***	-0.147***	-0.078*	-0.111***	-0.073**	-0.160***
	(-2.89)	(-4.67)	(-1.88)	(-2.67)	(-2.24)	(-4.43)
In Foreclosure (d)	-0.012	-0.048	0.045	0.025	-0.042	-0.098**
	(-0.34)	(-1.30)	(0.95)	(0.51)	(-1.10)	(-2.28)
Unemployment Duration	-0.042***		-0.030***		-0.050***	
	(-16.57)		(-9.13)		(-17.93)	
Income	0.000***		-0.000		0.000***	
	(5.46)		(-0.14)		(7.54)	
Liquid Assets to Income	-0.055***		-0.022		-0.073***	
	(-4.51)		(-1.25)		(-5.85)	
Specification	RE	RE	FE	FE	Pooled	Pooled
Demographic Controls	Yes	No	Yes	No	Yes	No
State Controls	Yes	No	Yes	No	Yes	No
P-val Coeff. 90+ DL = Coeff. Foreclosure	0.09	0.03	0.02	0.01	0.53	0.27
Observations	6,383	6,482	6,383	6,482	6,383	6,482
R-squared	.207	.004	0.043	0.003	0.208	0.004

*Note: t-statistics in parentheses: *** significant at 1%; ** significant at 5%; * significant at 10% . Demographic controls include age, sex, marital status, and education. State controls include recourse and judicial dummies. Sample includes 2009-2011 PSID mortgagor heads.*

Table 3: Panel Logit Dependent Variable is Employment Indicator. Average Marginal Effects Reported.

	(1)	(2)	(3)	(4)	(5)	(6)
30 Days Late (d)	-0.045	-0.011	-0.002	0.003	-0.043	-0.050
	(-1.55)	(-1.10)	(-0.18)	(0.03)	(-1.49)	(-1.41)
60 Days Late (d)	-0.052	-0.005	0.003	0.057	-0.073*	-0.050
	(-1.33)	(-0.51)	(0.19)	(0.33)	(-1.79)	(-1.07)
90+ Days Late (d)	-0.079**	-0.080**	-0.013	-0.201*	-0.060*	-0.160***
	(-2.30)	(-2.02)	(-0.21)	(-1.90)	(-1.89)	(-3.64)
In Foreclosure (d)	-0.019	-0.014	0.004	0.085	-0.031	-0.098**
	(-0.57)	(-0.90)	(0.20)	(0.47)	(-0.83)	(-1.98)
Unemployment Duration	-0.025***		-0.001		-0.031***	
	(-11.43)		(-0.20)		(-13.01)	
Income	0.000***		0.000		0.000***	
	(7.36)		(0.15)		(10.45)	
Liquid Assets to Income	-0.037***		-0.004		-0.042***	
	(-3.72)		(-0.20)		(-4.10)	
Specification	RE	RE	FE	FE	Pooled	Pooled
Demographic Controls	Yes	No	Yes	No	Yes	No
State Controls	Yes	No	Yes	No	Yes	No
P-val Coeff. 90+ DL = Coeff. Foreclosure (Coeff. Not Reported)	0.20	0.06	0.09	0.13	0.54	0.35
Observations	6,383	6,482	610	624	6,383	6,482

*Note: t-statistics in parentheses: *** significant at 1%; ** significant at 5%; * significant at 10% . Demographic controls include age, sex, marital status, and education. State controls include recourse and judicial dummies. Sample includes 2009-2011 PSID mortgagor heads.*

Table 4: SCF Composition Correction. Dependent Variable is Employment Indicator. Columns (1) and (2) OLS Coefficients Reported. Columns (3) and (4) Average Marginal Effects Reported.

	(1)	**(2)**	**(3)**	**(4)**
30 Days Late (d)	-0.006	-0.026	-0.010	-0.026
	(-0.22)	(-0.90)	(-0.38)	(-0.85)
60+ Days Late (d)	-0.030	-0.125***	-0.043	-0.125***
	(-0.97)	(-3.59)	(-1.23)	(-2.78)
In Foreclosure (d)	0.094**	0.035	0.091***	0.035
	(2.03)	(0.66)	(4.81)	(0.80)
Unemployment Duration	-0.064***		-0.033***	
	(-19.54)		(-11.96)	
Income	0.000*		0.000	
	(1.84)		(1.16)	
Liquid Assets to Income	-0.004***		-0.002**	
	(-2.63)		(-2.12)	
P-val Coeff. 60+ DL= Coeff. Foreclosure	0.022365	0.009973	0.008864	0.042883
Observations	1,587	1,587	1,587	1,587

