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LABOR MARKET DYSFUNCTION DURING THE GREAT RECESSION

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ABSTRACT

This paper documents the abnormally slow recovery in the labor market during the Great Recession, and analyzes how mortgage modification policies contributed to delayed recovery. By making modifications means-tested by reducing mortgage payments based on a borrower's current income, these programs change the incentive for households to relocate from a relatively poor labor market to a better labor market. We find that modifications raise the unemployment rate by about 0.5 percentage points, and reduce output by about 1 percent, reflecting both lower employment and lower productivity, which is the result of individuals losing skills as unemployment duration is longer.

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1 Introduction

The Great Recession differs considerably from most other significant U.S. economic declines, as the recovery, particularly recovery in the labor market, has been remarkably slow. In fact, the Great Recession and the Great Depression are the only severe U.S. downturns in which job loss persisted so long following respective business cycle troughs. This paper documents the very weak labor market recovery during the Great Recession and evaluates mortgage modification policies as one channel for understanding why high unemployment has continued for so long during the Great Recession. We study mortgage modifications as some economists have presented evidence linking housing market weakness to labor market weakness (Ohanian and Raffo, 2011), and because mortgage modification programs are means tested, and thus change the incentives for home borrowers to relocate to labor markets with more favorable job prospects.

Means-tested mortgage modifications reduce the cost of staying in a home by reducing mortgage payments, with the payment reduction based on the household's current earnings. This includes cases in which borrower income is limited to unemployment benefits and borrower current debt to income ratio is well above standard levels, so that a modified mortgage payment can be much lower than current payments. Mulligan (2009 and 2010), among others, has suggested that this policy may be significantly contributing to high unemployment by distorting incentives. In addition to concerns about incentives, modification programs are controversial because redefault rates, which are the percentage of defaults on the modified mortgage, are high, ranging between 30 percent and 50 percent within one year of modifying.

This paper evaluates the impact of mortgage modification programs on unemployment and other macroeconomic variables by constructing a very simple model that integrates a model of search unemployment along the lines of Ljungqvist and Sargent (1998, 2002) with a model of home ownership, including mortgages, mortgage modifications, and location choice. By reducing mortgage payments based on current income, mortgage modification changes the incentives to accept job offers and to relocate to labor markets with more favorable job prospects.

In the model, households are located in a particular local labor market (island), in which they receive stochastic job offers and whose skills evolve over time, as in Ljungqvist and Sargent (1998, 2002). Households can accept the job offer and remain in their local labor market, reject the offer and receive unemployment benefits, or relocate to another labor market. If the household has a mortgage, they choose whether to continue with an existing mortgage, which preserves their current flow of housing services, whether to walk away from the mortgage and rent either in their current labor market or rent in an alternative labor market, or whether to seek a one-time modification of their mortgage which reduces mortgage payments. Relocating is costly, but offers a job finding probability that stochastically dominates the job finding probability on a household's current island. While employed, households accumulate skill in expectation, and while unemployed, households decumulate

skill in expectation. By changing the cost to a borrower of maintaining an existing mortgage, modifications increase the incentives for a household to remain in their current location and forgo more favorable job prospects in another location.

Our model of the modification process is motivated by various modification programs that have been in place since 2007, in which modifications reduce mortgage payments to a debt service-to-income ratio (DTI) that depends on current income. Thus, households with low income, including those whose income is limited to unemployment benefits, can receive substantial reductions in their payments that increase the opportunity cost of relocating in the model economy.

We first analyze the implications of modifications by examining steady states of two economies that are identical except one has modifications. We next conduct an economic turbulence experiment along the lines of Ljungqvist and Sargent (1998) to assess how modifications impact the economy during a major recession. This experiment consists of two shocks: (i) the layoff rate in the model is doubled for one period, and (ii) for those who are laid off, their human capital stock is reduced by one level. The main finding from this experiment is that the unemployment rate rises by about 0.5 percentage points, and real GDP declines by about 1 percent for several years after the modification policies are in place. A number of empirical features in the model economy correspond to data, including the rate of modifications, the redefault rate on modifications, and mobility. We also estimate that a 10% reduction in payments reduces the chance of a person walking away from a home by 11.3% which is comparable to Haughwout, Okah, and Tracy (2009). We are then able to estimate that mortgagors who have a job at the date they request a modification are 48% less likely to default again.

The paper is organized as follows. Section 2 compares the Great Recession to other US downturns. Section 3 summarizes mortgage modification programs during the Great Recession with a focus on the labor market impact of these policies. Section 4 presents the model economy. Section 5 presents quantitative experiments that assess the impact of today's modification programs. Section 6 concludes.

2 The Great Recession Compared to other US Economic Declines

This section compares the Great Recession to other economic declines. Figures 1 and 2 compare the Great Recession labor market to other postwar recessions and highlight a number of patterns that contrast sharply with those in other downturns. Figure 1 shows employment following each recession, and Figure 2 shows employment during the Great Recession compared to the average of all other postwar recessions. Even abstracting from the size of employment loss during the recession, these two figures clearly suggest labor market dysfunction, in which employment during the Great Recession is not recovering at a normal

rate.

Figure 3 combines information from both the recession and the recovery by showing employment change in all post World War II recessions 36 months after the start of the recession. There are only two postwar recessions that do not feature employment recovery 3 years after the start of a recession - the 2000-01 recession and the Great Recession. Note, however, that the 2000-01 recession was relatively mild so that despite the slow recovery, employment was only about one percent lower three years after the start of that recession. In contrast, employment during Great Recession is nearly 6 percent lower three years after it started. In terms of the most recent severe recessions, both the 1973 and 1981 recessions feature rapid labor market recoveries, with employment rising three percent above previous business cycle peak values.

[Insert Figure 1 Here]

[Insert Figure 2 Here]

[Insert Figure 3 Here]

Tables 1 and 2 provide a more comprehensive comparison between the Great Recession and other recessions, and present additional evidence that the recovery from the Great Depression has been very slow. Table 1 shows the average recovery for detrended (2 percent annual growth) per capita output and its components and per capita employment through 6 quarters for all postwar recessions except the Great Recession. In the average recovery from a postwar recession, the economy is quite close to returning to trend. Table 2 shows the same variables for the Great Recession, which shows virtually no recovery relative to trend for any variable, with the exception of investment. This pattern is qualitatively very similar to that in the Great Depression.

[Insert Table 1 Here]

[Insert Table 2 Here]

Table 4 shows the same variables for the 1981-82 recession, which is the last severe recession in the U.S. The recovery from the 1981-82 recession is quite fast, with all variables, including employment, either very close to trend or even above trend. This rapid recovery following the 1981-82 recession is consistent with standard neoclassical growth theory, which predicts that recoveries should be relatively fast following severe recessions, reflecting transition dynamics associated with diminishing marginal product of capital and low investment during the recession.

[Insert Table 4 Here]

This evidence indicates that the recovery from the Great Recession has been comparatively very slow, with the restoration of jobs and output proceeding much more slowly than their postwar averages.

The only comparable episode in which a severe downturn was followed by such a slow

recovery is the Great Depression. Table 3 shows the severe depth and duration of the Depression, with relatively little recovery after its 1933 trough. Specifically, relative to 1929, per capita output is about 39 percent below trend, consumption is about 28 percent below trend, investment is about 75 percent below trend, and employment is about 25 percent below trend. And both the Great Depression and the Great Recession feature virtually no recovery in consumption, indicating that factors that are considered to be permanent are contributing to the slow recovery.

[Insert Table 3 Here]

What accounts for such slow recoveries, particularly in the labor market during these episodes? Ohanian (2009), and Cole and Ohanian (2004) present theoretic and empirical evidence that the severity of the Depression and the continuation of Depression significantly reflect industrial and labor policies that increased industrial cartelization and increased labor bargaining power which in turn substantially increased relative prices and real wages. The real manufacturing wages (relative to trend) rose approximately 17 percent from 1929 - 1939, which is abnormal from the perspective of the normal forces of supply and demand. Specifically, low consumption and high unemployment during the decade should have reduced real wages and expanded employment relative to its low level. Ohanian (2009) presents evidence that high real wages during the early phases of the Depression were the result of Hoover's nominal wage maintenance program in which Hoover promised firms protection from labor unions provided that industry maintain nominal wage levels and preserve jobs through work sharing, while Cole and Ohanian (2004) present evidence that New Deal policies that promoted monopoly and union formation, including the National Industrial Recovery Act, and the National Labor Relations Act, fostered higher real wages.

This interpretation of the Great Depression places economic policy, in particular, policies that distorted competition and prevented some markets from clearing, at the center of the Great Depression and its labor market dysfunction. Some economists have also suggested that economic policies are contributing to the persistence of high unemployment today. Specifically, the federal minimum wage increased by about 24 percent, rising from $5.85 in 2007 to $6.55 in 2008 and then to $7.25 in July, 2009, which may have priced a number of lower skill workers out of the job market. Some economists also point to a number of executive orders signed by President Obama designed to promote the use of union contractors on large-scale federal construction projects.

This paper analyzes an alternative policy channel that can connect the coincidence between the severity of housing sector depression and the failure of the labor market to recover. In particular, Ohanian and Raffo (2011) document that the only OECD countries to experience severe labor market dysfunction during the Great Recession were also the countries with the most severe housing market downturns: Ireland, Spain, and the U.S. The other OECD countries had much less employment loss and much less housing sector contraction. We therefore analyze the impact of mortgage modifications on persistently high levels of U.S. unemployment. Mulligan (2009 and 2010) has suggested that these policies distort individ-

ual behavior by changing the incentives to take jobs. We pursue this idea by considering the impact of mortgage modifications on location choice. In particular, by reducing the cost of servicing a mortgage, modifications change the incentives to relocate to labor markets with better job opportunities.

3 Mortgage Modifications During the Great Recession

This section summarizes mortgage modifications since 2007. Table 5 provides a national perspective on mortgage accounts (90 million accounts by 2010), broad modifications as defined below (11.4 million since 2007), and foreclosure starts (5.8 million since 2007). Following Adelino, Gerardi, and Willen (2009), we define a mortgage modification as a change in the interest rate, principal, or the term of the mortgage, or more broadly, as any change to a mortgage that increases or decreases the present value of the loan (many modifications merely tack the current 'forgiven' portion of the debt onto the end of the loan as a balloon payment). This may include an immediate payment in exchange for forgiveness of principal, such as a short sale (a pre-foreclosure sale) and a deed-in-lieu, in which a mortgagor hands over collateral property in exchange for a release from all obligations.

HOPE NOW estimates that there have been about 14.2 million modifications that satisfy one of these modification definitions. Adelino, Gerardi, and Willen (2009) find that roughly three percent of borrowers 90 days or more in arrears in their sample of mortgages, which covers roughly 60% of all mortgages through 2008:4, received a narrowly defined modification, while eight percent received a broader form of modification.

