Foreclosure Delay and U.S. Unemployment[*]

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Abstract

We study and document the growing trend of mortgagors who use their house as 'informal' unemployment benefits during the 2007 recession and the subsequent recovery. We capture this behavior by treating both delinquency and foreclosure not as one period events, but rather as protracted and potentially reversible episodes that influence job search behavior. We motivate our model by documenting foreclosure delays as well as movements into and out of default. The model portion of the paper includes search effort and wage draws to consider the *job acceptance distortions* associated with foreclosure delays. In more technical terms, the focus of the paper is to document and better understand the relationship between *prolonged mortgage delinquency as a consumption smoothing technology* and its implications for the labor market. We find that the delays can increase the unemployment rate by $\frac{2}{3}\%$ and this increase is persistent for one year or more. Those that use their mortgage as unemployment insurance borrow at real rates of interest between 10% and 55% depending on how delinquent the borrower is.

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1   Introduction

Our work is motivated by the recent observations in Ohanian and Raffo (2011) who document a strong relationship between labor market slumps and housing busts across OECD countries. After the initial boom in prices, the United States saw an early spike in subprime defaults that gradually spread into the prime market. The unemployment rate lagged the initial bust but has remained stubbornly above 8% for several years. Table 1 provides a unique glimpse into the relationship between the housing bust and employment status using the Panel Study of Income Dynamics (PSI); it shows the labor status of those who have defaulted is 2 to 3 times the unemployment rate of the population (10.88% overall unemployment in the PSID for 2009), depending on the definition of delinquency.[1] We explore this relationship between home mortgages and labor markets in a decision theoretic model with endogenous search effort and realistic mortgage default decisions. The goal is better understand how people use their mortgage as informal unemployment benefits and how this affects subsequent job search behavior.

Table 1: Unemployment Rates Among Delinquent Borrowers, 2009 PSID Supplement, Analytic Weights, Heads of House (Source: PSID)

	Labor Force Status Conditional on Delinquency		
	30+ Days Late	60+ Days Late	90+ Days Late
Working	78.50%	73.20%	71.20%
Temp. Layoff	2.00%	1.70%	1.00%
Unemployed	19.50%	25.20%	27.80%

Our paper also builds on our earlier work Herkenhoff and Ohanian (2011) in which we looked at the interaction between labor markets and housing markets in a partial equilibrium setting with frictional employment, skill loss and means-tested mortgage subsidies.[2] The model predicts agents use the modification "option" at the last possible moment to lock-in low payments and potentially avoid eviction. In order to qualify for a modification, agents must become at least 1 month delinquent; the novelty of that model was that the initial

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[1]The PSID borrowers are well behaved, however. The delinquency rate in the PSID data is an order of magnitude smaller than that observed in a nationally representative LPS sample. This leads us to believe that the numbers stated in the table are smaller than reality.

[2]In that model, agents were living hand-to-mouth and given one tool to keep their home, mortgage modification (for a general equilibrium treatment of modifications in an endowment economy see Chatterjee and Eyigungor (2009) and for empirical facts of modifications see Adelino, Gerardi, and Willen (2009)).

delinquency did not result in foreclosure- instead the agent had free rent for one period.[3] This changes the model economic agents' incentives to relocate to relatively better labor markets, and as a result, unemployment reaches .5% higher in the world with modifications. This moderate *relocation distortion* has been verified by others including Head and Llyod-Ellis (2008) and Karahan and Rhee (2011).

This paper takes our past analysis one step further by treating both delinquency and foreclosure not as one period events, but as protracted and potentially reversible episodes that influence job search behavior. To capture this, we explicitly model search effort and wage draws to consider the *job acceptance distortions* associated with these delays. In more technical terms, the focus of the paper is to document and better understand the relationship between *prolonged delinquency (default) as a new consumption smoothing technology* and its implications for the labor market. While it is typically hard to use data to infer the direction of causality in this relationship, we propose a dynamic stochastic model of optimizing behavior in a similar spirit to Benjamin and Wright (2008) to tease out the effect of these foreclosure delays on labor market outcomes. To understand the magnitude of these delays, Figure 6 shows the average time spent in delinquency until foreclosure notice is given, and Figure 7 illustrates time spent in foreclosure across the nation.[4] These images show data for loans originated after 2004.[5] [6]

While the pandemic of mortgage default and its impact on the financial sector has been well documented for the current recession, implications for the labor market have remained relatively untouched. We propose a new model, of the same general type in Herkenhoff and Ohanian (2011), where mortgage default does not necessarily lead to eviction. In this model, as the time in default increases, the likelihood of eviction increases. This is related to recent work on sovereign debt renegotiations as in Benjamin and Wright (2008), unsecured consumer credit such as Chatterjee (2010) and Benjamin and Mateos-Planas (2011), thought experiments in Calomiris and Higgins (2010), and the concept of *informal default* coined by Dawsey and Ausubel (2004).[7]

The unique feature of this model is that over the course of the mortgage default episode the reservation wage and search effort of an agent change nontrivially- so much so that in some cases agents will accept any job in order to repay the amount owed the bank and

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[3]Delinquency is the technical term for mortgages that miss payments, but we will use this interchangeably with 'default.' According to Wikipedia, "In finance, **default** occurs when a debtor has not met his or her legal obligations according to the debt contract, e.g. has not made a scheduled payment, or has violated a loan covenant (condition) of the debt contract." We will use the word "foreclosed" to mean eviction which occurs with the sheriff sale at the **end of the foreclosure process**.

[4]The data is explained in more detail in Appendix A

[5]These definitions are described in the next section. In short, delinquency episodes are the first time a person is 60+ days late until the last time the person is late, and foreclosure is the first time a foreclosure status is observed in the data until the last time a foreclosure state is observed.

[6]The issue with using loans originated after 2004 is with censoring since all spells must end at the last observation date regardless if they will continue for many more months

[7]Informal default is the process of skipping unsecured payments without filing bankruptcy.

Figure 1: Delay from first time 60+ days late until foreclosure notice is issued (Source: LPS Loans Originated After 2004)

in other cases agents ruthlessly default after turning down feasible wages. Initially, when the agent defaults, the probability of foreclosure is low so the agent economizes on search effort and turns down relatively good wage draws; in the later stage of default, eviction is imminent, and so the agent searches intensely trying to find any wage that may eventually pay the mortgage bill (we will present evidence below on delays and the probability of foreclosure). Our modeling choice to break the link between default and eviction is new to the housing literature (for standard models see Garriga and Schlagenhauf (2009) or Corbae and Quintin (2010) and Hatchondo, Martinez, and Sanchez (2011)), but not new for financial and empirical economists (see Adelino, Gerardi, and Willen (2009) and Ambrose, Buttimer, and Capone (1997)). In recent times, Chatterjee and Eyigungor (2011) get one step closer to this concept by considering a one period delay in the foreclosure process, but as in all previous models, default ultimately leads to foreclosure.