*Note: t-statistics in parentheses: *** significant at 1%; ** significant at 5%; * significant at 10% . Demographic controls include age, sex, marital status, and education.*

Table 5: Back-End Debt-to-Income Ratios

Back-End DTI, 2009 Mortgagor PSID Heads, Non-Self Employed							
p10	p25	p50	p75	p90	Mean	Std. Dev	Obs
0.09	0.14	0.21	0.33	0.49	0.32	0.97	2416
Back-End DTI, Delinquent 2009 Mortgagor PSID Heads, Non-Self Employed							
p10	p25	p50	p75	p90	Mean	Std. Dev	Obs
0.14	0.23	0.36	0.49	0.83	0.64	2.03	165

Notes: 2009 PSID heads of household. After tax income generated using TAXSIM. Back-end debt-to-income ratios are taken as ratio of mortgage payments over after-tax income less insurance expenses, lease outlays, and an imputed unsecured debt service flow equal to 14.31% of the stock of unsecured debt. In the event that a household had negative income after these adjustments, we dropped them from the sample, thus understating the burden of mortgage debt.

Table 6: Steady State: Targeted Moments

	Data	**Source**	**Model**	**Parameters**	
Homeownership Rate	43.91%	Census	43.71%	c_h	0.23146
Unemployment Target	6.50%		6.88%	α_s	6.4642
Mean Back-End Debt-to-Income (DTI)	31.70%	2009 PSID, NBER TAXSIM	31.19%	r_b	0.004737
Fraction of Mortgagors with 0-5% Liquid Assets to Income	50.20%	2009 PSID	56.39%	$1 - f_m$	0.2126
Foreclosure Rate	8.61%	LPS 2001-2003	9.92%	f_c	0.030283
Default Rate	0.45%	LPS 2001-2003	0.77%	β	0.98728
60+ Days Late Cure Rate	39.67%	LPS 2001-2003	45.40%	$\bar{r}$	0.000899
90 to 60+ Days Late Cure Rate	15.18%	LPS 2001-2003	17.62%	z_h	1.8971
Homeowner Unemployment Rate	6.29%	2009 PSID	6.22%		
Fraction of Defaulters with 0-5% Liquid Assets to Income	84.55%	2009 PSID	95.58%		
DTI Defaulting Homeowners	64%	2009 PSID, NBER TAXSIM	59%		

Table 7: Monthly Job-Finding Rates (Source: Job Finding Rate from CPS and Code from Shimer [2005], Layoff Rate from JOLTS)

	JF Rate	**Layoff Rate**
2007	0.26	1.34
2009	0.17	1.71
Percent Change '07 to '09	36.5%	27.6%

Table 8: Steady State: Wage Bill and Foreclosure Delays

	9-Month	15-Month	24-Month
Wage Bill Per Capita	0.79254	0.79472	0.79542
Percentage Gain Relative to 9-Month		0.28%	0.36%

Table 9: Foreclosure Transition Rates from 'In Foreclosure' to 'REO' or 'Liquidation'

10 Slowest States, 2009-2011

State	Legal	Transition Probability FC to Liquidation	95% CI, LB	95% CI, UB	Obs
New Jersey	Judicial	0.01	0.01	0.02	1042
Delaware	Judicial	0.02	-0.02	0.05	61
New York	Judicial	0.02	0.01	0.03	660
Hawaii	Judicial	0.02	-0.01	0.06	82
Connecticut	Judicial	0.03	0.00	0.05	197
Florida	Judicial	0.03	0.02	0.03	4673
Maine	Judicial	0.03	0.00	0.06	100
Massachusetts	Nonjudicial	0.03	0.01	0.05	231
West Virginia	Nonjudicial	0.03	-0.01	0.07	64
Louisiana	Judicial	0.03	0.00	0.06	155

10 Fastest States, 2009-2011

State	Legal	Transition Probability FC to Liquidation	95% CI, LB	95% CI, UB	Obs
Colorado	Nonjudicial	0.10	0.06	0.14	218
Alabama	Nonjudicial	0.10	0.05	0.15	143
Missouri	Nonjudicial	0.10	0.05	0.15	152
Iowa	Judicial	0.12	0.05	0.20	73
Arizona	Nonjudicial	0.12	0.10	0.15	610
Alaska	Nonjudicial	0.13	-0.04	0.29	16
Georgia	Nonjudicial	0.14	0.10	0.18	316
Arkansas	Nonjudicial	0.16	0.05	0.26	45
Michigan	Nonjudicial	0.16	0.12	0.20	343
New Hampshire	Nonjudicial	0.17	0.06	0.28	47

Note: Based on LPS sample of mortgages originated in 2004. Calculated as monthly probability of exiting foreclosure into REO or Liquidation over the 2007-2009 time period.