Modifications fall into one of two categories, government modification programs developed by, or associated with, either the Federal Deposit Insurance Corporation (FDIC), the Federal Housing Finance Agency (FHFA), the Troubled Asset Relief Program (TARP), or the Home Affordable Modification Program (HAMP), and other modification programs. Almost all modifications change the mortgagor's current payment by changing the mortgage interest rate and/or the time profile of payments, and/or changing the term of the mortgage, and/or deferring payment of principal or forbearance. There have been about 1.9 million HAMP modifications, which accounts for about 17 percent of all permanent modifications, including the broad definition of modifications, and all other programs account for about 83 percent of modifications.

[Insert Table 5 Here]

The three main government programs are HAMP, the FDIC Loan Modification Program, and the Federal Home Finance Agency Streamlined Modification Program. All the government programs feature modifications that reduce payments to either 31 percent or 38 percent of current income (DTI). This is accomplished by reducing the mortgage payment, subject

to a minimum interest rate. This minimum interest rate is operative for a fixed period, after which the interest rate rises over time. If the initial interest rate adjustment does not satisfy the DTI requirement, then the term of the mortgage is increased, up to a maximum of 40 years. If these modifications together do not generate the required DTI, then principal is deferred to the end of the mortgage as a balloon payment in order to satisfy the DTI requirement of the program, and this deferred principal does not accumulate interest. Some programs also provided benefits to borrowers by paying off principal, waiving late fees, and re-capitalizing arrears in principal, interest, and taxes. The median DTI for those receiving HAMP modifications is about 45 percent of current income when debt only includes mortgage principal, interest, homeowners insurance, and property taxes (front end DTI). The median "back end" DTI is nearly 80 percent for HAMP modifiers, as this broader measure of debt includes other mandated payments, including credit card, auto, and other debt, and spousal and child support.

We focus on HAMP modifications since they represent the most frequently used modification among the government programs. Other government programs and non-government programs are similar along several dimensions. The main exception is that some programs reduce DTI for eligible applicants to 38 percent, rather than HAMP's 31 percent. Descriptions of some of the other programs is in Herkenhoff and Ohanian (2011b).

3.1 Home Affordable Modification Program (HAMP)

This section summarizes the HAMP program and how it evolved over time. The Making Home Affordable (MHA) Program was announced in February of 2009 and operative by March of 2009. The program touted $75 billion for mortgage modifications. However according to the Treasury's expense report, only $1 billion was spent through 2010. There were several changes to the program on June 1, 2010, but for the sake of space, we will only describe the Pre-June 1, 2010 version of HAMP:

Eligibility: HAMP eligibility criteria are listed below (loosely quoted from the HAMP Servicer Guide, 2009):

1. The mortgage loan is a first lien mortgage loan originated on or before January 1, 2009.
2. The mortgage loan has not been previously modified under the HAMP.
3. The mortgage loan is delinquent or default is reasonably foreseeable.
4. The borrower documents a financial hardship by completing a Home Affordable Modification Program Hardship Affidavit and provides the required income documentation. The documentation supporting income may not be more than 90 days old.
5. The borrower has a monthly mortgage payment ratio of greater than 31 percent (mortgage payment over gross income).

6. A borrower actively involved in a bankruptcy proceeding is eligible for HAMP at the servicer's discretion.

7. The current unpaid principal balance is no greater than $729,750.

8. The loan must pass a standardized NPV test that compares the NPV result for a modification to the NPV result for no modification. If the NPV result for the modification scenario is greater than the NPV result for no modification, the servicer MUST offer the modification, otherwise the servicer has the option of performing the modification in its discretion.

Unemployment Eligibility: Unemployed persons are eligible and unemployment benefits count as qualified income. The February 2010 report includes statistics on the main hardship reasons. Roughly 57% of the *permanent* modifications were for people with employment problems, including outright unemployment.

Terms of Modification:

1. A borrower may be asked to complete a trial period. The trial period typically lasts 3 months. During this period the bank verifies income and assesses whether the borrower can make the new payments.

2. If a borrower has an adjustable-rate mortgage (ARM) or interest-only mortgage, the existing interest rate will convert to a fixed interest rate, fully amortizing loan.

3. The following steps outline the process for determining the 31 percent monthly mortgage payment ratio:

   (a) Capitalize accrued interest, out-of-pocket escrow advances to third parties, and any other third party fees that are reasonable and necessary.

   (b) Reduce the interest rate. The interest rate floor in all cases is 2.0 percent. The reduced rate will be in effect for the first five years followed by annual increases of one percent per year (or such lesser amount as may be needed) until the interest rate reaches the Interest Rate Cap, at which time it will be fixed for the remaining loan term.[1]

   (c) If necessary, extend the term and reamortize the mortgage loan by up to 480 months to achieve the target monthly mortgage payment ratio.

   (d) If necessary, the servicer must provide for principal forbearance to achieve the target monthly mortgage payment ratio. The principal forbearance amount is non-interest bearing and non-amortizing. The amount of principal forbearance

[1]The 'Interest Rate Cap' is the Freddie Mac Weekly Primary Mortgage Market Survey (PMMS) Rate for 30-year fixed rate conforming loans as of the modification date.

will result in a balloon payment fully due and payable upon the earliest of the borrower's transfer of the property, payoff of the interest bearing unpaid principal balance, or maturity of the mortgage loan.

Performance: By June 1, 2010 there were 398,021 permanent modifications and 1,300,526 trials had been started. The January 2011 Making Home Affordable report claims that the Pre-June 1,2010 conversion rate (from trial to permanent) was roughly 41%. For HAMP modifications started in 2009:4, 81.6% had payment reductions of 20% or more.[2] Figure 4 illustrates the redefault rates (which means the loan is again at least 60+ days delinquent) for a cohort of HAMP permanent modifications. Annual redefault rates reach 30% even with sizeable reductions. Figure 4 also illustrates the redefault rates for government-guaranteed loans (e.g. Federal Deposit Insurance Corporation Insured), government sponsored enterprise loans (e.g. Fannie Mae and Freddie Mac, see below), private loans with no government affiliation, and the loan portfolio of the participating institutions (i.e. the loans that the banks do not service for someone else).

[Insert Figure 4 Here]

Failed Trials and Rejections: Of those who had their trial period canceled, 44.2% received an alternative modification, 5.9% were somewhere in the foreclosure process, and only 6% were current.[3] A person who fails a trial is no longer eligible for HAMP; however, a rejected person may re-apply. Pre-June 1, 2010, the lack of paperwork necessary led to many unsuccessful modifications.[4]

3.2 Alternative Modifications

HOPE NOW reports that of the approximately 4.2 million permanent modifications, 3.6 million were completed independently of HAMP guidelines. Pre-March 4, 2009, there was no HAMP criteria and the streamlined modifications were used scarcely. The Pre-HAMP modification performance is relatively poor. Very few loans are current (a mere 24%), and even fewer have actually been foreclosed upon (11% completed, 16% in process).[5] Table 6 details a Post-HAMP comparison of the modifications. The HAMP reductions hover around 35-40% and the alternative reductions are also considerably generous around 15-20%. The alternative modifications were similar in several respects to HAMP, though often focused on reducing payments to 38 percent DTI for eligible applicants, instead of 31 percent as in HAMP.

For those who did not satisfy one or more eligibility criteria, modifications were still performed outside of HAMP, but in these cases, payments were reduced less than under

[2]OTS 2010:3 Report
[3]HAMP Servicer Performance Report Through January 2011
[4]See Flyod Norris' 2009 article in the NY Times entitled, 'Why Many Home Loan Modifications Fails.'
[5]OTS 2010:4 Report

HAMP, and as we will see below, led to higher redefault rates. Specifically, about 44 percent of canceled HAMP trials obtain an alternative modification and about 30 percent of denied applicants obtain an alternative modification.

[Insert Table 6 Here]

We now describe the performance of these modifications in terms of redefault rates, which are defaults on modified mortgages. Adelino, Gerardi, and Willen (2009) find that the redefault rate for Pre-HAMP loans lies between 30% and 50%. Furthermore, there is a large fraction of loans (30%) that have a larger Net Present Value (NPV) after the modification. They also reported that 'fewer than 5 % of all of our troubled [90+ days past due] borrowers repaid their mortgages.'

In terms of reallocation, the government is allowing people to maintain their mismatch with the local labor market by providing loan modifications. Clearly those who could not pay their mortgages initially are redefaulting. The process of modifying and then redefaulting is precisely the delay that we focus on in the model below.

3.3 Analyses of Current Modification Programs

We are unaware of studies that quantify the impact of modification programs on unemployment within an optimizing model framework. There are several related papers including Mulligan (2010) who considers the implicit marginal tax rates generated by actual guidelines for FDIC and HAMP modifications. Mulligan (2009) also discusses the incentive effects of mortgage modifications on employment, and suggests that modifications have significantly increased unemployment, but he does not provide a quantitative assessment. Chatterjee and Eyigungor (2009) consider the HAMP program in a single location DSGE model with endogenous prices, but their model lacks an employment margin and therefore does not allow for employment incentive effects or relocation. Adelino, Gerardi, and Willen (2009) argue that there are few modifications because lenders expect to make more money foreclosing than modifying. Their conclusion is that preventable foreclosures are rarer than most people believe. The probability of redefault in their sample ranges between 30% and 50% depending on the quality of the mortgage and the type of modification. If a modification uses resources, it may be socially optimal to have few modifications. Gerardi and Li (2010) provide a useful summary and timeline of the policies that were enacted to save homes.

In terms of the link between housing and unemployment, Oswald (1996) hypothesized that areas with high homeownership rates have higher unemployment rates. Green and Hendershott (2001) use a 1988-1992 PSID panel to track 9000 US household outcomes over time. Among their findings, they present evidence that supports the Oswald hypothesis and found significant heterogeneity in the effect of homeownership on unemployment outcomes. There are also studies that have presented evidence against the Oswald Hypothesis. These studies primarily are based on European data. Vuuren (2009) studies panel data from the

Netherlands and rejects a number of predictions of the Oswald hypothesis.

DiPasquale and Glaeser (1998) consider homeownership and mobility and argue that homeowners are less mobile. Studies based on US data from the recent recession include Ferreira, Gyourko, and Tracy (2009), who use a panel from the American Housing Survey to document that negative equity (which is much more prevalent than modifications) greatly reduces mobility. Schulhofer-Wohl (2010) disputes these mobility claims, suggesting that the empirical methodology of Ferreira, Gyourko, and Tracy is flawed. Winkler (2011) analyzes homeownership and homeowner mobility, and finds that homeownership reduces mobility by 40 percent and that homeownership also negatively impacts income.[6] While Winkler does not consider mortgage modifications, his economic environment is perhaps the closest to ours in that he also uses an optimizing model that includes locational choice.