We do a similar analysis as Hurst and Stafford (2002) who consider the use of refinancing in consumption smoothing for unemployed agents with positive home equity, except we turn the focus on the increasingly relevant role of *prolonged default* for unemployed agents with negative equity ("underwater") attempting to maintain their standard of living (for empirical documentation of foreclosure delays with subprime mortgages and the subsequent outcomes, see Capozza and Thomson (2006)). With the rise of underwater mortgagors, traditional "cash-out" refinancing is no longer an option as illustrated in Figure 3; instead, given the long foreclosure delays in many states, many turn to a new technology to smooth consumption,

Figure 2: Time spent in foreclosure (Source: LPS Loans Originated After 2004)

prolonged default.[8] As observed in recent data with abnormally long foreclosure delays, many people enter deep into default without ever losing their homes; the delinquency and subsequent repayment mimic an undocumented loan provided by the servicing bank.

In our new model, the typical trigger for default is unemployment. Aside from the initial mortgage endowment, agents are not allowed to borrow to smooth consumption which is consistent with the standard credit crunch hypotheses (for the Equifax data on regional credit crunches, see Mian and Sufi (2011)). While we do not model bankruptcy since we focus on post 2007 outcomes, this is consistent with the work done by Li and White (2010) who document that after the 2005 bankruptcy reform, households substituted away from bankruptcy into default and foreclosure.[9] Figure 4 documents the fact that while bankruptcies are important, they are a relatively small pandemic compared to a generic measure of delinquencies, defined by those who have skipped one or more payments.[10]

In our model, agents are given access to a riskless savings technology, but for those with limited savings, agents choose to default because it is the best available technology to smooth their consumption.**Because skipped payments accumulate interest, this is the same**

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[8]"Cash-out" refinancing refers to the process of obtaining a larger loan than the original loan, paying off the original loan and pocketing the difference. This is only feasible if there is equity in the home, which means the price is greater than the amount owed on the mortgage.

[9]In general, they find that default and foreclosure predict bankruptcy, and vice versa. They are unable to isolate causation, but they do plot similar graphs to us that show bankruptcy applies to a small fraction of delinquent households.

[10]We will be clear about what is defined as delinquency in the coming sections

Figure 3: Refinancing Composition (Source: LPS)

Fraction of All Refinancing that is Cash Out Refinancing

as a temporary loan; the only downside is the stochastic probability of losing the house.

In the labor market, agents are subject to exogenous separation shocks, at which point they receive half their previous wage as an unemployment benefit. Searching for a job is costly in terms of utility, but this directly affects the probability of finding a job. Job offers are drawn from a known distribution, and agents are free to turn down offers. While on the job, wages evolve stochastically, which is meant to capture wage gains from on the job search and other types of job to job transitions.

We run an experiment in which there is a decline in house prices and a concurrent layoff shock; we then consider (i) a typical 3 month foreclosure delay and (ii) a prolonged 12 month delay. We find that the unemployment rate increases by 2/3 % for roughly one year.

Figure 4: Delinquency and Bankruptcy Rates (Source: LPS)

2 Institutional Details of Skipping Payments

2.1 Non-Foreclosure Cost of Missed Payments

Mortgage payments are usually due on the first of the month and have a late fee if it is not paid within two weeks. The late fee is a fraction of the payment amount. If the scheduled payment is \$1000 and the late fee is 3%, then the mortgagor must pay \$1030. Most late fee interest rates fall in the range of 3% to 6% (see Goodman (2010)).

2.2 Foreclosure Process

The order of events in a foreclosure has potential to distort buyers' incentives to pay since eviction is usually enforced *after* the foreclosure sale. The usual order of events is given below:

1. Miss payments (30+ days late)

2. Notice of Default (Enter Delinquency which is the same as Default)

3. Notice of Sale which is also called a Foreclosure Notice (Enter Foreclosure)

4. Foreclosure Auction (Sheriff Sale)

5. Eviction

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

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

There are two main types of foreclosures in the United States (i) judicial, and (ii) non-judicial (half of the states are non-judicial, including California).

Legally, if a person making payments breaks the terms of the mortgage, the bank can ask for the entire debt to be paid immediately. If the person cannot pay this entire amount, the bank can foreclosure.

A judicial foreclosure is long and complicated. 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 is given to the person who defaulted on their payments. This 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.

It is possible to postpone the foreclosure process by bankruptcy or challenging the banks' right to the property they are trying to foreclose (see Li and White (2010)). The recent robo-signing scandal has to do with the banks' inability to prove that it had the right of interest in the property, i.e. they do not have the correct paperwork showing that they have a mortgage on the property.

If the bank is unable to sell the home in a public auction, which means 'no acceptable bids are made,' the house becomes owned by the bank. The term for this is 'real estate owned' (REO).

Regardless of the foreclosure procedure, each state has laws about recourse and non-recourse loans. In a state with recourse, selling a home for less than the amount due may result in a deficiency judgment. Deficiency judgments mandate the the borrower pay the difference between the sale price and the amount owed on the mortgage. Many mortgages however are non-recourse loans, meaning that the bank cannot go after 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 mortgage for a residential property is a non-recourse loan.

There is a chance for homeowners to 'redeem' their homes after foreclosure if they are able to raise enough money. These redemption periods can last up to a year.

3 Default ≠ Foreclosure

In most standard models with limited commitment and housing, default is synonymous with leaving the home (see Garriga and Schlagenhauf (2009), Corbae and Quintin (2010), and Chatterjee and Eyigungor (2011)). This assumption makes it difficult to match the actual default rates observed in the real world.[11] Our earlier work found that delays played an important role in labor market outcomes through the *relocation channel*. As Herkenhoff and Ohanian (2010) find in a search economy and Chatterjee and Eyigungor (2011) find in an endowment economy, a small delay with free rent can dramatically change incentives to skip payments. On the empirical side, it is well established that default episodes are protracted and often times do not result in foreclosure (see Danis and Pennington-Cross (2010) for subprime mortgages). To our knowledge, we are the first to model the "ins" and subsequent "outs" of mortgage delinquency in a dynamic model optimization model with mortgages and labor markets. As mentioned in the introduction our analysis is similar in spirit to Benjamin and Wright (2008) who model endogenous renegotiation of debts and Benjamin and Mateos-Planas (2011) who apply Benjamin and Wright's model to unsecured credit defaults.