Table 10: Dependent Variable is Employment Indicator. OLS Regression Coefficients Reported. Sample includes states with the 10 lowest and 10 highest foreclosure to liquidation rates (Source: CPS and LPS)

	(1)	**(2)**	**(3)**	**(4)**
Slow Foreclosure (d)	0.005***	0.002	0.004*	0.006***
	(3.12)	(0.96)	(1.79)	(2.63)
Homeowner (d)	0.021***	0.075***	0.022***	0.019***
	(14.44)	(30.20)	(11.22)	(8.63)
Slow Foreclosure (d) x Homeowner (d)	-0.004**	-0.008***	-0.004*	-0.004
	(-2.25)	(-2.64)	(-1.73)	(-1.50)
Occupation and Industry Controls	Yes	No	Yes	Yes
Sample Years	2003-2013	2003-2013	2007-2013	2003-2007
Observations	349,319	349,319	200,562	148,757
R-squared	0.755	0.287	0.743	0.772

*Note: t-statistics in parentheses: *** significant at 1%; ** significant at 5%; * significant at 10%. CPS Heads of Household. All regressions include demographic controls such as age, sex, marital status, race, and education. Occupation and industry controls include dummies for "major occupation" and "major industry" as designated by the CPS.*

APPENDIX: FOR PUBLICATION ONLINE ONLY

11 Data and Image Descriptions

11.1 PSID Composition Correction

PSID Sample: 2009-2011 PSID Core/Immigrant Sample, Working-Age Heads with Mortgages (or Previously Had a Mortgage but was Foreclosed Upon).

When computing employment rates across delinquency status, we must control for composition. For example, it may be the case that those who are in foreclosure also work in lower-paying jobs and therefore have better employment prospects since the labor market is polarized. We control for basic differences across households in Tables 2 and 3. We estimate regressions of the basic form

$$I(employed_t) = \beta_0 + \beta_1 delinquent_t + \beta_2 foreclosure_t + \beta_3 X_t + \epsilon_t.$$

The controls X_t include basic demographic controls for age, sex, marital status, and education as well as income and asset controls, and state level controls for foreclosure procedures. Table 1 illustrates employment per capita across delinquency status and states for both years.

11.2 SCF Composition Correction

SCF Sample: 2007-2009 SCF Sample, Working-Age Heads with Mortgages (or Previously Had a Mortgage but was Foreclosed Upon).

We follow the same exact procedure with the SCF to correct for composition. Table 4 reports both the OLS (Columns (1) and (2)) and Logit (Columns (3) and (4)) results used to construct the composition corrected employment per capita by delinquency in the main text.

12 Spousal Employment Patterns

Using the same methodology as Appendix 11, Table 11 illustrates a similar pattern of increasing employment among spouses who are in foreclosure. The dependent variable is an indicator if the head's spouse is employed. Columns (1) and (2) include all heads, and Columns (3) and (4) only include married heads. Column (1) shows that relative to spouses who have a head of household that is current on the mortgage, spouses who are 90+ days late are 7.8% less likely to be employed. However, relative to spouses who have a head of household that is current on the mortgage, spouses in foreclosure are only 1.9% less likely to be employed. One possible interpretation of these correlations is that both the head and the spouse seek jobs in order to stave off foreclosure.

Table 11: Spousal Employment Patterns During Delinquency. Dependent variable is employmeny indicator of spouse. Columns (1) and (2) include all heads coding all missing spousal employment statuses as zero, Columns (3) and (4) condition on the head being married (Source: PSID 2009-2011).

	(1)	**(2)**	**(3)**	**(4)**
30 Days Late (d)	-0.060**	-0.039	-0.049	-0.028
	(-2.12)	(-1.36)	(-1.30)	(-0.75)
60 Days Late (d)	-0.003	-0.022	0.007	-0.025
	(-0.08)	(-0.59)	(0.11)	(-0.42)
90+ Days Late (d)	-0.078**	-0.147***	-0.095**	-0.128***
	(-2.45)	(-4.67)	(-2.16)	(-2.89)
In Foreclosure (d)	-0.019	-0.048	-0.028	-0.064
	(-0.52)	(-1.30)	(-0.53)	(-1.18)
Unemployment Duration (Spouse)	-0.023***		-0.024***	
	(-7.28)		(-6.68)	
Unemployment Duration	0.003		0.003	
	(1.25)		(0.94)	
Married Only	N	N	Y	Y
Demographic and State Controls	Y	N	Y	N
Observations	6,383	6,482	4,525	4,590
Number of id	3,864	3,927	2,674	2,718