4 Model Economy

This section presents the model economy we use to assess the impact of mortgage modification programs on economic activity. We blend a search model of unemployment with housing and with the choice of relocating from one local labor market (island) to another island. To focus on the relocation effect and to keep the model tractable, we model only the consumer side of the economy and treat prices exogenously. Herkenhoff and Ohanian (2011a) consider the employment incentive effect along with the large eviction delays in a related paper.

Households face a constant probability of death (δ), and maximize the sum of expected utility discounted using a fixed interest rate (r_h). With a one month period, this means households discount the future using a discount factor $\beta = \frac{(1-\delta)}{(1+r_h)^{\frac{1}{12}}}$. They have preferences over sequences of a nondurable consumption good (c) and a flow of housing services, which is higher if a household owns a home (z_m) rather than rents, (z_r). Mortgages are treated as a perpetuity. Thus owning a home requires making a fixed mortgage payment each period ($\bar{m}$). The mortgage payment is tax-deductible. Renters pay a rental payment (r) each period, but this payment is not tax-deductible.

Households are located on one of two symmetric islands, A or B. They are either employed (W) or unemployed (U). Each period, each household receives a wage offer drawn from a stationary Markov chain. Households can either accept the offer or reject the offer and receive unemployment benefits. The household can also choose to relocate to the alternative island which offers a job finding distribution that stochastically dominates the distribution

[6]He also finds that after a labor shock, the homeowner subgroup has an unemployment rate that is 6% higher one or more years after the shock as compared to before the shock. However, renters show no significant difference in unemployment rates. The estimated job offer equation implies that the probability of receiving a job offer from another location is increasing in education (skill in our model). He also estimates the following offer rates: 16% of renters receive offers per period, 13% of homeowners receive offers per period.

in their current island. If they relocate, they exit from their home permanently and incur a one time utility cost, (MC).

Mortgage modifications are challenging to model as these programs may include many changes to the mortgage contract, several of which are difficult to represent recursively. Because mortgages are a perpetuity, all modifications are a temporary reduction in payments which is exactly what HAMP and other modification programs do. This temporary reduction can lower payments enough so that people who would otherwise move choose to remain in their current location. We call this change in incentives to relocate the *relocation effect* of mortgage modifications.[7]

In our model, households may request a modification, but one time only, as is the case with many modification programs. A modification in the model works as follows. As long as an agent has a DTI between 31% and 75% (in the model notation described below, $\overline{DTI} > \frac{\bar{m}}{w\pi_A} > \underline{DTI}$), the agent is eligible for a temporary modification that reduces mortgage payments as a fraction of their current gross income to 31%. However, to keep the state space tractable, the modification term ends with probability η. Since the modification depends on the mortgagor's current income, this means-testing of modifications means that the incentives to relocate in order to sample a better wage distribution are distorted, as the opportunity cost of relocating is higher, reflecting the fact that relocating means losing the modification.

Each agent's skills evolve over time, and skill evolution depends on employment status, which is motivated by Ljungqvist and Sargent (1998, 2002). Specifically, while employed, an agent's skills can increase or decrease, and the probability of increasing their skill level exceeds the probability of receiving a lower skill. For unemployed agents, their skills on average depreciate. Let π_A denote the skill of an agent on island A. The skill transitions are governed by a Markov chain which is described in Section 4.3. We assume that the probability of finding a job increases monotonically with skill. To capture this, $f(\pi_A)$, which is the job finding probability for an agent with skill π_A, is monotonically increasing. Layoffs occur with probability $1 - p_e$, with p_e denoting the probability of job continuation.

The period budget constraint for an employed mortgage borrower with taxable income I is given by:

$$c + \bar{m}(1 - \tau_l(I)) + T_m = w\pi_A(1 - \tau_l(I))$$

Employed agents earn income $w\pi_A$ where w scales the skill level, π_A. Agents face a progressive income tax schedule which is summarized by the function $\tau_l(\cdot)$. We use progressive income taxes as it allows the model to help match observed home ownership rates by increasing the incentive to own a home as income rises. This allows the model to generate regions in the state space in which consumers prefer renting, and regions in which consumers prefer a mortgage. The tax function is piecewise linear, which we describe in detail in Section 4.2.

[7]This model of modifications does not include another important element of the HAMP modification, which is a trial period for a modification. Specifically, in a trial period, the borrower may decline some offers because this would result in a more expensive modification later.

After-tax income finances non-durable consumption (c), the after-tax mortgage payment, $\bar{m}(1-\tau_l(I))$, and T_m, which is obligated payments corresponding to other homeownership costs including property insurance and homeowner association fees, and in addition, includes other mandated payments such as revolving debt service, child support, and spousal support. These other obligated payments are important to include in the model since their level affects the incentive to request a mortgage modification. Renters also face obligated costs, (T_r), where $T_r < T_m$.

If an agent cannot finance a mortgage, which means that the level of other obligated payments is greater than or equal to income, then the mortgagor is forced to leave the home and rent. While unemployed, agents are provided with unemployment benefits $b(\pi_A)$. Benefits are weakly monotone in the skill level with a 50% replacement rate and an benefit cap of $\bar{b}$ (see Section 4.2). As skills decumulate, benefits expire. This declining path of benefits is adopted because it allows us to formulate the problem recursively while maintaining computational tractability. Moreover, this declining time path of benefits in the model reflects the fact that benefits do indeed decline over time.[8] Specifically, extended benefits or emergency unemployment compensation, which apply in many states after 26 weeks can fall to only 24 percent of the original benefit level. Moreover, it is likely that other sources of financial support that unemployed individuals receive, including support from family, friends, unions, and charities also decline.

An agent that searches on another island finds a job with probability $f(\pi'_B)$, where π'_B is stochastically drawn and depends on the previous island's skill, π_A.

4.1 Value functions

Let $S \in \left\{W, U, W^M, U^M, W^R, U^R\right\}$ represent the status of an agent. $W(\pi_A)$ is the value function of an agent with an offer and skill level π_A. $U(\pi_A)$ is the value function of an agent without an offer and skill level π_A. $W^M(\pi_A, \kappa)$ is the value function of an agent with an offer and a mortgage payment that has been reduced by $100 \cdot (1-\kappa)\%$. In other words, $\kappa = .75$ indicates a 25% reduction in payments. $U^M(\pi_A, \kappa)$ is defined similarly for an agent without an offer. $W^R(\pi_A)$ is the value function of a renter that has an offer and skill level π_A. $U^R(\pi_A)$ is defined similarly for an agent without an offer. In general, the superscript M indicates that the agent currently has a modification and the agent is no longer eligible to have a modification in the future. The M superscript will stay with an agent even when $\kappa = 1$, which means that the temporary modification period is over and the agent pays $1 \cdot \bar{m}$. The superscript R indicates that the agent is a renter.

As indicated above, mortgages are perpetuities with fixed payments. Once an agent

[8]Emergency Unemployment Compensation has different stages called 'tiers.' With each tier there is a duration and a replacement rate. Tier 1 lasts 20 weeks and pays 80% of the maximum benefit amount. Tier 2 lasts 14 weeks and pays 54% of the maxmimum benefit amount, and so on. The last tier pays 24% of the maximum benefit amount.

defaults on a mortgage, the agent is a renter for the remainder of their lifetime. Agents are only allowed one modification in a lifetime, and the modification is structured to reduce payments to 31% of gross income. The modification term is stochastic: with probability η a modification ends. When a modification ends, the mortgage payment returns to its original level $\bar{m}$.

Gross income is $w\pi_A$ for employed people and $b(\pi_A)$ for unemployed people. At the time of the modification request, κ, which denotes the mortgage payment reduction, is set so that the new payment $\kappa \cdot \bar{m}$ is 31 percent of income: $\frac{\kappa(w\pi_A)\bar{m}}{w\pi_A} = .31$. After this initial period, κ becomes a fixed state variable and will only change once the modification ends. When the modification period is over, $\kappa \to 1$, reflecting the fact that payments return back to $\bar{m}$. Mortgagors who decide to default or redefault are subject to a one-time moving cost $-MC$ which reflects the costs of leaving the home.

There are two important states for a mortgagor with no previous modification activity, the skill level π_A and the employment status which is summarized by S. For this type of agent $\mathbb{Q}_S(\pi_A)$ describes the choice set. This choice set will reflect eligibility restrictions for modifications. For instance, if the agent has an offer ($S = W$) and the payment ratio falls between the cap and the eligibility cutoff, $\overline{DTI} > \frac{\bar{m}}{w\pi_A} > \underline{DTI}$, then the choice set includes a modification option,

$$\mathbb{Q}_W(\pi_A) = \big\{ \text{Accept Offer and Pay}, \quad \textit{Accept Offer and Modify}, \\ \text{Reject Offer and Pay, Reject Offer and Default} \big\}$$

If $\frac{\bar{m}}{w\pi_A} < \underline{DTI}$ or $\frac{\bar{m}}{w\pi_A} > \overline{DTI}$ then no modification is allowed and the choice set is now restricted,

$$\mathbb{Q}_W(\pi_A) = \big\{ \text{Accept Offer and Pay, Reject Offer and Pay}, \\ \text{Reject Offer and Default} \big\}$$

There are three key states for a modified mortgagor, the skill level π_A, the modification payment reduction κ, and the employment status summarized by S. For this type of agent $\mathbb{Q}_S(\pi_A, \kappa)$ summarizes the choice set of the agent. Consider an unemployed modified agent ($S = U^M$).

$$\mathbb{Q}_{U^M}(\pi_A, \kappa) = \big\{\text{Search for Job and Pay, Redefault and Move}\big\}$$

In the value functions below, we drop the state π_A which is already summarized in the value function, and we refer to $\mathbb{Q}_S$ as the choice set that implicitly summarizes the qualification criteria.