Table 5 succinctly establishes several stylized facts:[12]

i. Default/Delinquency is often temporary, with high probabilities of transition current or closer to being current (default is the period of time before the foreclosure notice is delivered)

ii. Foreclosure is often temporary, with high probabilities of transition current or closer to being current (foreclosure is the time between the foreclosure notice being delivered and eviction)

iii. Entry into foreclosure is a slow process, most sit in the 90+ days late category for several months.

iv. Conditional on reaching foreclosure, households spent significant portions of time in foreclosure

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[11]Several authors use 2-4 year periods to make the discount rate small enough to generate default

[12]See Appendix B for the strategy use to identify the modifications.

Figure 5: Homeowner Transitions 2007-2009 (Source: LPS)

Transition Matrix 2007-2011 (Source: LPS)

	Current	30 Days Late	60 Days Late	90+ Days Late	In Foreclosure Process	Foreclosed, Paid-Off	Modified
Current	97.25	1.58	0.01	0	0	1.14	0.01
30 Days Late	28.92	44.33	25.18	0.16	0.02	1.11	0.29
60 Days Late	7.34	12.77	34.43	41.75	2.4	0.58	0.74
90+ Days Late	1.16	0.8	1.93	80.05	11.99	0.98	3.08
In Foreclosure Process	0.84	0.15	0.09	4.62	87.4	6.22	0.67
Foreclosed, Paid-Off	0	0	0	0	0	1	0
Modified	78.03	12.43	3.23	3.7	1.14	0.09	1.38

Figure 6: Homeowner Transitions 2001-2003 (Source: LPS)

Transition Matrix 2001-2003 (Source: LPS)

	Current	30 Days Late	60 Days Late	90+ Days Late	In Foreclosure Process	Foreclosed, Paid-Off	Modified
Current	95.98	1.52	0.02	0	0	2.49	0
30 Days Late	41.17	38.75	15.92	0.37	0.03	3.76	0
60 Days Late	18.71	20.92	24.74	30.46	2.65	2.52	0
90+ Days Late	7.14	3.4	4.75	68.43	14.59	1.7	0
In Foreclosure Process	5.3	1.13	0.07	7.78	75.32	10.4	0
Foreclosed, Paid-Off	0	0	0	0	0	1	0
Modified	0	0	0	0	0	0	1

4   Foreclosure Delays

To handle the censoring issue in the data, we calculate the mortgage status transition matrix for each year. We then simulate the 'ergodic distribution' for this matrix using Monte Carlo simulation with several thousand mortgages over 35 years. Using this measure, the average time from default until observing the loan being foreclosed upon or paid off went from roughly 4 months until 12 months; this will guide the experiment below. Figures 7 through 11 illustrate the buildups in default/foreclosure as well as the lengths of delays, including the distribution of delays. Figure 7 is the simulated 'ergodic' measure of delay. Figure 8 is the stock of delinquent mortgages sorted by the degree of lateness. Figure 9 is the PDF distribution of total time spent in foreclosure conditional on being in the foreclosure process as of August 2011. Figure 10 is a PDF of the time delays through foreclosure after initial default conditional on being in the foreclosure process as of August 2011.[13]

Figure 7: Foreclosure Delays - Ergodic (Source: LPS and Author's Calculations)

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[13]This is by construction skewed right compared to 9 since it includes the earlier delinquency episode as well as the delay after entering the foreclosure process

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Figure 8: Delinquency Stock and Foreclosure Stock (Source: LPS)

Figure 9: Foreclosure Delay Distribution, June 2011 Cross-Section (Source: LPS)

Distribution of Foreclosure Delay (All Mortgages in Foreclosure as of July 2011)

Figure 10: Delinquency Delay Distribution, June 2011 Cross-Section (Source: LPS)

Distribution of Delinquincy Delay (All Mortgages in Foreclosure as of July 2011)

Figure 11: Fraction Delinquent (30+ Days Late, Compare to Model) (Source: LPS)

5 Literature Review

The norm in the literature is to model default and foreclosure as immediate eviction, and in general this allows authors to focus on the mechanism of interest. Examples include Garriga and Shlagenhauf (2009), Corabe and Quintin (2010), Hatchondo, Martinez, and Sanchez (2011) and Campbell and Cocco (2011); each of these papers contributes substantially to the work on mortgage innovation, but omits the role of protracted default and foreclosure.

Benjamin and Wright (2008) were the first to model protracted default episodes for nations using renegotiation delays. They find that the ability to renegotiate debt significantly improves the standard defaultable debt model's ability to match observed default rates and interest rate spreads. Benjamin and Mateos-Planas (2011) apply the same structure as Benjamin and Wright to look at protracted renegotiation over unsecured consumer credit in an endowment economy where agents have the option to file for bankruptcy.

Chatterjee and Eyigungor (2011) use an endowment economy to model the effect of the construction boom on home prices and foreclosure. As a subsection of their paper, they look at foreclosure delay which is modeled as a one period delay between default and foreclosure. In essence, a homeowner picks between paying, inviting eviction (with 1 period of free rent), or selling. They find that this one period delay is important in generating a large incidence of foreclosure (it also allows them to keep the discount factor lower). However, they find that this has no impact on house prices. Herkenhoff and Ohanian (2011) include a similar foreclosure delay in which agents skip one payment before either modifying a loan or being foreclosed upon. Building on a similar defaultable debt framework, Mitman (2011) considers the interaction between home default and bankruptcy. He follows Li and White's (2010) empricial work and finds meaningful substitution margins between the two forms of default; while Mitman interprets the secured lending in his model as housing, the analysis is based on divisible "housing units" which are refinanced every period (i.e. there are no mortgages, only 1 period debt, making this type of borrowing look more like short term secured debt), and housing default is synonymous with immediate foreclosure and an exogenous price. In related work, Herkenhoff, Ohanian, and Sanchez (2011) consider the delinquency interactions across unsecured debt and secured debt, including long term contracts, in a life-cycle consumption smoothing model.

Calomiris and Higgins (2010) provide some thought experiments on foreclosure delay. They walk through the costs of the delays including (i) bank lending reduction, (ii) uncertain and transitory affect on income, (iii) less housing construction, (iv) neighborhood blight and the benefit of (i) stabilizing house prices, and (ii) keeping people in their homes. Calomiris, Higgins, and Mason (2011) apply a similar thought experiment to the mortgage servicer settlement that mandates modifications; similar to Herkenhoff and Ohanian (2010), these authors argue that modifications are merely another foreclosure delay that slows down the economy.