*Note: t-statistics in parentheses: *** significant at 1%; ** significant at 5%; * significant at 10% . Demographic controls include head age, sex, marital status, and education. State controls include recourse and judicial dummies. Sample includes 2009-2011 PSID mortgagor heads in Columns (1) and (2), and married heads in (3) and (4).*

13 Computational Details, Wage Offer Distribution and Aggregate Transition Matrix

We solved the dynamic programming problem by using value function iteration over a discrete state space. The grid for search effort is evenly spaced over the interval [0,1] with 21 nodes. The asset grid is evenly spaced over the interval [0,1] with 21 nodes. The grid for wages is evenly spaced over the interval $[.1, 1]$ with 37 nodes corresponding to the PSID $1 wage bins illustrated in Table 12.

The offer distribution is constructed as follows. Let $G(w)$ be the empirical cumulative distribution function of wages of employed households. The stock of employed workers earning w or less is given by $(1-u)G(w)$. Let the grid of wages be given by $[w_1, \ldots, w_K]$, where grid slots are indexed by k. Let $p_{i,j}$ be the probability of transiting from wage i to wage j next month. In steady state the following relationship must be true:[39]

$$\begin{aligned} &\mu u F(w_k) + \sum_{j>k} p_{j,k}(1-u)G(w_j) && \textit{(flows in)} \\ &- \Big(\sum_{j>k} p_{k,j} + \delta\Big)(1-u)G(w_k) && \textit{(flows out)} \\ &= 0 \end{aligned}$$

Rearranging, the expression for the offer distribution is given below:

$$F(w_k) = \frac{(\sum_{j>k} p_{k,j} + \delta)(1-u)G(w_k) - \Big(\sum_{j>k} p_{j,k}(1-u)G(w_j)\Big)}{\mu u}$$

We take the empirical acceptance rate μ from Krueger and Mueller [2011] (from Table 6.1b = (361*.444+417*.738)/(361+417)=.602), we set the unemployment mass to $u = .06$, and the job destruction rate is set to 1.4%. In the rigid wage calibration, $p_l = p_h$=0, and in the flexible wage calibration, we take the transition probabilities from SIPP. To make the text size readable, Table 15 illustrates the transition rates over a coarse wage grid (the fine wage grid used in the model has a wage bin size of $1 with the same limits from $5 to $40).

We also constructed the monthly good-times-bad-times transition matrix from business cycle data on the NBER website; the probability of transiting from good times to bad times is .0146 and the probability of staying in good times is .9854:

[39] This condition is approximate and assumes a constant positive probability of accepting any wage drawn.

Figure 15: Coarse Wage Transition Table (Source: SIPP)

	w ∈ (5, 7.5]	w ∈ (7.5, 10]	w ∈ (10, 12.5]	w ∈ (12.5, 15]	w ∈ (15, 17.5]	w ∈ (17.5, 20]	w ∈ (20, 22.5]	w ∈ (22.5, 25]	w ∈ (25, 27.5]	w ∈ (27.5, 30]	w ∈ (30, 32.5]	w ∈ (32.5, 35]	w ∈ (35, 37.5]	w ∈ (37.5, 40]	w>40
w ∈ (5, 7.5]	91.3	5.02	1.47	0.73	0.43	0.22	0.16	0.11	0.1	0.09	0.06	0.06	0.03	0.03	0.18
w ∈ (7.5, 10]	1.09	95.9	1.7	0.47	0.29	0.15	0.1	0.06	0.05	0.03	0.03	0.02	0.01	0.01	0.08
w ∈ (10, 12.5]	0.38	1.78	94.8	1.61	0.58	0.26	0.16	0.11	0.07	0.06	0.03	0.02	0.02	0.01	0.12
w ∈ (12.5, 15]	0.29	0.67	2.21	93.5	1.79	0.57	0.3	0.15	0.14	0.09	0.06	0.03	0.03	0.02	0.15
w ∈ (15, 17.5]	0.17	0.45	0.73	2.08	93	1.85	0.66	0.29	0.2	0.1	0.09	0.07	0.03	0.03	0.22
w ∈ (17.5, 20]	0.17	0.34	0.41	0.68	2.41	92	2.05	0.76	0.36	0.21	0.15	0.07	0.07	0.05	0.3
w ∈ (20, 22.5]	0.14	0.26	0.34	0.44	0.79	2.53	91.3	1.87	0.92	0.38	0.27	0.14	0.1	0.05	0.5
w ∈ (22.5, 25]	0.12	0.19	0.3	0.29	0.5	0.99	2.85	89.7	2.5	0.92	0.49	0.29	0.18	0.09	0.6
w ∈ (25, 27.5]	0.1	0.14	0.19	0.29	0.35	0.54	1.14	2.95	89.6	1.96	0.95	0.57	0.23	0.2	0.8
w ∈ (27.5, 30]	0.08	0.16	0.19	0.24	0.28	0.41	0.66	1.09	3.19	88.4	2.11	0.99	0.72	0.28	1.21
w ∈ (30, 32.5]	0.12	0.14	0.19	0.2	0.3	0.33	0.45	0.71	1.17	2.94	87.8	2.41	0.93	0.64	1.69
w ∈ (32.5, 35]	0.1	0.14	0.15	0.18	0.17	0.27	0.36	0.43	0.97	1.23	3.57	86.6	2	1.09	2.73
w ∈ (35, 37.5]	0.07	0.1	0.12	0.14	0.16	0.27	0.29	0.36	0.6	0.99	1.12	3.11	86.6	1.89	4.15
w ∈ (37.5, 40]	0.11	0.17	0.11	0.19	0.14	0.31	0.22	0.36	0.52	0.63	1.26	1.56	3.51	83.8	7.13
w>40	0.06	0.14	0.18	0.08	0.16	0.12	0.4	0.32	0.46	0.57	0.71	1.2	1.58	3.46	90.6