An agent that begins with an offer and has not previously modified starts the period with a value function $W(\pi_A)$. Recall that taxable income is given by (I). The agent has several choices: (i) pay the mortgage, receive a utility flow $u\big(\big[w\pi_A - \bar{m}\big](1-\tau_l(I)) - T_m, z_m\big)$,

accumulate on the job skills, and face some probability of being fired $(1-p_e)$, (ii) skip a payment and request a modification (so long as the the payment ratio lies between $\overline{DTI}$ and $\underline{DTI}$) (iii) reject the offer (*notice that there is no lag between certain states*), or (iv) default and rent which gives the agent the option to search on the other island.

$$W(\pi_A) = \max_{\mathbb{Q}_W} \Bigg\{ u\Big(\big[w\pi_A - \bar{m}\big]\big(1-\tau_l(I)\big) - T_m, z_m\Big) + \beta E_{\pi'_A|\pi_A,W}\Big[p_e W(\pi'_A) + (1-p_e)U(\pi'_A)\Big],$$
$$u\Big(w\pi_A\big(1-\tau_l(I)\big) - T_m, z_m\Big) + \beta E_{\pi'_A|\pi_A,W}\Big[p_e W^M\big(\pi'_A, \kappa(w\pi_A)\big) + (1-p_e)U^M\big(\pi'_A, \kappa(w\pi_A)\big)\Big],$$
$$U(\pi_A),\ -MC + W^R(\pi_A)\Bigg\}$$

An agent that begins with an offer and a modified mortgage (either currently modified or modified in the past) starts the period with a value function $W^M(\pi_A, \kappa)$. With probability η, payments step back up.

$$W^M(\pi_A,\kappa) = \max_{\mathbb{Q}_{W^M}} \Bigg\{ u\Big(\big[w\pi_A - \kappa\bar{m}\big]\big(1-\tau_l(I)\big) - T_m, z_m\Big) + \eta\beta E_{\pi'_A|\pi_A,W}\Big[p_e W^M(\pi'_A,1) + (1-p_e)U^M(\pi'_A,1)\Big]$$
$$+ (1-\eta)\beta E_{\pi'_A|\pi_A,W}\Big[p_e W^M(\pi'_A,\kappa) + (1-p_e)U^M(\pi'_A,\kappa)\Big],$$
$$U^M(\pi_A,\kappa),\ -MC + W^R(\pi_A)\Bigg\}$$

An agent that begins the period without an offer and has not previously modified starts the period with a value function $U(\pi_A)$. The agent has several choices: (i) pay the mortgage, receive a utility flow $u\big(\big[b(\pi_A) - \bar{m}\big](1-\tau_l(I)) - T_m, z_m\big)$, decumulate skills while unemployed, and search locally which results in a job with probability $f(\pi_A)$ (ii) skip a payment and ask for a modification (so long as the the payment ratio lies between $\overline{DTI}$ and $\underline{DTI}$), or (iii) default and rent which allows the agent the option to also search on the other island.

$$U(\pi_A) = \max_{\mathbb{Q}_U} \Bigg\{ u\Big(\big[b(\pi_A) - \bar{m}\big]\big(1-\tau_l(I)\big) - T_m, z_m\Big) + \beta E_{\pi'_A|\pi_A,U}\Big[f(\pi'_A)W(\pi'_A) + \big(1-f(\pi'_A)\big)U(\pi'_A)\Big],$$
$$u\Big(b(\pi_A)\big(1-\tau_l(I)\big) - T_m, z_m\Big) + \beta E_{\pi'_A|\pi_A,U}\Big[f(\pi'_A)W^M\big(\pi'_A,\kappa(w\pi_A)\big) + (1-f(\pi'_A))U^M\big(\pi'_A,\kappa(w\pi_A)\big)\Big],$$
$$-MC + U^R(\pi_A)\Bigg\}$$

An agent that has no offer and a modified mortgage (either currently modified or modified sometime in the past) starts the period with a value function $U^M(\pi_A, \kappa)$. With probability η, payments increase to their original level ($\kappa = 1$).

$$U^M(\pi_A,\kappa) = \max_{\mathbb{Q}_{U^M}} \Bigg\{ u\Big(\big[b(\pi_A) - \kappa\bar{m}\big]\big(1-\tau_l(I)\big) - T_m, z_m\Big) + \eta\beta E_{\pi'_A|\pi_A,U}\Big[f(\pi'_A)W^M(\pi'_A,1) + (1-f(\pi'_A))U^M(\pi'_A,1)\Big]$$
$$+ (1-\eta)\beta E_{\pi'_A|\pi_A,U}\Big[f(\pi'_A)W^M(\pi'_A,\kappa) + (1-f(\pi'_A))U^M(\pi'_A,\kappa)\Big],$$
$$- MC + U^R(\pi_A)\Bigg\}$$

An agent that begins the period renting with an offer has a value function $W^R(\pi_A)$. This agent has two choices: (i) continue to work on the same island, or (ii) quit and pick an island to search for a new job.

$$W^R(\pi_A) = \max_{\mathbb{Q}_{W^R}} \left\{ u\big(w\pi_A(1-\tau_l(I)) - r - T_r, z_r\big) + \beta E_{\pi'_A|\pi_A,W}\Big[p_e W^R(\pi'_A) + (1-p_e)U^R(\pi'_A)\Big], U^R(\pi_A)\right\}$$

An agent that begins the period renting without an offer has a value function $U^R(\pi_A)$.

$$U^R(\pi_A) = u\big(b(\pi_A)(1-\tau_l(I)) - r - T_r, z_r\big)$$
$$+ \beta \max\left\{ E_{\pi'_A|\pi_A,U}\Big[f(\pi'_A)W^R(\pi'_A) + (1-f(\pi'_A))U^R(\pi'_A)\Big], E_{\pi'_B|\pi_A,U}\Big[\ f(\pi'_B)W^R(\pi'_B) + (1-f(\pi'_B))U^R(\pi'_B)\Big]\right\}$$

4.2 Functional Forms, Parameters, and Results

The utility function is given by:

$$u(c,z) = \log(c) + z$$

The job finding probability is strongly monotone in the interior, and weakly monotone in the tails. This functional form captures the intuition that it is easier for persons with high skills to find jobs.[9]

$$f(\pi_A) = f_c \cdot \max\left\{\underline{f}, \min\left\{\overline{f}, \frac{\pi_A - \underline{\pi}_A}{\overline{\pi}_A - \underline{\pi}_A}\right\}\right\}$$

This job finding function is graphed in Figure 5 for $f_c = 3/10$, which is used in the simulations. The expected job finding rate on the alternative island is also graphed, and shows the expectation of an island A agent with skill π_A finding a job on island B. This functional form is in line with Shimer's (2008) estimate that the probability of being reemployed in the

[9]Mincer (1991) presents evidence supporting this choice. We make use of the following notation: $\underline{x}$ is the lower bound of x and $\overline{x}$ is the upper bound of x.

next month, on average, for all workers in the Current Population Survey dataset is 28.6%. We match on average that renters have 3% more job offers, as estimated in Winkler (2011).

[Insert Figure 5 Here]

Unemployment benefits are monotone in the lower half of the support with a 50% replacement rate, but benefits are capped by $\bar{b}$. For the simulations that follow, $\bar{b}$ is set approximately to one half the mean observed wage. Given the skill process described below, benefits last on average for 2 years:

$$b(\pi_A) = \frac{1}{2} \cdot w \cdot \min\left\{\pi_A - \underline{\pi}_A, \bar{b}\right\}$$

The income tax function is described below:

$$\tau_l(I) = \tau_{1/5}\mathbb{I}(I < I_{1/5}) + \cdots + \tau_{4/5}\mathbb{I}(I_{3/5} < I < I_{4/5}) + \tau_{5/5}\mathbb{I}(I_{4/5} < I)$$

This describes an average rate that is applied to all labor income, and the cutoffs are income quintiles which are defined by $I_{x/5}$ for $x \in \{1, \cdots, 5\}$.

4.3 Parameter Values

The period length is one month. Given the period length, there are several parameter values: the wage (w), the interest rate (r_h), the death probability (δ), the probability that a modification ends (η), the probability of continued employment (p_e), the modification cutoffs for debt-to-income ($\overline{DTI}$ and $\underline{\text{DTI}}$),the mortgage payment ($\bar{m}$), the rental payment (r), the housing utility flow (z_m), the renter utility flow (z_r), non-mortgage debt payments for a homeowner (T_m), non-mortgage debt payments for a renter (T_r), the costs of foreclosure and leaving a house, (MC), the tax schedule $\tau_l(\cdot)$, the grid for skill levels, the transition probabilities, and the initial draws.

The wage rate is set to unity. The annual household discount is set to 6%, which is in line with Lipshits, MacGee, and Tertilt (2006). The death probability δ is set such that the average lifetime is 42 years. η follows from the HAMP modification program which reduces payments for 5 years. The probability of remaining employed, p_e is set to match the average job duration of 4.6 years.[10] Modifications reduce mortgage payments to 31% of current gross income. The upper limit on debt to income, $\overline{DTI} = .75$, is set to match the modification rate (note that by picking the cap to match this moment, the initial front-end DTI of a mortgagor is larger than in the data since the option value of modifying skews this decision) and $\underline{\text{DTI}} = .31$ is taken from the HAMP servicer manual. The fixed mortgage payment $\bar{m}$ is set such that in the absence of modifications, the average mortgage payment to income ratio is 20% as in Corbae and Quintin (2010). The rental payment r is set to 90% of the mortgage payment.[11] The flow from housing z_m is picked to be the log of the average mortgage payment $z_m = \log(\bar{m})$. z_r is scaled in proportion to payments: $z_r = \frac{r}{\bar{m}} z_m$. The fixed cost for a mortgagor, T_m, is set to match the difference between the back-end and front-end DTI of a modifier which is roughly 30% in the HAMP Data. T_r is set to match the fraction of people renting, which is about 35%.[12] The cost of foreclosure and leaving a house to become a renter, MC, is set to one year's worth of the median wage in order to match the annual migration rate of 6.3% as reported in Davis, Fischer, and Veracierto (2010).[13] Once an agent becomes a renter, the agent is free to move between locations without any additional cost. The tax schedule $\tau_l(\cdot)$ matches the average effective tax rates by income quintile as published by the Congressional Budget Office.[14] By quintile, the tax rates are 4.3%, 9.9%, 14.1%, 17.3%, and 25.2%.

The grid for π_A has 7 nodes that are evenly spaced between $[\frac{1}{2}, 14\frac{1}{2}]$. Ljungqvist and Sargent (2002) use a process calibrated to 2 weeks with 11 nodes. In their model, agents lose one node with a 10% chance. We follow their setup and have agents move down twice as

[10] Ljungqvist and Sargent (1998).

[11] American Housing Survey for the United States: 2003, Table 2-13, Selected Housing Costs and Occupied Units

[12] 66% Homeownership rate in the 2000 Census

[13] While this may seem high, this is conservative in lieu of Kennan and Walker (2011) who find an average moving cost of $312,000.

[14] CBO, Historical Effective Federal Tax Rates: 1979 to 2005 December 2007

fast in the unemployed state (10% chance of moving down one level every 4 weeks while unemployed, 5% change of moving down one level every 4 weeks while employed). Agents keep their original skill level 80% of the time while employed, 85% of the time while unemployed, and 75% of the time when searching on another island. Employed agents move up one slot with a probability of 15% and unemployed agents move up one slot with a probability of 5% (in our model, unlike Ljunqvist and Sargent, the unemployed can increase their skill level). A person who searches on another island moves up one slot 15% of the time and moves up two slots 10% of the time.