Pace and Zhu (2010) find that borrowers are more likely to default if there is a longer

period of free rent during foreclosure delay. While the text of their document is not yet available, their abstract explains that they "document the increase in foreclosure duration in recent years and find a statistically and economically significant impact of foreclosure delay on borrower default behavior... When the property value is likely to be less than the mortgage balance, the expected delay tends to have a larger impact on default."

Head and Llyod-Ellis (2008) consider housing markets, labor markets, and mobility. This paper is one of the first to include a labor market and some form of housing market. Their focus is on the relocation effect, similar to Herkenhoff and Ohanian (2010). They find that there are important interactions between the labor market and the housing market, but that the effects are a wash in aggregate.

There are several recent papers that have built on Head and Llyod-Ellis' work such as Karahan and Rhee (2011) and Hedlund (2011). Both of their models are cast in a block recursive equilibrium (BRE). The BRE uses directed search allows them to solve the model without having to use moments of the aggregate wealth distribution.Karahan and Rhee look at a directed search model of housing markets and labor markets. They create an aggregate price shock similar to Corbae and Quintin (2010) by letting construction technology unexpectedly improve. This model generates a 1% decline in mobility and a 1% decline in aggregate unemployment. Hedlund (2011) uses a similar model of directed search in the housing market to consider how house prices and liquidity respond to default decisions.

Mulligan (2008, 2011) considers the impact of mortgage modifications and means testing on labor supply decisions. Mulligan shows that the replacement rate of income has increased substantially since the onset of the recession and that this replacement rate manifests itself as a labor wedge. This is consistent with the diagnosis in Mulligan (2007) and Ohanian (2010).

Li and White (2010) consider the relationship between bankruptcy and foreclosure. They find that bankruptcy and foreclosure/default are substitutes after the 2005 reform. Bankruptcy rates go down for those in default after the reform, but there is still a strong relationship between bankruptcy and foreclosure as well as bankruptcy and default.

As mentioned above, this paper takes the additional step of modeling the fact that households enter and exit default regularly in times of crises in order to smooth consumption. With frictional employment, these ins and out of default correspond to unemployment spells. Default episodes are often times serially correlated, and often times do not result in eviction (the sheriff sale of foreclosure). We document facts about default and then model the changes with search.

6 Search Model with "Ins" and "Outs" of Default

Consider a mortgagor that makes homeownership decisions, saving decisions, and must search for employment. While employed, there is an aggregate state contingent risk of being laid-off $\delta(\theta)$ where (θ) is the aggregate state. In good times the probability of being laid off is much lower than in bad times, and in good times the job finding probability $\pi(s, \theta)$ also improves. Similar to Ljungqvist and Sargent's search models (1998, 2007a, 2007b, workers exert a search effort (s) in the hopes of finding a job. There are wage changes once employed which may be creatively interpreted as on-the-job search or skill accumulation in the case of a wage increase.

In the event of a low wage draw or unemployment shock, the mortgagor may default to smooth consumption. However, in this world, default is not synonymous with eviction; there is a stochastic probability of eviction that increases with the time spent in default. Agents can also save to help smooth consumption at a risk free rate of $\bar{r}$.

Households may enter and exit default as they like; however, the time spent in default (n) increases the odds of eviction and liquidation of the house (see Figure 12 for an example of the foreclosure probability).

To keep the model simple, mortgages are perpetuities, and mortgages have a constant housing payment (c_h) denoted in units of consumption. The house price depends on the aggregate state (θ) and it is assumed to be below the present discounted value of the mortgage perpetuity in bad times $(p(\theta) < \frac{c_h}{r_b})$ where r_b is the interest rate the bank charges on loans. In this particular case, the homeowner is underwater.

The mortgage payment is strictly greater than the rental payment $(c_h > c_r)$, but the utility flow from owning a home strictly dominates the utility flow from renting $(z_h > z_r)$.

Employed and unemployed persons can be current on mortgage payments or in default. Rent is set such that the renter with the lowest possible unemployment benefits receives subsistence consumption, $\bar{c}$. Let superscript h denote homeowners and superscript r denote renters.

Table 2: Typical State Space

E or **U**	**g** or **d**	**h** or **r**	**w** or **b**	**a**	**n**	θ
Employed/ Un-employed	Current/ Defaulting [Redundant]	Homeowner/ Renter	Wages/ Benefits	Assets	Periods in De-fault	Aggregate State

For those who default, there is a utility cost of initially entering default (Δ), and there

Table 3: Value Functions

Employed Decisions

Value Function	Description	Choices
VE_h^g	Employed, Good Standing Homeowner Decision	Continue to Pay (E_h^g), Default (E_g^d), Sell (E_h^s)
VE_h^d	Employed, Bad Standing Homeowner (Defaulted)	Make 2 Payments (E_h^p), Continue in Default (E_g^d), Sell (E_h^s)
E_h^r	Employed, Renter	
Continuous Choice Variables Employed	Assets (a)	

Unemployed Decisions

Value Function	Description	Choices
VU_h^g	Unemployed, Good Standing Homeowner Decision	Continue to Pay (U_h^g), Default (U_g^d), Sell (U_h^s)
VU_h^d	Unemployed, Bad Standing Homeowner (Defaulted)	Make 2 Payments (U_h^p), Continue in Default (U_g^d), Sell (U_h^s)
U_h^r	Unemployed, Renter	
Continuous Choice Variables Unemployed	Search Intensity (s) and Assets (a)	

is a penalty fee (late fee) assessed at the end of each mortgage default episode (LF).

6.1 Employed Decisions

The pre-decision value function for an employed homeowner with wage w, liquid assets a, current on payments $(n = 0)$, and in aggregate state θ is $VE_h^g(w, a; 0, \theta)$ (**In general, if there is a V in front of a value function it involves a discrete choice, e.g.** $VE_h^g(w, a; 0, \theta)$ **is the choice for an employed agent and** $E_h^g(w, a; 0, \theta)$ **is one particular option**).

An employed homeowner that is in good standing has the following set of choices: pay $(E_h^g(w, a; 0, \theta))$, default at a utility cost Δ and face the risk of foreclosure $(E_h^d(w, a; 0, \theta) - \Delta)$, or sell $(E_h^s(w, a; 0, \theta))$.

$$VE_h^g(w, a; 0, \theta) = \max_{Pay,\ Default,\ Sell} \left\{ E_h^g(w, a; 0, \theta), E_h^d(w, a; 0, \theta) - \Delta, E_h^s(w, a; 0, \theta) \right\}$$

The pre-decision value function for an unemployed homeowner with wage w, liquid assets a, current on payments $(n = 0)$, and in aggregate state θ is $VE_h^g(w, a; 0, \theta)$.