$$\theta_{Transition} = \begin{bmatrix} 0.9854 & 0.0146 \\ 0.0833 & 0.9167 \end{bmatrix}.$$

Table 12: Employed Wage Distribution (PSID: 2007, employed working-age heads of household)

$w =$	5	6	7	8	9	10	11	12	13	14
Frequency	2.21%	1.34%	1.83%	2.11%	3.01%	3.45%	3.20%	4.25%	4.30%	3.80%
$w =$	15	16	17	18	19	20	21	22	23	24
Frequency	4.20%	4.28%	3.73%	3.44%	2.83%	3.38%	2.88%	2.54%	2.67%	2.54%
$w =$	25	26	27	28	29	30	31	32	33	34
Frequency	2.60%	2.22%	1.79%	1.73%	1.52%	1.60%	1.50%	1.73%	1.12%	0.92%
$w =$	35	36	37	38	39	40	$w > 40$			
Frequency	0.98%	1.03%	1.00%	0.67%	0.95%	0.84%	15.82%			

14 Theoretical Characterization: Proofs

Restatement of Lemma 6.1: *Define $\psi(n) = 1 - \lambda_F(n)$ as the degree of default protection (the probability of not being foreclosed upon). Let θ be constant, let δ be the constant job destruction rate, and let b be the constant benefit rate. Suppose that the domain of the household dynamic programming problem is convex and the return function $u(c, z) - x(s)$ is concave, then the optimal reservation wage $w_i^*(b, a, n; \theta)$, $i \in \{h, r\}$ is increasing in the degree of protection for any interior points of the state space.*

Proof. Consider an unemployed agent that is comparing the options of (i) turning down a wage draw equal to their reservation wage, i.e. remaining unemployed, and continuing to default, versus (ii) accepting a wage draw equal to their reservation wage and paying current. Suppressing the state space, denote the reservation wage $w^*(b) = w_i^*(b, a, n; \theta)$. Implicitly, the reservation wage depends on the degree of default protection, thus denote the reservation wage $w^*(b; \psi)$. Likewise, suppress the states for the value of defaulting while unemployed $U^d(b) = U^d(b, a, n; \theta)$ as well as paying and being employed $W^p(w) = W^p(b, a, n; \theta)$. Implicitly, the value of defaulting and being unemployed $(U^d(b; \psi))$ and the value of paying and being employed $(W^p(w; \psi))$ depend on ψ (however, the value of realized and completed foreclosure $(U^f(b))$ does not depend on ψ, but rather on recourse enforcement etc.). By definition, the reservation wage makes the agent indifferent between option (i) and option (ii):

$$\psi U^d(b; \psi) + (1 - \psi) U^f(b) = W^p(w^*(b, \psi); \psi)$$

Differentiating,

$$\psi \frac{\partial U^d(b; \psi)}{\partial \psi} + U^d(b; \psi) - U^f(b) = \underbrace{\left.\frac{\partial W^p(w; \psi)}{\partial w}\right|_{w=w^*(b;\psi)} \frac{\partial w^*(b; \psi)}{\partial \psi}}_{\text{Indirect Effect}} + \underbrace{\left.\frac{\partial W^p(w; \psi)}{\partial \psi}\right|_{w=w^*(b;\psi)}}_{\text{Direct Effect}}$$