This human capital process captures much of the dispersion and volatility of monthly income. According to monthly Survey of Income and Participation Program (SIPP) data from 2001, the coefficient of variation (σ/μ) for monthly income ranges from .78 to .26 depending on where an individual falls relative to the poverty line (e.g. those at least 150% above the poverty line have an *average* CV of .31 for monthly earnings and .28 for monthly income).[15]

Tables 7 and 8 illustrate the moments that we try to match by picking appropriate parameters. Several other references are included in the tables for completeness.

[Insert Table 7 Here]

[Insert Table 8 Here]

5 The Impact of Mortgage Modifications in the Model Economy

The following section presents analyses to evaluate the quantitative impact of modifications on unemployment levels, unemployment duration, and skill levels (productivity). We consider two experiments: (1) a comparison of steady states between an economy with no modifications and one with modifications, (2) a one-time economic turbulence analysis along the lines of Ljunqvist and Sargent (1998 and 2002), in which we follow the economy over time after there is a one-time, unanticipated, large, exogenous destruction of jobs.

5.1 Steady State Comparison

We solved for a stationary mass of agents using the techniques outlined in Hopenhayn (1992). We use value function iteration on the grids described above to solve for the policy functions, and we proxy the unit mass of agents on each island with a large number of simulated agents. The stationary mass of 300,000 agents is symmetric across islands, with island A movers exactly offset by replica island B movers. The results in Table 9 below are for

[15] Bania and Leete (2009)

an economy that gives modifications in the same proportion as observed in HAMP data. To capture current conditions, the newly born agents are born with mortgages, they are randomly endowed with skills over skill slots 2 to 6, and 9% of them start unemployed.[16]

[Insert Table 9 Here]

5.2 Steady State Discussion

The duration of unemployment increases in the modification economy, which is the consequence of the lower incentive to relocate. Specifically, low skill workers and unemployed mortgagors receive on average large mortgage payment discounts to reduce payments to 31% of their currrent income. The modification program thus subsidizes unemployment/low skills by reducing the opportunity cost of staying in the local labor market. In the no-modification world, there is no such subsidy and as a result the incentive to relocate to the labor market with better job prospects is higher. As a consequence, the modification policies generate 30 basis points of higher unemployment. Unemployment is about 50 basis points higher in the turbulence experiment, which is described below.

In addition to the 30 basis point steady state difference in unemployment, the average duration of unemployment in the modification economy is about one week longer, which is about a 10 percent increase. Duration increases because there are more households staying in local (poor job prospect) labor markets. By moving, households expect to move up one skill level, and this is proportional to their chance of finding a job. This implication of higher unemployment duration in the modification economy is consistent with a key fact reported by Winkler (2011), which is that homeowners have a lower hazard rate out of unemployment after an adverse labor shock.

Mobility falls in the modification economy to a migration rate of about 8 percent per year, compared to a 10 percent migration rate in the economy without modifications. This impact on mobility is moderate compared to that estimated by Kennan and Walker (2011), who find that a $10,000 subsidy for moving results in a two percentage point rise in mobility. In our model, agents receive a 45% reduction in payments on average for 5 years. Mapping this into the $6,000 median annual reduction in payments observed in HAMP data, then there is an undiscounted subsidy to modifiers of about $30,000, which is about 1/3 as large as that estimated by Kennan and Walker.

We also find that the quarterly foreclosure rate is about 20 basis points lower in the modification economy, and the fraction of renters is much lower. The foreclosure rate is higher in the no-modification economy for the same reason that unemployment is lower, which is because more households leave the local labor market when modifications are unavailable. While the difference in the foreclosure rates between the two economies is fairly small, there are large differences in the number of renters. Because modifications are always available,

[16]Recall, there are 7 possible skill slots, so agents are not started in the extremes

this quarterly 20 basis point difference generates a much higher steady state mass of renters. Specifically, about 48 percent are renters in the non-modification steady state, while about 38 percent are renters in the modification steady state.

To compare our results to those in the literature, we estimated the following equation:

$$D_{i,t=12} = \beta_0 + \beta_1 \pi_{i,t=1} + \beta_2 \kappa_{i,t=1} + \beta_3 JO_{i,t=1} + \epsilon_i$$

The variable i indexes the individual. We estimate this in the cross section where $D_{i,t=12}$ is an indicator of default within 12 months after modification, $\pi_{i,t=1}$ is the skill level at the date of modification, $\kappa_{i,t=1}$ is the payment reduction expressed as a fraction, $JO_{i,t=1}$ is a job offer indicator at the date of modification, and ϵ_i is the error term.

The estimated results, which are in Table 10, are very similar to the empirical results presented in Haughwout, Okah,and Tracy (2009) who estimate a proportional hazard model of the form $D_t = \exp(\alpha(t)) \exp(X\gamma)$. Since their coefficients are in a non-separable exponential form, it is difficult to directly compare the results. However, they report, that "the data indicate that a 10 percent reduction in the required monthly mortgage payment is associated with around a 13 percent reduction in the re-default hazard." In our model, if payments are reduced by 10% (i.e. κ is reduced by .1), then the redefault probability falls by $11.3\% = .1 \times 1.13 \times 100$. This is roughly the same as their empirical results. Haughwout et al. did not have data on individual employment status, but our model provides results about this effect on redefault. Our estimated equation predicts that a person who has a job at the date of requesting a modification is 48% less likely to default one year later as compared to an unemployed person. Likewise, an increase in skill, which is a proxy for income, also reduces the probability of default.

The median modified mortgage payment declines by about 45 percent, compared to a median decline of about 40 percent reported by HAMP. Without the cap on the qualifying DTI, the reduction in the model would be much larger, as households would tend to wait to take the modification until their income is very low. Given that payments are reduced to 31% of current income and a modification can be taken one time only, there is an option value to wait to modify.

[Insert Table 10 Here]

5.3 Economic Turbulence Experiment

Ljungqvist and Sargent (1998, 2002) analyze the impact of labor market policies by conducting what they refer to as 'turbulence experiments.' Specifically, they analyze policies in an economy which has a one-time large, exogenous destruction of jobs, and in which the skill level of the unemployed declines. We pursue a similar turbulence experiment to analyze the consequences of mortgage modifications in the model with a one-time, large job destruction and a reduction in skills of those who are unemployed.

Specifically, our turbulence experiment is as follows: (i) we double the layoff rate $(2 \cdot (1 - p_e))$ for 1 period, and (ii) for those who are laid off, their skill level is cut by 1 notch from their initial condition skill level. The layoff shock and skill shock are unanticipated. We simulate a unit mass (approximated by 300,000 individuals) and follow them for 2 years after the shock, and compare the following variables over time between the modification economy and the non-modification economy: (a) the unemployment rate, (b) average skill level, (c) modification rate, (d) the redefault rate, and (e) the unemployment survival function. Modifications are allowed one time only, and can be applied for from the initial date of the shock until the end of year 2. The results of this experiment are illustrated in Figures 6 to 9.

[Insert Figure 6 Here]

[Insert Figure 7 Here]

[Insert Figure 8 Here]

[Insert Figure 9 Here]

The initial conditions, which are identical across the modification and no-modification economies, are as follows: 35% begin as renters, 65% begin as mortgagors, and the intial mean Front-End DTI is 14% with a 2% standard deviation. The initial mean Back-End DTI is 21% with a 4% standard deviation. The initial skills are distributed uniformly over skill slots 3 to 6.[17] Figures 6 to 9 compare the turbulence experiments for the modification and non-modification economies.

5.4 Turbulence Discussion

The main findings are that modifications raise unemployment, increase the duration of unemployment, reduce the average skill level, reduce worker mobility, and reduce foreclosures. Specifically, the unemployment rate in the modification economy is about one half percentage higher than in the non-modification economy. The 0.5 percent difference in unemployment is reached after about 10 months, and continues at about that level for the 30 month horizon that we have examined. While this program does not account for the bulk of the increase in current unemployment, it does generate a persistent increase in unemployment, correspond-

[17] There are 7 slots in total, and no one begins in the extremes

ing to about 730,000 unemployed individuals, given the current size of the US labor force. Unemployment duration in the modification economy is about 18.1 weeks, compared to 17.3 weeks in the economy without modifications.

The average skill level of the employed in the modification economy is about 0.5 percent lower than in the non-modification economy. Figure 7 illustrates that this difference grows over time as the low skilled unemployed modifiers eventually reintegrate back into the workforce and drag down the average. It is interesting to note that the modification rate in the first year following the job destruction shock is about four percent, which is close to the peak rate of modifications of 4.5 percent in 2009. The median modifier in this economy has a back end DTI of 0.88 as compared to a back end DTI of 0.79 in the data.

Despite relatively generous modifications, there are a number of redefaults in the modification economy. Many of those who lose their job in the turbulence experiment choose to modify immediately. Of those who modify, many redefault shortly afterwards. Specifically, 41 percent of modifiers redefault within one year, which is very similar to the 48 percent rate reported by the Office of Thrift Supervision for overall mortgages (OTS 2010-IV, Table 3). As in actual experience, many modifications are unsuccessful from the perspective of keeping the mortgagor in their home. Of those who successfully modify, it is precisely those with low skill who pay their modified mortgages that create the difference between the two economies. These successful modifiers change the speed of recovery by delaying relocation to better job markets. Moreover, note that while the redefault rates settle down over time, there is still a persistent flow of new modifications even after the initial shock. This means that agents who do not lose their job in the initial period of job destruction do make use the modification afterwards.

These results also have implications for the recent change in the Beveridge curve. Specifically, many economists, including Hall (2010 and 2011) note that the Beveridge curve has shifted recently such that the efficiency of labor market matching is significantly lower today than in the past. While our model does not have a vacancy dimension, it is consistent with less efficient matching as modified households choose to stay in relatively poor labor markets, and thus may be consistent with a shifted Beveridge Curve.

6 Conclusion

This paper has documented the slow recovery of the labor market from the Great Recession, and has analyzed the impact of mortgage modification programs on why recovery has been delayed. These modification programs are means-tested, as the extent that mortgage payments are reduced by a modification depends on a borrower's current economic circumstances, including circumstances in which income is limited to unemployment benefits. Means-testing thus changes the incentives for workers to relocate from relatively poor labor markets to better labor markets. Our findings indicate that these policies, as modeled in this

version of the paper, can add about 0.5 percent to the unemployment rate, and reduce per capita income by about 1 percent, which reflects both lower employment and lower worker productivity through skill erosion.

In terms of understanding why unemployment remains so high, it appears that other factors in addition to modifications are impacting current labor markets. Hall (2011) analyzes a model in which high real interest rates, combined with labor market rigidities, are important. It would be of interest to blend Hall's world with the modifications presented here, as well as consider sectoral issues, given that some sectors of the economy, such as housing, have been more severely impacted.