When $n = 0$, the borrower is current $VE_h^d(w, a; 0, \theta) = VE_h^g(w, a; 0, \theta)$ (i.e. a current defaulter is the same as a homeowner in good standing), but for $n > 1$, the choice of a delinquent homeowner is as follows:

$$VE_h^d(w, a; n, \theta) = \max_{Pay\ Current,\ Default,\ Sell} \left\{ E_h^p(w, a; n, \theta),\ \lambda_F(n) E_h^f(w, a; n, \theta) + \lambda_M(w, n) E_h^g(w, a; 0, \theta) \right.$$
$$\left. + (1 - \lambda_F(n) - \lambda_M(w, n)) E_h^d(w, a; n, \theta),\ E_h^s(w, a; n, \theta) \right\}$$

6.2 Employed Value Functions

An employed renter with wage w and liquid assets a has value function $E_r(w, a; \theta)$. Unemployment benefits $(b(\cdot))$ are weakly monotone in the past wage . Below we will allow benefits that go up to half of the mean wage, $b(w) = \frac{1}{2} \min \left\{ w, \frac{1}{2}(\bar{w} + \underline{w}) \right\}$. After benefits are initially set they decline stochastically over time in order to mimic the current tier structure of unemployment benefits in the United States. $\delta(\theta)$ is the job destruction rate and it depends on the current aggregate state. z_r is the flow utility from renting and $\widehat{beta}$ is the death adjusted discount factor. c_r is the rental payment, and $\bar{r}$ is the return on savings. The renter must pick next period's liquid asset holdings a'.

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

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 $E_h^g(w, a; 0, \theta)$. the mortgage payment

is c_h consumption units. z_h is the flow utility from living the house, and $\delta(\theta)$ is the aggregate state contingent job destruction probability.

$$E_h^g(w, a; 0, \theta) = \max_{a'} \ u(c, z_h) + \widehat{\beta}(1 - \delta(\theta))\mathbb{E}\big[VE_h^g(w', a'; 0, \theta')\big] + \delta(\theta)\mathbb{E}\big[VU_h^g(b(w), a'; 0, \theta')\big]$$

Such that

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

An employed homeowner in default $(n > 0)$ with wage w and liquid assets a that decides to make no payments solves the following problem:

$$E_h^d(w, a; n, \theta) = \max_{a'} \ u(c, z_h) + \widehat{\beta}(1 - \delta(\theta))\mathbb{E}\big[VE_h^d(w', a'; n + 1, \theta')\big] + \delta(\theta)\mathbb{E}\big[VU_h^d(b(w), a'; n + 1, \theta')\big]$$

Such that

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

Notice that the delinquency indicator ticks upwards $n' = n + 1$ and an unemployed person receives $b(w)$ in benefits.

An employed homeowner that is in default and begins to pay current $(E_h^p(w, a; n, \theta))$ is not subject to foreclosure. In this case the delinquency ticker moves down $n' = n - 1$ and if $n' = 0$, the borrower is current once again; however, the bank assesses a fixed late fee LF for any default episode which reflects the additional advancement fees and servicing costs incurred by the bank. The homeowner must pay twice, and to simplify the matter, the homeowner must pay today's mortgage payment (c_h) plus the *longest outstanding mortgage payment with interest* $((1 + r_b)^n c_h)$. The full problem is written below:

$$E_h^p(w, a; n, \theta) = \max_{a'} \ u(c, z_h) + \widehat{\beta}(1 - \delta(\theta))\mathbb{E}\big[VE_h^d(w', a'; n - 1, \theta')\big] + \delta(\theta)\mathbb{E}\big[VU_h^d(b(w), a'; n - 1, \theta')\big]$$

Such that

$$c + c_h + (1 + r_b)^n c_h + \mathbb{I}(n = 1) \cdot LF + a' = w + (1 + \bar{r})a$$

An employed homeowner that sells has value function $(E_h^s(w, a; n, \theta))$. A seller becomes a renter and must payback all late fees with interest $(\sum_{i=1}^{n}(1 + r_b)^i c_h)$ off of the top of the sale price (see Thompson (2010)); this is an accurate portrayal of the legal structure of delinquent sales.

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

Such that

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

$\chi(\theta)$ is the state contingent discount on the house price $p(\theta)$, and $\frac{c_h}{r_b}$ is the remaining balance on the mortgage. $S(\cdot)$ reflects the recourse status of a state (note this is different

from $G(\cdot)$ to allow for differences between forced sale and voluntary sale). For instance, in a non-recourse state $S(\cdot) = \max\{0, \cdot\}$ and depends on the institutional details of the state in which the foreclosure occurs.

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

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

Such that

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

Once again, late fees $(\sum_{i=1}^{n}(1 + r_b)^i c_h)$ are taken off of the top of the discounted sale price $\chi(\theta)p(\theta)$. $G(\cdot)$ reflects the institutional detail of foreclosure sale/sheriff sale. This is different from $S(\cdot)$ which illustrates a non-pressured sale.

6.3 Unemployed Decisions

The problem of an unemployed agent closely mimics the problem of an employed agent. The main difference is in the search choice s and subsequent job finding probability $\pi(s, \theta)$ which depends on the aggregate state θ. An unemployed person in good standing has the following choices:

$$VU_h^g(b, a; 0, \theta) = \max_{Pay, \ Default, \ Sell} \big\{U_h^g(b, a; 0, \theta), U_h^d(b, a; 0, \theta) - \Delta, U_h^s(b, a; 0, \theta)\big\}$$

When $n = 0$, the borrower is current and $VU_h^d(b, a; 0, \theta) = VU_h^g(b, a; 0, \theta)$ (i.e. a current defaulter is the same as a homeowner in good standing), but for $n > 1$, unemployed person in bad standing had the following holds:

$$VU_h^d(b, a; n, \theta) = \max_{Pay \ Current, \ Default, \ Sell} \big\{U_h^p(b, a; n, \theta), \ \lambda_F(n)U_h^f(b, a; n, \theta) + \lambda_M(b, n)U_h^g(b, a; 0, \theta)$$
$$+ (1 - \lambda_F(n) - \lambda_M(b, n))U_h^d(b, a; n, \theta), \ U_h^s(b, a; n, \theta)\big\}$$