and rearranging,

$$\frac{\partial w^*(b; \psi)}{\partial \psi} = \frac{\psi \frac{\partial U^d(b;\psi)}{\partial \psi} - \frac{\partial W^p(w^*(b;\psi);\psi)}{\partial \psi} + U^d(b; \psi) - U^f(b)}{\frac{\partial W^p(w^*(b;\psi);\psi)}{\partial w}} \tag{1}$$

Consider the effect of protection on a newly employed agent that pays current on the mortgage, $\frac{\partial W^p(w^*(b;\psi);\psi)}{\partial \psi}$. Since the agent is paying, the agent is not at risk of foreclosure. Thus, it must be the case that ψ matters only in the case that the agent loses their job and then begins defaulting again. This implies that the derivative is bound in a convenient way (assume for simplicity that benefits are constant):

$$\frac{\partial W^p(w^*(b;\psi);\psi)}{\partial \psi} \leq \beta\delta\Big(\psi\frac{\partial U^d(b;\psi)}{\partial \psi} + U^d(b;\psi) - U^f(b)\Big) \tag{2}$$

Subbing (2) into (1) and grouping terms,

$$\frac{\partial w^*(b;\psi)}{\partial \psi} \geq \frac{(1-\beta\delta)\Big(\frac{\partial U^d(b;\psi)}{\partial \psi} + U^d(b;\psi) - U^f(b)\Big)}{\frac{\partial W^p(w^*(\psi))}{\partial w}} > 0$$

The value of default $\frac{\partial U^d(b;\psi)}{\partial \psi} > 0$ is strictly increasing in the degree of default protection, and the value of employment $\frac{\partial W^p(w^*(b;\psi))}{\partial w} > 0$ is strictly increasing in the wage. That the agent chooses default implies that $U^d(b;\psi) - U^f(b) > 0$. Thus the inequality holds. □

Restatement of Lemma 6.2: *Consider a version of the model that satisfies the hypothesis of Lemma 6.1. Under the additional assumptions that the disutility of search is increasing and strictly convex in search effort, $x'(s) > 0$ and $x''(s) > 0 \ \ \forall s > 0$, and $\pi(s,\theta)$ is linear in s with $\partial\pi(s,\theta)/\partial s = \alpha_s$, then the optimal search effort $s_h^*(b,a,n;\theta)$ is decreasing in the degree of protection for any interior point in the state space.*

Proof. Suppressing all household states except for unemployment benefits, let $s^*(b;\psi) = s_i^*(b,a,n;\theta) \ \ i \in \{h,r\}$ be the optimal search decision. Implicitly, the search effort depends on the underlying degree of default protection ψ (see the first order conditions below). The assumptions in the hypothesis ensure that first order conditions suffice for search effort decisions. Consider a defaulting homeowner with $n \geq 1$, and let $\widetilde{U}_h(b;\psi) = \widetilde{U}_h(b,a,n+1;\psi)$ and $\widetilde{W}_h(b;\psi) = \widetilde{W}_h(b,a,n+1;\psi)$. Differentiating, the optimal search effort is implicitly given below:

$$\begin{aligned}\frac{\partial x(s^*(b;\psi))}{\partial s} =& \widehat{\beta}\mathbb{E}\Big[-\alpha_s\widetilde{U}_h(b;\psi) \\ &+ \alpha_s\Big(\widetilde{U}_h(b;\psi)F(w^*(\psi)) + \int_{w^*(\psi)}^{\bar{w}} \widetilde{W}_h(\hat{w};\psi)\ dF(\hat{w})\Big)\Big]\end{aligned}$$

To characterize the effects of protection on search effort, apply the envelope theorem:

$$\begin{aligned}
\frac{\partial^2 x(s^*(b;\psi))}{\partial^2 s}\frac{\partial s^*(b;\psi)}{\partial \psi} &= \widehat{\beta}\mathbb{E}\Big[-\alpha_s\frac{\partial \widetilde{U}_h(b;\psi)}{\partial \psi}+\alpha_s\Big(\frac{\partial \widetilde{U}_h(b;\psi)}{\partial \psi}F(w)+\int_w^{\bar{w}}\frac{\partial \widetilde{W}_h(\hat{w};\psi)}{\partial \psi}\ dF(\hat{w})\Big)\Big]\Big|_{w=w^*(\psi)} \\
&< \widehat{\beta}\mathbb{E}\Big[-\alpha_s\frac{\partial \widetilde{U}_h(b;\psi)}{\partial \psi}+\alpha_s\Big(\frac{\partial \widetilde{U}_h(b;\psi)}{\partial \psi}F(w)+\frac{\partial \widetilde{U}_h(b;\psi)}{\partial \psi}(1-F(w))\Big)\Big]\Big|_{w=w^*(\psi)} \\
&= 0
\end{aligned}$$