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Table 1:

Detrended Levels of Output and Its Components in a Typical Postwar Recovery (excludes 2007 recession)

Measured Quarterly from trough, Peak=100

Quarters From Trough	Output	Consumption	Investment	Government Purchases	Employment	Compensation to employees
0	95.4	97.8	82.0	98.9	95.8	99.2
1	96.3	98.3	86.9	97.8	95.5	100.0
2	97.0	98.7	91.6	97.9	95.9	100.1
3	97.9	99.5	95.0	97.4	96.6	100.0
4	98.6	99.7	99.5	97.5	97.4	100.3
5	98.7	99.9	99.3	98.1	97.8	100.2
6	99.0	99.8	100.9	99.5	98.1	100.4

Source: Output and components, Bureau of Economic Analysis. Employment, Bureau of Labor Statistics

Table 2:

Detrended Levels of Output and Its Components in 2007-IV to 2009-II recession

Measured Quarterly from trough, Peak=100

Quarters From Trough	Output	Consumption	Investment	Government Purchases	Employment	Compensation to employees
0	92.1	93.7	65.6	99.7	92.8	100.0
1	91.7	93.5	67.0	99.3	91.7	99.1
2	92.1	93.0	70.5	98.2	91.0	98.9
3	92.4	92.8	74.7	97.3	90.9	98.5
4	92.2	92.7	78.6	97.5	91.0	99.2
5	92.1	92.5	80.8	97.7	91.0	98.9
6	92.1	92.7	76.2	96.6	91.1	98.2

Source: Output and components, Bureau of Economic Analysis. Employment, Bureau of Labor Statistics

Table 3:

Consumption, investment, and other components of GNP, 1930-39

1929=100

	Real GNP	Consumption		Investment	Government	Foreign Trade		Employment
Year		Durables	Non Durables	nonresidential	Purchases	Exports	Imports	
1930	87.4	76.2	90.9	79.2	105.1	85.3	84.9	93.8
1931	78.1	63.4	85.4	49.4	105.4	70.6	72.4	86.7
1932	65.2	46.7	76.0	27.9	97.3	54.5	58.1	78.9
1933	61.9	44.4	72.2	24.6	91.7	52.8	60.8	78.6
1934	64.6	49.0	72.1	28.4	101.1	52.8	58.3	83.7
1935	68.1	58.9	73.1	34.4	100.1	53.8	69.3	85.4
1936	74.9	70.8	77.0	45.9	113.9	55.1	71.9	89.8
1937	76.0	72.2	77.2	53.6	106.3	64.3	78.3	90.8
1938	70.6	56.3	74.3	37.8	112.0	62.8	58.3	86.1
1939	73.5	64.3	75.0	40.5	112.9	61.7	61.6	87.5

Source: Cole and Ohanian (2000)

Table 4:

Detrended Levels of Output and Its Components in 1981-III to 1982-IV recession

Measured Quarterly from trough, Peak=100

Quarters From Trough	Output	Consumption	Investment	Government Purchases	Employment	Compensation to employees
0	97.6	98.8	74.4	99.8	95.1	100.6
1	98.2	99.0	76.5	99.8	95.0	101.3
2	99.5	100.2	83.2	99.9	95.7	100.6
3	100.9	101.2	88.1	100.8	96.6	100.0
4	101.9	102.0	96.7	98.3	98.0	99.4
5	102.3	102.0	105.8	98.4	99.1	99.2
6	102.8	102.6	108.6	99.8	100.1	98.8

Source: Output and components, Bureau of Economic Analysis. Employment, Bureau of Labor Statistics

Table 5:

Modifications, Foreclosures, and Mortgage Accounts

	2007 Q3-Q4	2008	2009	2010 Q1-Q3
Mortgage Accounts (Stock Var.)	97,205,000	97,705,000	93,760,000	90,893,333
Modifications Started (Broad Definition, Flow Var.)	912,671.00	2,258,603.00	4,253,364.00	3,691,320.00
Subset: HAMP Modifications (Broad Definition, Flow Var.)			1,023,224	891,967
Modifications Completed (Flow Var.)	206,240	961,355	1,239,428	1,413,271
Fraction of Mortgage Accounts Modified (Broad Definition)	0.9%	2.3%	4.5%	4.1%
Fraction of Mortgage Accounts Modified (Narrow Definition)	0.21%	0.98%	1.32%	1.55%
Foreclosure Starts (Flow Var.)	673,960	1,755,860	2,037,940	1,397,580
Fraction of Foreclosure Starts	0.69%	1.80%	2.17%	1.54%

Source: NY Fed Consumer Credit Report and HOPE NOW

Table 6:

Comparison of HAMP Modifications and Alternative Modifications

	2009-IV	2010-I	2010-II	2010-III	2010-IV
Average HAMP Reduction	-39.40%	-37.20%	-37.80%	-35.60%	-35.90%
Average Alternative Modification Reduction	-14.70%	-15.10%	-18.50%	-20.70%	-21.60%

	3 Months	6 Months	9 Months
HAMP Modifications, Redefault Rates Since 2009-Q1	11%	13%	17%
Alternative Modifications, Redefault Rates Since 2009-Q1	12%	24%	32%

Source: OTS Report, 2010-IV

Table 7:

Reference Moments

Demographics and Unemployment

Description	Data	Model	Parameter	Source
Average Time Until Layoff	4.3 Yrs.	4.3 Yrs.	Firing Rate	Ljunqvist and Sargent (1998)
Expected Duration of Working Life	42.7 Yrs	42.7 Yrs.	Death Rate	Ljunqvist and Sargent (1998)
Homeownership Rate (HR)	66.20%	61.00%	Renter's Fixed Payment	US Census Bureau (2000)
Adjustment to HR for Negative Equity	-5.60%			Haughwout, Peach, Tracy (2009)
Mean Duration of Unemployment in Weeks (Great Recession)	18.5 Weeks	18.1 Weeks	Job Finding Rate	Bureau of Labor Statistics (Table A-12)

Renting and Default

Description	Data	Model	Parameter	Source
Ratio of Renter Payment to Mortgage Payment	0.9	0.9	Ratio of payments and ratio of housing flows	American Housing Survey (2003)

Modifications

Description	Data	Model	Parameter	Source
12 Month HAMP Redefault Rate (HAMP Data Summary 2010-III)	25.40%	29.82%	Transition Probabilities and DTI Cap	OTS 2010-IV (Table 3)
Duration of Modification	5 Years	5 Years	Stochastic Term Probability	HAMP Servicer Guidelines (2009)

Table 8:

Reference Moments, Continued

Modifications, Continued

Description	Data	Model	Parameter	Source
Median of Back End DTI Minus Front End DTI	33.90%	30.00%	Mortgagor Fixed Costs	HAMP Data Summary (p. 3, January 2011)
Median Front End DTI Before Modification	45.30%	59.00%	DTI Cap	HAMP Data Summary (p. 3, January 2011)
Median Back End DTI Before Modification	79.20%	88.00%	DTI Cap	HAMP Data Summary (p. 3, January 2011)
Median Front End DTI After Modification	31.00%	31.00%	Modification Scalar	HAMP Data Summary (p. 3, January 2011)
Median Back End DTI After Modification	62.40%	60.00%	Modification Scalar	HAMP Data Summary (p. 3, January 2011)
Modification Rate Per Annum (Broad)	1.4% to 4.5%	1.76%	Transition Probabilities and DTI Cap	(FRBNY Quarterly Report on Household Credit and Debt, Nov. and HOPE NOW)
Average Quarterly Foreclosure Rate Until 2006	0.25%	0.38%	Transition Probabilities	(Corbae and Quintin 2010)

Migration and Moving

Description	Data	Model	Parameter	Source
1 Year MSA Migration Rate, Tax Data	6.36%	8.52%	Moving Costs	Davis, Fisher, and Veracierto (2010)

Income Process

Description	Value			Source
Coefficient of Variation (CV) x100, Monthly Income, 150% + of Poverty Income	24.8	21.9	Transition Probabilities	Bania and Leete (2009), Table 2

Table 9:

Steady State Comparison

Modification Policy In Place?	Yes	No	Ratio
Unemployment Rate	7.71%	7.40%	1.084
	(0.015085)	(0.014023)	-
Average Unemployment Duration	18.1081 Weeks	17.3597 Weeks	1.043
	(0.024106)	(0.021994)	-
Average Renter Unemployment Duration	17.695 Weeks	17.0168 Weeks	1.040
	(0.033485)	(0.028446)	-
Average Skill of Employed	12.8805	12.9526	0.995
	(0.0024433)	(0.0025297)	-
Average Skill of Unemployed	11.0629	11.5008	0.995
	(0.0068475)	(0.0068613)	-
Annual Migration Rate	8.53%	10.68%	-
	(0.051711)	(0.05259)	-
Quarterly Foreclosure Rate	0.38%	0.56%	0.685
	(0.0029566)	(0.0041526)	-
Modification Rate Per Quarter	0.44%	NaN%	-
	(0.0016293)	(NaN)	-
Redefault Rate Within 12 Months	29.82%	NaN%	-
	(0.22319)	(NaN)	-
Mean Pay Reduction	0.45126	NaN	-
	(0.00039674)	(NaN)	-
Fraction of Modifiers with Offer	0.40316	NaN	-
	(0.0022109)	(NaN)	-
Average Mortgagor DTI	0.13713	0.1864	0.736
	(0.00018456)	(0.00014419)	-
Fraction Renting	0.38397	0.4807	0.799
	(0.002414)	(0.0024185)	-

Table 10:

Hazard for Redefaulting Within 12 Months

Dependent Variable: 12 Month Redefault Indicator	
Constant	0.85509
	(0.17707)
$\pi_{(i,t=1)}$ (Skill)	-0.14873
	(0.008327)
$\kappa_{(i,t=1)}$ (New Payment)	1.1396
	(0.52317)
$JO_{(i,t=1)}$ (Job Offer Dummy)	-0.47614
	(0.070691)

Figure 1:

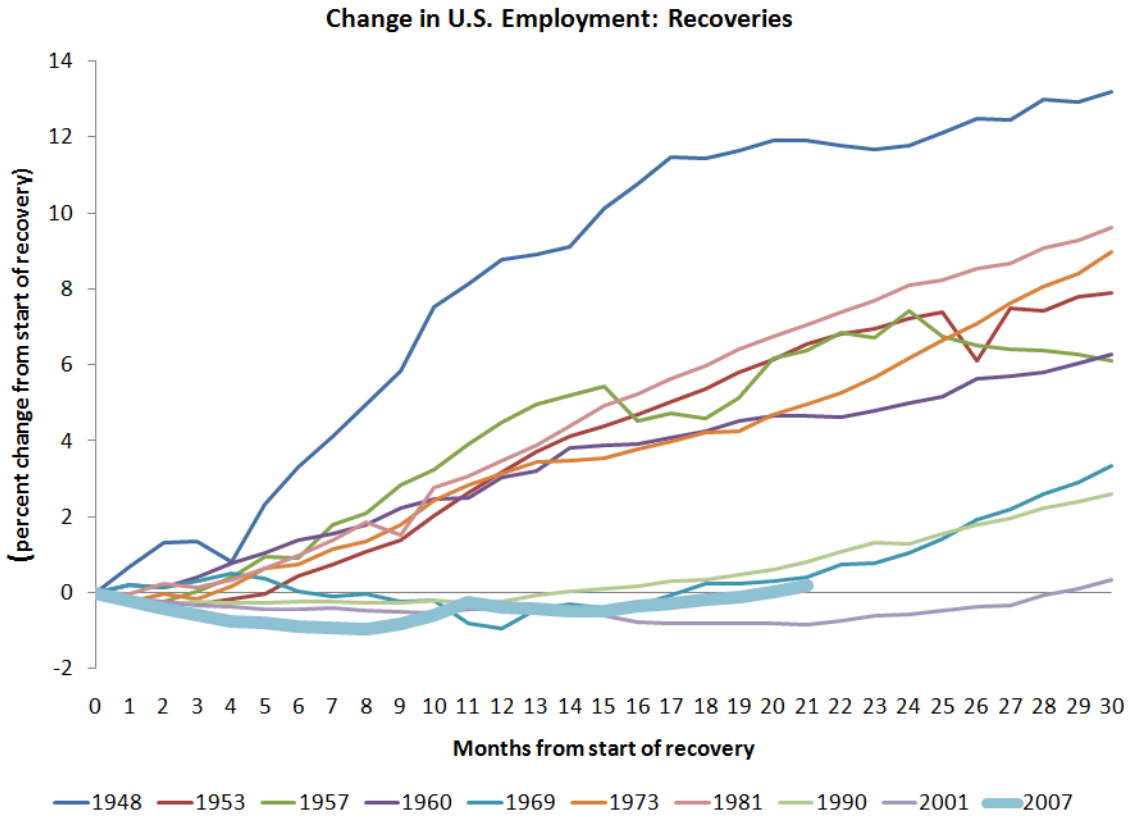
Change in U.S. Employment: Recoveries
(percent change from start of recovery)
14
12
10
8
6
4
2
0
-2
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Months from start of recovery
1948
1953
1957
1960
1969
1973
1981
1990
2001
2007

Figure 2:

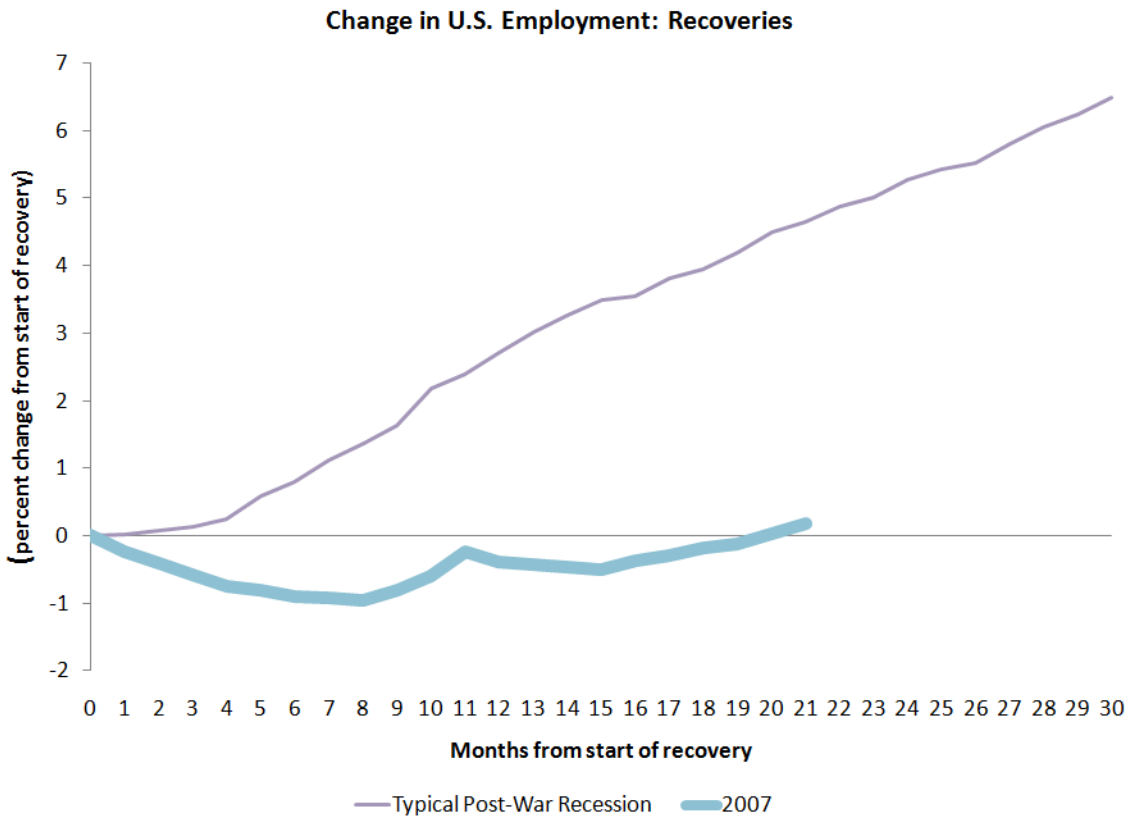
Change in U.S. Employment: Recoveries
(percent change from start of recovery)
7
6
5
4
3
2
1
0
-1
-2
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Months from start of recovery
Typical Post-War Recession
2007

Figure 3:

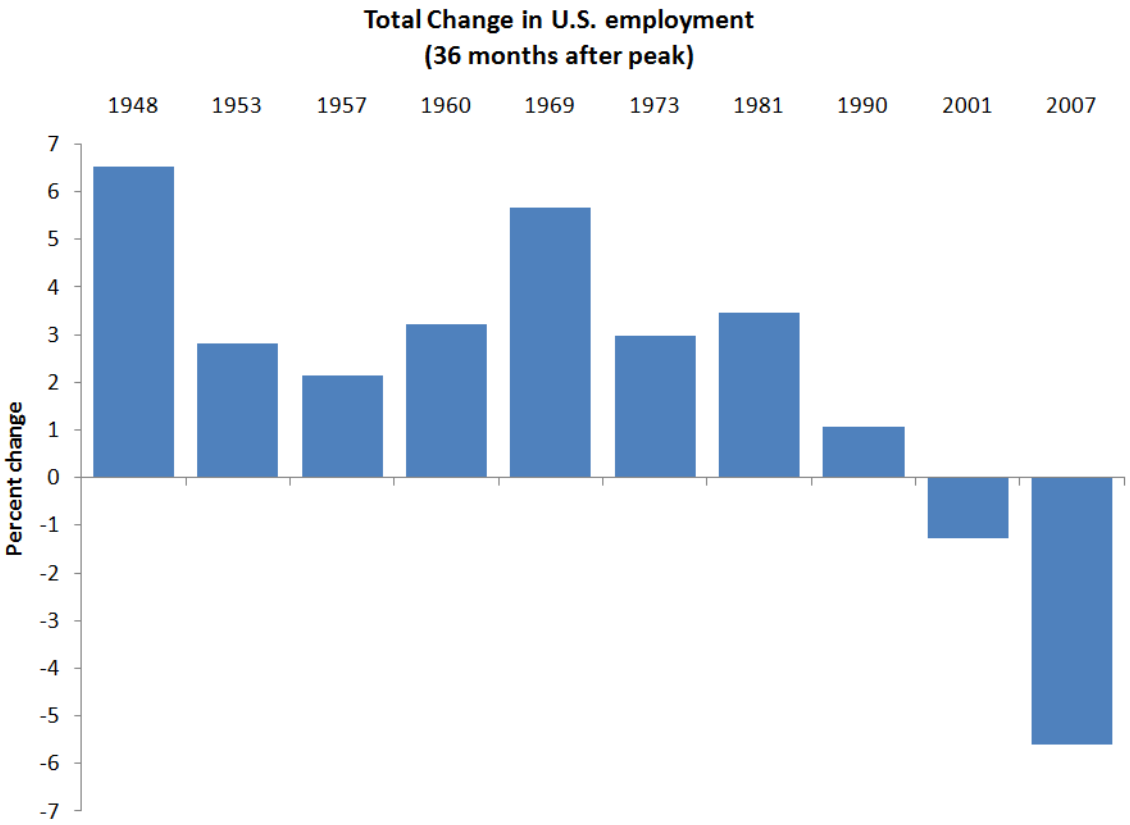
Total Change in U.S. employment
(36 months after peak)
1948
1953
1957
1960
1969
1973
1981
1990
2001
2007
Percent change
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7

Figure 4: Redefault Rates (At Least 60+Days Late,% Percent) (Source: MHA and OTS)