6.4 Unemployed Value Functions

An unemployed renter must pick search intensity s which comes with a weakly convex cost $x(s)$. The job finding probability $\pi(s, \theta)$ is concave which ensures an interior solution to the search choice. b is the current unemployment benefit, a is the liquid asset holding, and $\hat{w}$ is the wage drawn from $F(\hat{w})$. The timing is such that the wage is drawn and then the unemployed renter can choose to accept or reject the offer $\hat{w}$ and keep benefits b' (which are

evolving stochastically).

$$U_r(b, a; \theta) = \max_{a', s} \ u(c, z_r) - x(s) + \widehat{\beta} \mathbb{E}\Big[(1 - \pi(s, \theta'))U_r(b, a'; \theta')$$

$$\pi(s, \theta') \int_{\hat{w}} \max\big\{E_r(\hat{w}, a'; \theta'), \ U_r(b', a'; \theta')\big\}dF(\hat{w})\Big]$$

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 $w_r^*(b, a'; \theta')$ (the star indicates a reservation wage, the subscript indicates the renter status). The upper bound for the support of w is $\bar{w}$:

$$\int_{\hat{w}} \max\big\{E_r(\hat{w}, a'; \theta'), \ U_r(b', a'; \theta')\big\}dF(\hat{w})$$

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

An unemployed homeowner with benefits b, liquid assets a, no late payments ($n = 0$) that pays on time solves the following problem:

$$U_h^g(b, a; 0, \theta) = \max_{a', s} \ u(c, z_h) - x(s) + \widehat{\beta} \mathbb{E}\Big[(1 - \pi(s, \theta'))VU_h^g(b', a'; 0, \theta')$$

$$\pi(s, \theta') \int_{\hat{w}} \max\big\{VE_h^g(\hat{w}, a'; 0, \theta'), \ VU_h^g(b', a'; 0, \theta')\big\}dF(\hat{w})\Big]$$

Such that

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

An unemployed homeowner that is in default and makes no payments has their default indicator tick up $n' = n + 1$ and engages in search just like any other agent. A defaulting non-payer solves the following problem:

$$U_h^d(b, a; n, \theta) = \max_{a', s} \ u(c, z_h) - x(s) + \widehat{\beta} \mathbb{E}\Big[(1 - \pi(s, \theta'))VU_h^d(b', a'; n + 1, \theta')$$

$$\pi(s, \theta') \int_{\hat{w}} \max\big\{VE_h^d(\hat{w}, a'; n + 1, \theta'), \ VU_h^d(b', a'; n + 1, \theta')\big\}dF(\hat{w})\Big]$$

Such that

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

The reservation wage $w_d^*(b, a'; n+1, \theta')$ is the key function to characterize. 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 unemployed.

$$VE_h^d(w_d^*(b', a'; n + 1, \theta'), a'; n + 1, \theta') = VU_h^d(b', a'; n + 1, \theta')$$

For a given level of assets and benefits, there are several forces at play

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- As n increases, the likelihood of foreclosure goes up equally for any wage below the mortgage payment c_h.

- As n increases, the benefit of accepting any wage above c_h goes up.

- At one extreme, if foreclosure is imminent, any wage above the benefit level is accepted.

- At the other extreme, if foreclosure occurs with an extremely low probability, everyone waits to find a good paying job.

An unemployed homeowner in default that begins to pay current is not subject to foreclosure. The value function is given below:

$$U_h^p(b, a; n, \theta) = \max_{a'} u(c, z_h) - x(s) + \widehat{\beta}\mathbb{E}\Big[(1 - \pi(s, \theta'))VU_h^d(b, a'; n - 1, \theta')$$

$$\pi(s, \theta') \int_{\hat{w}} \max\big\{VE_h^g(\hat{w}, a'; n - 1, \theta'), \ VU_h^g(b, a'; n - 1, \theta')\big\}dF(\hat{w})\Big]$$

Such that
$$c + c_h + (1 + r_b)^n c_h + \mathbb{I}(n = 1) \cdot LF + a' = b + (1 + \bar{r})a$$

An unemployed homeowner that sells solves the following problem:

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

$$\pi(s, \theta') \int_{\hat{w}} \max\big\{E_r(\hat{w}, a'; \theta), \ U_r(b, a'; \theta')\big\}dF(\hat{w})\Big]$$

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

As above, $\chi(\theta)$ is the discount on the house price $p(\theta)$, and $\frac{c_h}{r_b}$ is the remaining balance on the mortgage. $S(\cdot)$ reflects the recourse status of a state. For instance, in a non-recourse state $S(\cdot) = \max\{0, \cdot\}$ and depends on the institutional details of the state in which the foreclosure occurs.

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

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

$$\pi(s, \theta') \int_{\hat{w}} \max\big\{E_r(\hat{w}, a'; \theta'), \ U_r(b, a'; \theta')\big\}dF(\hat{w})\Big]$$

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

As above, $G(\cdot)$ reflects the institutional details of foreclosure sales. For instance, in a non-recourse state $G(\cdot) = \max\{0, \cdot\}$.

7   Simple Parameterization

We solved the above model using value function iteration over a discrete grid. The grid for search effort is evenly spaced over the interval $[0, \frac{1}{2}]$ with 5 nodes. The asset grid is evenly spaced over the interval $[0,3]$ with 18 nodes (note that this is restrictive for the highest wage workers, but not for low wage defaulters). Wages are evenly spaced from $[0,1]$ with 10 nodes (denote $\underline{w}$ the lower support and $\bar{w}$ the upper support). Wages are stochastic but are constant in expectation; each period there is 1/3 chance the wage stays the same, a 1/3 chance it increases, and a 1/3 chance it decreases; this is a simple process mean to capture the unmodeled feature of job to job transitions. Each period, benefits remain the same 2/3 of the time and move down one notch 1/3 of the time; this is meant to capture the tier structure of emergency unemployment benefit compensation. The rest of the parameters are described in Table 5. The appendix includes the regressions and transition matrix for the aggregate state.