The last line follows from the inequality below:

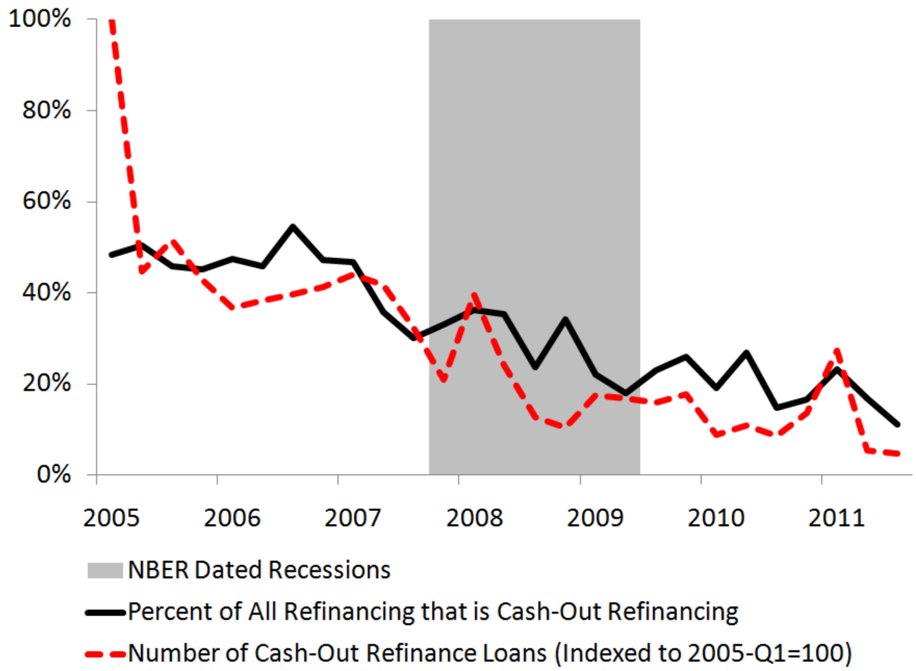
$$0 < \frac{\partial \widetilde{W}_h(w;\psi)}{\partial \psi} \leq \beta\delta\frac{\partial \widetilde{U}_h(w;\psi)}{\partial \psi} < \frac{\partial \widetilde{U}_h(w;\psi)}{\partial \psi} \leq \frac{\partial \widetilde{U}_h(b;\psi)}{\partial \psi} \quad \forall w > b$$

The intuition behind the inequality is that the effect of protection is strongest for those who are unemployed with low benefits, as one would expect. Since benefits are constant, the reservation wage is at least the benefit amount, thus for all the wages above the reservation wage, the above inequality holds. □

15 Cash-Out Refinancing

As shown in Figure 16, the cash-out refinancing mortgage market collapsed during the 2007-2009 recession in the United States. Large declines in home equity along with tightened lending standards led to the 5 fold reduction in cash out refinancing mortgage volume.

Figure 16: Cash-Out Refinancing (Source: LPS)