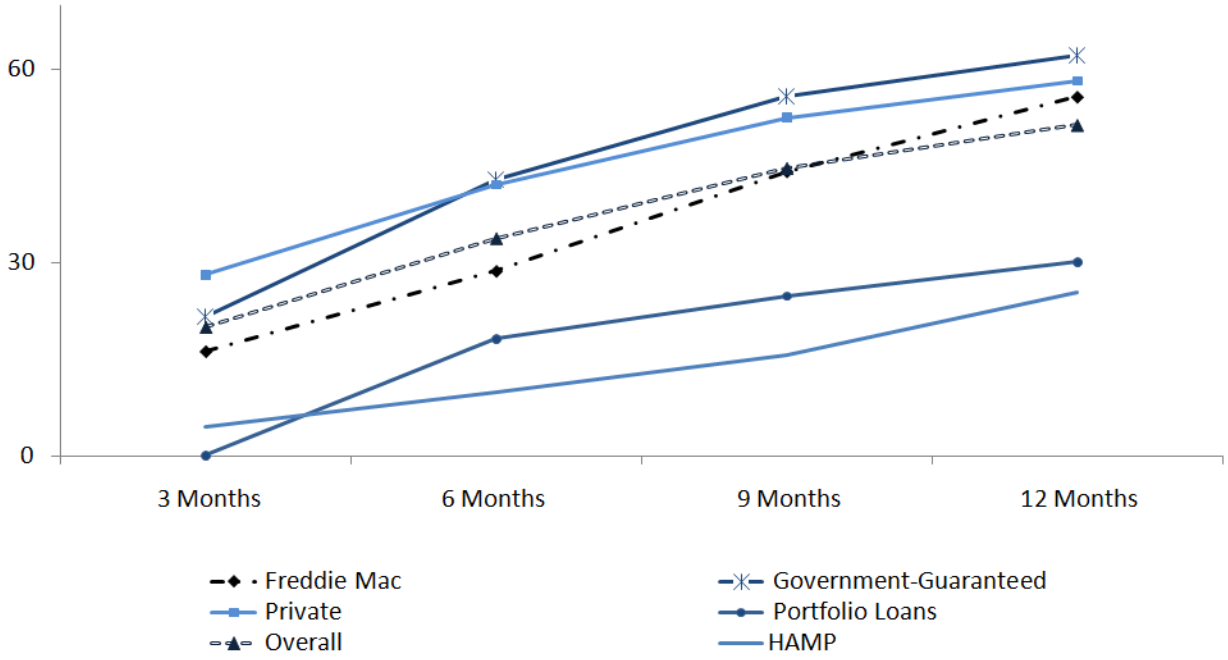

Figure 5: Monthly Job Finding Probability

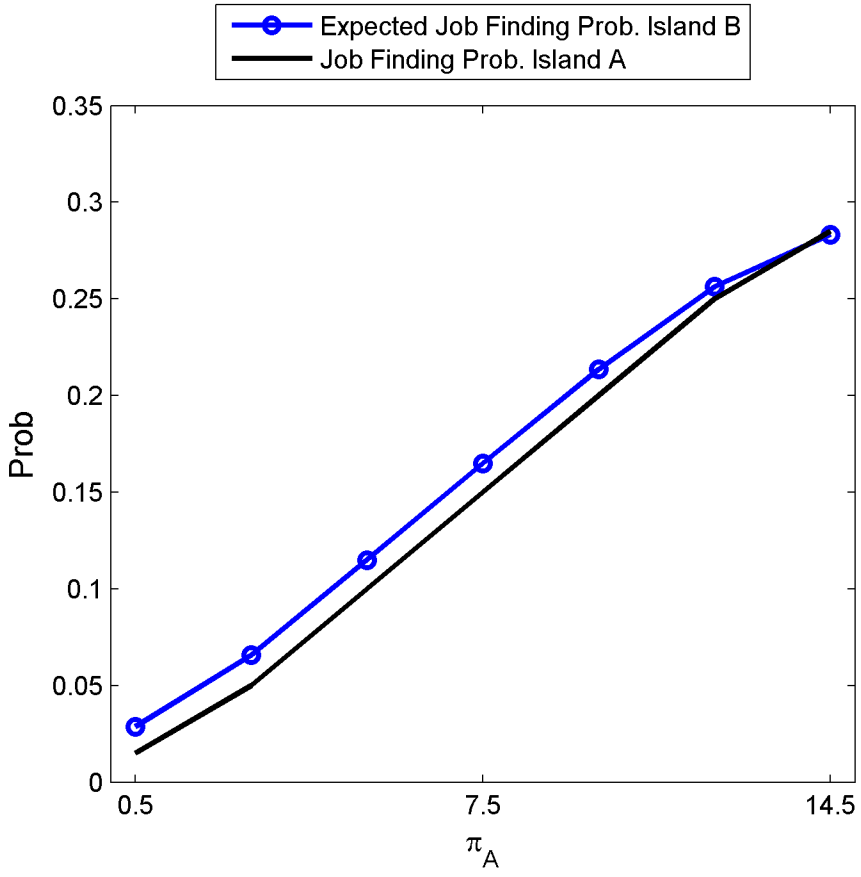

Figure 6: Turbulence Experiment: Unemployment Rate

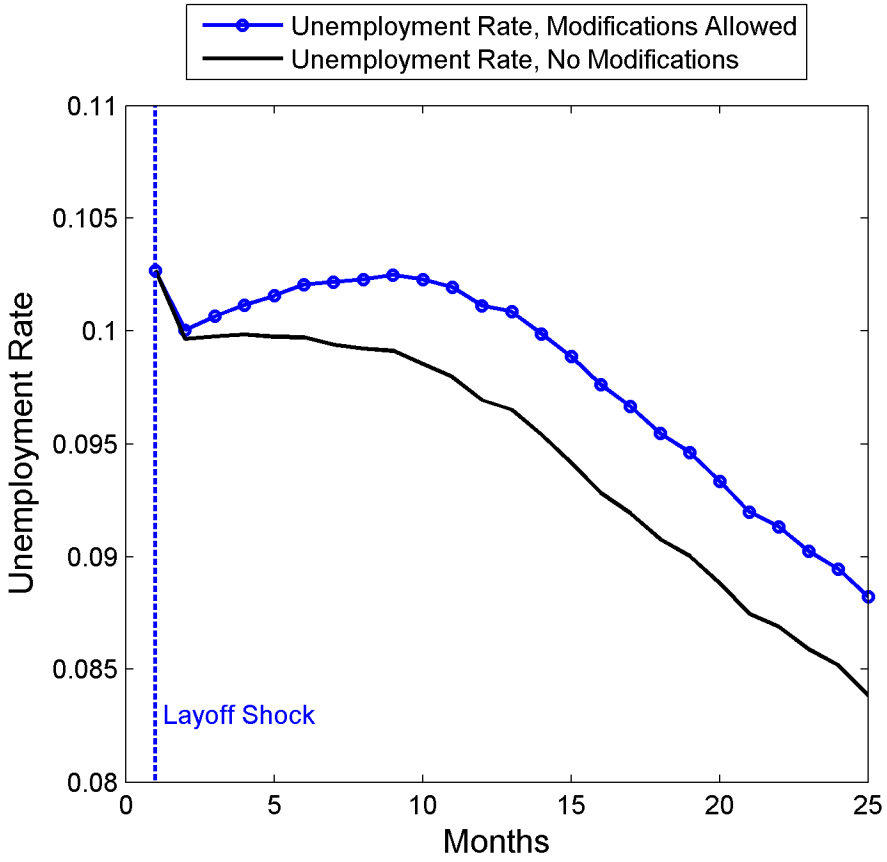

Figure 7: Turbulence Experiment: Employed Skill

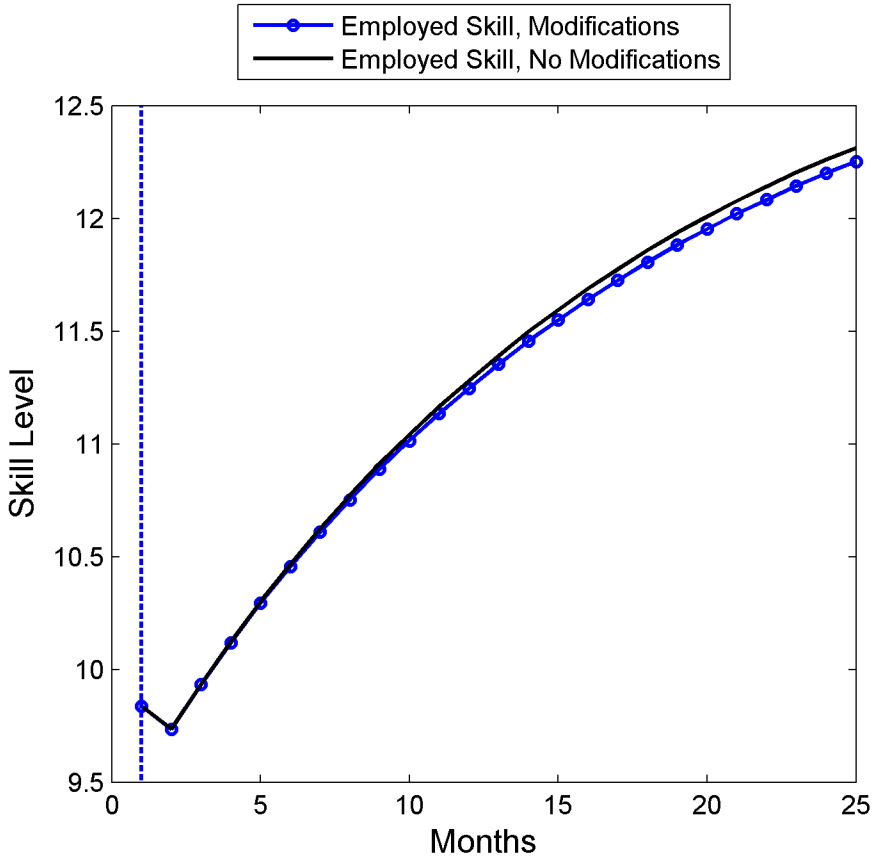

Figure 8: Turbulence Experiment: Percent Modifying

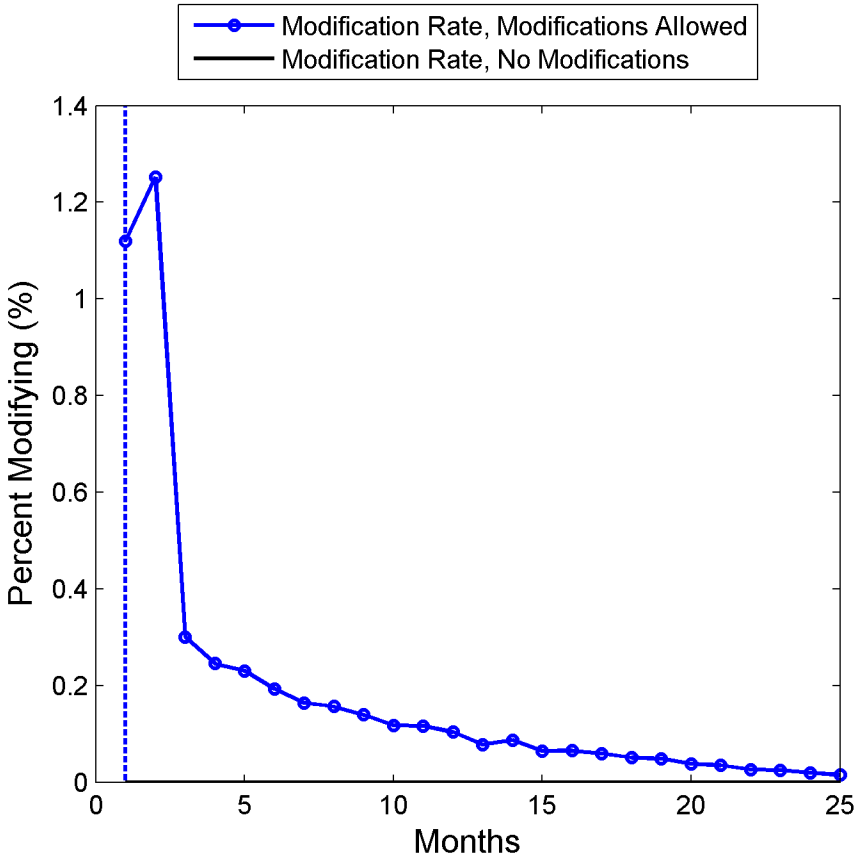

Figure 9: Turbulence Experiment: Fraction Redefaulting