Table 4: Parameter Values, Monthly Simulation

Basic Variables

Variable	Description	Parameter Value/ Functional Form
c	Consumption	Choice Variable
a	Assets	Choice Variable
s	Search intensity	Choice Variable
n	Periods in Default (Skipped Payments)	$N = 12$ in delay model, $N = 3$ in non-delay model (calculated using LPS data in 2007 and 2001)
b	Benefits	$b(w) = \frac{1}{2}\min\left\{w, \frac{1}{2}(\bar{w} + \underline{w})\right\}$ (taken from Herkenhoff and Ohanian (2010))
$\widehat{\beta}$	Effective Monthly Discount Rate	0.9932 (taken from Herkenhoff and Ohanian (2010))
$\bar{r}$	Risk Free Savings Rate	2% annual interest rate
r_b	Bank Mortgage Rate	5.95% annual interest rate (Calculated from LPS data set)
z_h	Flow from Housing	$4 \cdot z_r$ (Targeted to Homeownership Rate)
z_r	Flow from Renting	1
c_h	Cost of housing (mortgage payment), in consumption	.2 (Targeted to match average Front End DTI observed in LPS)
c_r	Cost of Renting	0 (Set to avoid negative consumption trap)
p_d	Probability of dying	42 Year Working Life, p_d=.002 (Ljungqvist and Sargent (1998))

Table 5: Parameter Values, Monthly Simulation
Functional Forms

Variable	Description	Parameter Value/ Functional Form
$x(s)$	Disutility of search	$x(s) = 3 \cdot s$ (Linear Form, Ljungqvist and Sargent (1998))
$\pi(s,\theta)$	Job Finding Rate	$\pi(s,\theta) = s^{.3}$ in bad times, $\frac{3}{4}\pi(s,\theta) = s^{.3}$ in good times (Concave Form, Ljunqvist and Sargent (1998))
$\delta(\theta)$	Layoff Shock	$\delta(\theta) = 0.036$ in bad times, $\delta(\theta) = 0.018$ in good times (Employment Duration, Ljungqvist and Sargent (1998))
$p(\theta)$	Price of house	$p(\theta) = .99 \cdot \frac{c_h}{r_b}$ in bad times, $p(\theta) = \frac{c_h}{r_b}$ in good times (Requires Sensitivity Analysis)
$\chi(\theta)$	Forced sale price discount	$\chi(\theta) = .99$ in bad times, $\chi(\theta) = 1$ in good times (Requires Sensitivity Analysis)
$G(x)$	Deficiency Enforcement if Sheriff Sale	$\frac{1}{2}x\mathbb{I}(x < 0) + x\mathbb{I}(x > 0)$ (Requires Sensitivity Analysis)
$S(x)$	Deficiency Enforcement if Voluntary Sale	$\frac{1}{2}x\mathbb{I}(x < 0) + x\mathbb{I}(x > 0)$ (Requires Sensitivity Analysis)
$\lambda_F(n)$	Foreclosure probability after skipping n payments	Linear and increasing after month 3, everyone booted after **month 12** in delay economy everyone booted after **month 3** in no delay economy (Calculated from LPS data)
$\lambda_M(w,n)$	**Set to zero for the experiment below, in general linear and increasing (Calculated from LPS data)	

8   Turbulence Experiment

We ran the following turbulence experiment in an economy with foreclosure delays and an economy without foreclosure delays:

- Date 0: The economy is in the good state with initial assets, initial wages, and home-ownership set to match the observed distribution of liquid assets in the 2007 PSID, the initial DTIs in the 2007 LPS data set, and the homeownership rate.

- Date 1: The job destruction rate triples for one month

- Dates 2-6: The economy is in the bad state (job destruction still twice what it is in the good state)

- The economy then begins to recover after month 6 by entering the good state.

Figure 12 has the foreclosure probabilities whose slopes were based on the data. See the Appendix for more information. In the delay economy, people are only booted after 12 months, but face an increasing risk of foreclosure as the process continues. In the no delay economy, people are booted after month 3.

Figure 12: Foreclosure Probability $\lambda_f(n)$

8.1   Transition Matrices

The transition matrix generated from the 12-period default economy is shown below in Table 13 and for the 3-period default economy it is shown in Table 14. The model does well in matching flows into and out of default; δ was set to match the flow from current into 30 days late and the late fee LF is set to match the flow from 30 days late to current, all other entries

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Figure 13: Model Homeowner Transitions Delay

Transition Matrix from Model, Delays

	Current	30 Days Late	60 Days Late	90+ Days Late	Foreclosed or Paid Off
Current	0.9601	0.0399	0	0	0
30 Days Late	0.3822	0	0.607	0	0.0108
60 Days Late	0	0.2634	0	0.7255	0.0111
90+ Days Late	0	0	0.0517	0.8869	0.0615
Foreclosed or Paid Off	0	0	0	0	1

were endogenous to the model. Agents are hit with unemployment shocks, and to smooth consumption they temporarily stop paying. Most of those that stop paying eventually find jobs and get back out of default. The incidence of eviction is smaller than that of eventually making it back out into being current. Compare this to Table 5 which was generated from the LPS data.

Figure 14: Model Homeowner Transitions No Delay

Transition Matrix from Model, No Delays

	Current	30 Days Late	60 Days Late	90 Days Late	Foreclosed or Paid Off
Current	0.9651	0.0349	0	0	0
30 Days Late	0.2754	0	0.7062	0	0.0184
60 Days Late	0	0.2711	0	0.6145	0.1143
90 Days Late	0	0	0.1619	0.5189	0.3192
Foreclosed or Paid Off	0	0	0	0	1

Note that people are able to stay in the 90 Days late category when their state moves to $n = 4$, but they pay twice to move it back down to $n = 3$ without being foreclosed upon.

9 Aggregates

Figures 15 to 19 show how the aggregate economy responds to the shock. First and foremost, Figure 15 and 16 illustrate the large and persistent .5 % gap in unemployment that opens up; what causes this is the reduced search effort of defaulters and the higher default rate in the delay economy.

Figure 17 shows that people use this margin for protracted periods of time, nearly 7 months on average in the delay economy. Figure 18 illustrates the sheer number of people that use this mode of consumption smoothing. These levels of default are high, but remember that this is 30+ Days late and is actually comparable to what is in the data (see Figure 11).

Figure 19 shows that homeownership falls as people leave their homes. This number is quite low, but it is artificially low due to the modeling assumption of no repeat homeowners, i.e. people cant default and then eventually become a homeowner again.