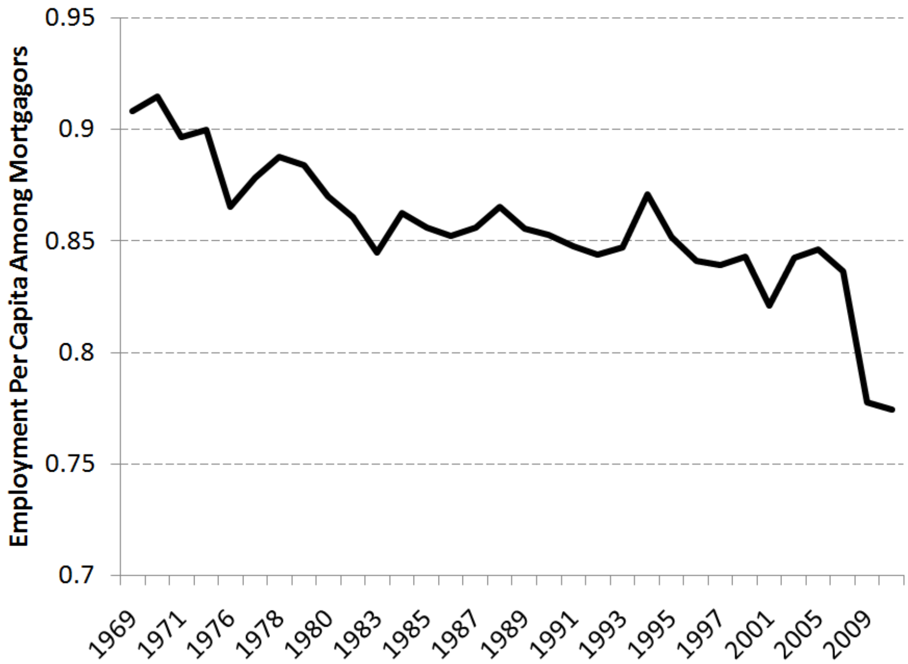


16 Employment Per Capita among Mortgagors

As shown in Figure 17, the 2007-2009 recession in the United States is marked by a record number of non-employed mortgagors and a record number of delinquent mortgagors.[40] Employment per capita drops by more than 6 percent between 2007 and 2009 and remains depressed through 2011 (the last year plotted). The magnitude of this record reduction in employment per capita is consistent with our model.

[40]The image includes several data sources including the Panel Study of Income Dynamics (PSID) up to the most recent publicly available survey in 2011, Lender Processing Services Data (LPS) through 2011, CoreLogic House Price Data through 2011, and the National Bureau of Economic Research (NBER) business

Figure 17: Mortgagor Employment Per Capita (PSID)



17 Institutional Details of Foreclosure

This section provides background information on the way mortgage default and foreclosure typically work. It is important to note that there is considerable variability across servicers and states as to how they handle foreclosure.

The order of events in a foreclosure has potential to distort buyers' incentives to pay since foreclosure is a slow and relatively predictable process. The usual order of events is as follows:

1. Miss payments (30+ days late, Enter Delinquency)
2. Notice of Default (Enter Foreclosure)
3. Notice of Sale (1 month prior to foreclosure sale)
4. Foreclosure Auction (Sheriff Sale)

cycle dates.

5. Eviction

6. *Potential* Deficiency Judgment if Sale Price < Remaining Mortgage Balance

7. Ineligible for government-backed loans for 7 years (see Lowrey [2010]).

Legally, if a mortgagor breaks the terms of the mortgage, the bank can ask for the entire debt to be paid immediately. If the mortgagor cannot pay this entire amount, the bank can foreclose. There are two main types of foreclosures in the United States: judicial and nonjudicial (see Ghent and Kudlyak [2011] for state classifications). To complete a judicial foreclosure, the bank that owns the mortgage must sue the person living in the home in a state court. A judge is required to rule on the case before a foreclosure sale can occur. A foreclosure sale is called a "sheriff sale." A non-judicial foreclosure, also known as a foreclosure by power of sale, allows the bank to sell the house without the court's approval. A notice of default explains that the bank intends to sell the property and that if the debt is not cured, there will be a public auction for the house. A notice of sale is issued 1 month prior to the foreclosure auction date. If the bank is unable to sell the home in a public auction, which means "no acceptable bids are made," or the bank bids for the house itself, then the house becomes owned by the bank. The term for this is "real estate owned" (REO).

It is possible to temporarily postpone the foreclosure process by bankruptcy (however the courts cannot modify loans) or by challenging the banks' right to the property they are trying to foreclose upon.[41] One component of the recent robo-signing scandal has to do with the banks' inability to prove that they had the right of interest in the property.

Regardless of the foreclosure procedure, each state has laws about recourse and nonrecourse loans. In a state with recourse, selling a home for less than the amount due may result in a deficiency judgment. Deficiency judgments mandate that the borrower pay the difference between the sale price and the amount owed on the mortgage. Many mortgages however are nonrecourse loans, meaning that the bank cannot sue to obtain the assets of the person who held the mortgage. As a result, in most cases, borrowers are exempt from deficiency judgments. In California, for instance, the first purchase-money mortgage for a residential property is a nonrecourse loan. However, the state laws are not entirely uniform across all mortgages, e.g. all refinanced loans in California are recourse.

There is also a chance for homeowners to 'redeem' their homes after foreclosure if they

[41] For more on bankruptcy and foreclosure, see Li and White [2009], Luzzetti and Neumuller [2012], and Mitman [2011]

are able to raise enough money. These redemption periods can last up to a year and vary by state.