Figure 15:

Figure 16:

Figure 17:

Average Duration of Delinquency (30+ Days Late to Current), Delay
Average Duration of Delinquency (30+ Days Late to Current), No Delay

Figure 18:

Figure 19:

Homeownership Rate, Delay   Homeownership Rate, No Delay

10 Real Rate of Interest

A skipped payment is nothing more than an unsolicited loan by the bank to the mortgagor. We define the real rate of interest on the "skipped payment loan" as the potential payment in consumption terms, which is a foreclosure-probability-weighted summation of the late payment and the consumption equivalent to the utility loss of foreclosure, over the loan amount (c_h). In symbols, the real rate of interest is given as a function of skipped payments (n):

$$\hat{r}(n) = \frac{\lambda_f(n)\tilde{c} + (1 - \lambda_f(n))(1 + r_b)c_h}{c_h} - 1$$

Such that

$$\tilde{c} = e^{\left\{\frac{r_b + p_d}{1 + r_b}(E_h - E_r)\right\}}$$

The notation is the same as in the model where r_b is the late interest rate on the payment, p_d is the death probability, $(E_h - E_r)$ is the utility cost of becoming a renter if foreclosure happens, and $\lambda_f(n)$ is the chance of being foreclosed upon after having skipped n payments. Figure 20 plots this real rate for an unemployed person with low assets and medium unemployment benefits during good times; the real rate peaks above 50% per month which points to an efficiency argument in the way these 'informal unemployment benefits' are funded; when the government can borrow with a 2-3% annual rate, there is no reason to finance consumption at a monthly interest rate of 12-55%.

Figure 20: Real Rate of Interest

11 Mechanisms

The two main mechanisms are the search effort and reservation wage of defaulters. The defaulters who are between 30-90+ days late face a small chance of losing their home, and so they do not search as hard. Moreover, their reservation wages are higher since they have time to spare to find a better paying job. Figures 21 through 25 illustrate these concepts. Figure 21 is the reservation wage profile in good times ($\theta = \theta_H$) for a given level of assets (a) across the delay/no-delay economies. The no delay economy has lower reservation wages due to the increased risk of foreclosure. Figure 22 is the difference in search intensities for the two economies. The no delay economy agents search much harder because of the shorter timeline until eviction. Figure 23 shows the cumulative probability of remaining in unemployment for a given length of unemployment spell. The no delay economy has much higher exit rates from unemployment. Figures 24 and 25 are the 3 dimensional versions of the reservation wage profiles and search intensity profiles for the delay economy at different points in the default process. The entire reservation wage policy shifts down as the agent goes from 30 days late (n=1) to imminent foreclosure next period (n=N-1). The search intensity policy shifts up simultaneously since the agents are desperate to find a job.

Figure 21: Difference in Reservation Wages After Initially Defaulting (GT)

Figure 22: Difference in Search Effort After Initially Defaulting (GT)

Figure 23: Cumulative Survival In Unemployment (GT)

Figure 24: Reservation Wages Over Default Episode (Delay Economy, BT)

Figure 25: Search Intensity over Default Episode (Delay Economy, BT)

Initially (n=1), mortgagors that enter default are picky with wages and exert a low level of search effort. As the process advances (n=N-1), the reservation wage falls and the search effort increases, reflecting the increased probability of foreclosure. Agents in this model try to avoid foreclosure since it will potentially leave them with very little consumption, and the curvature of the utility function means they will have a near infinite marginal utility of consumption if this occurs.

This increases homeowner durations of unemployment, which is something observed in this recession, and not other downturns for which we have data. See Figure 26 for the durations of unemployment and 27 for the unemployment rates of homeowners in the CPS March Supplement.

Figure 26: Homeowner Durations (Source: CPS)

Once the homeowner finds a job, the process begins to reverse as the agent begins to make the late payments. After all the late payments are made, the agent begins to accumulate assets at a greater rate again.

In comparison to homeowners, renters have a lower reservation wage and are more willing to take jobs. This is difficult to reconcile with the high renter unemployment rate unless renters are less likely to find jobs. the ordering of reservation wages change when the benefit amount is less than the mortgage payment- in this case default is necessary in order to have

Figure 27: Homeowner vs. Renter Unemployment Rates (Source: CPS)

a chance at keeping the home.

The agents that default are those with low assets and low benefits who were recently fired. This group of people, without access to other forms of borrowing, rely on default to smooth consumption. In the even that they find a job, the agents begin to repay the accumulated debt and continue to live in the home.

12   Conclusion

To our knowledge, we are the first to document the transitions into and out of foreclosure and the first to capture this behavior in a model; our model featured several new mechanisms such as job search and differing degrees of default allow us to capture the feedback between mortgage default and unemployment. While our analysis is primarily positive, it gives future researchers the opportunity to use the data in this paper to analyze the normative implications of foreclosure delay.

With plausible turbulence, we find significant and persistent affects from the foreclosure delays on the unemployment rate reaching $\frac{2}{3}\%$ and persisting for a year or more. The delays also have a substantive affect on default rates and the duration of unemployment.

The question now becomes whether or not the unemployment effects from delays are outweighed by the price effects from actual foreclosures which are carefully documented in Calomiris, Longhofer, and Miles (2008) and further explored in Gerardi, Willen, and Lambie-Hansen (2011).

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A Data

The mortgage data is randomly sampled from the Lender Processing Services (LPS) McDash database and is nationally representative. The database extends back to 1992:Q2 and covers roughly 2/3 of all mortgage until the present.

The wealth, wage, and asset data is taken from the Panel Study of Income Dynamics (PSID), and only household heads are considered.

The homeowner durations of unemployment and unemployment rates by homeowner status are taken from the Current Population Survey (CPS) March Supplement.

B Calibration Regressions and Aggregate State Transition Matrix

For non-censored observations, we estimated a few simple linear hazard regressions. In Table 6 the dependent variable is an indicator that takes the value 1 when the person is asked to leave the house.[14] Our estimates look at the probability of being asked to leave the home conditional on being 90+ days late.

Table 6: Estimation results : Dependent variable is indicator of eviction $\mathbb{I}(Eviction\ Occured)$, sample is conditional on being 90 days late (Source: LPS)

Variable	Coefficient	(Std. Err.)
Time Since 90 Days Late	0.00797	(0.00028)
Intercept	0.07992	(0.00563)

This table says, that for each missed payment after having already skipped 3 payments, the probability of eviction goes up by .797%.

Table 7 shows the estimates for how likely it is to be modified as a function of skipped payments. These hazards are easy to interpret, which is the reason we used this simple setup for our preliminary results. In later versions we will use Cox proportional hazard models that can correct for censoring.

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

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[14]The "paid-off" state can indicate many outcomes, but we count all of those outcomes as evictions- if this were not the case, and if we took into account censoring, the delay periods would look much longer

Table 7: Dependent variable is indicator of modification $\mathbb{I}(Modification\ Occured)$, sample conditional on being 30+ days late (Source: LPS)

Variable	Coefficient	(Std. Err.)
Time Since 30 Days Late	-0.00002	(0.00004)
Intercept	0.00556	(0.00058)

$$\theta_{Transition} = \left[\begin{array}{cc} 0.9854 & 0.0146 \\ 0.0833 & 0.9167 \end{array} \right].$$