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Redefaults of Modified Loans: Can Principal Reduction Be an Alternative?

구조조정 대출의 채무불이행: 원금삭감이 대안이 될 수 있는가?

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< Abstract >

미국 모기지 대출의 압류율이 2006년에는 1% 정도 이었는데, 세계 금융 위기 발생의 여파로 2010년에는 4.6%로 격증하였다. 이에 대하여 미국 정부는 연체 혹은 리파이낸싱에 곤란을 겉는 주거용 및 상업용 모기지 대출을 정상화하고, 경제에 활력을 불어 넣기 위해, 다양한 노력을 기울여 왔다. 대부분의 정책은 대출 이자를 낮추어 주거나 대출 기간을 늘려 줌으로써 월 원리금 지급액을 줄여 주는 전통적 방식에 연구의 중점을 두고 있다. 그러나 채무 부담 자체를 본질적으로 줄여 주지 않은 채, 임기응변적으로 단기간에 한 해, 원리금 지급액부담을 줄이는 형태의 채무 조정 방식은, 실업이 만연하고, 임금 인상이 정체된 현 상황에 비추어, 커다란 개선 효과를 기대하기 어렵다. 결국 이런 형태로 구조조정된 대출들이 다시 채무불이행 상태로 되돌아가는 퇴행현상에 대한 우려도 비례해서 높아지고 있다. 이 논문은 월 원리금 지급액 삭감이 채무불이행 재발에 어느 정도 효과가 있는지에 대하여 연구한다. 연구의 대상은 1999년에서 2007년 사이에 기채된 30년 만기 고정금리 대출이다. 단기적으로 월 지급액 삭감은 채무불이행 위험을 감소시킨다. 하지만 그 효과는 시간이 지남에 따라 감소한다. 본 연구에 따르면 36 개월 정도 경과하면, 그 효과가 급속히 감소함을 볼 수 있다. 장기적으로는 대출액 대비 자산가치 (주택가격)가 중요한 요인으로 작용하게 된다. 따라서 궁극적으로 채무 불이행을 방지하기 위해서는 원금삭감이 대안이 될 수 있음을 제시한다.

주 제 어 : 채무불이행, 대출 구조조정, 지급액 삭감, 원금삭감
key word : Default, Loan Modification, Payment Reduction, Principal Reduction

I. 서론

The foreclosure rate, which was approximately 1% in 2006, surged to 4.6% at the end of 2010 after the mortgage market crashed in 2007-2008[1]. Foreclosure filings peaked in 2010 up to 2.9 million homes and 1.8 million homes were still facing foreclosure at the end of 2012[2]. Foreclosure entails significant costs to the lender in addition to the principal losses. The

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1) The Mortgage Bankers Association.

2) Year-End 2012 U.S. Foreclosure Market Report™, RealtyTrac LLC.

foreclosure costs are estimated at $44,000-$59,000 per foreclosure (Cutts and Green, 2004 ; Hatcher, 2006) or 30-60% of the remaining loan balance (Capone, 1996). Recently White (2009) reports that the average foreclosure losses on a first-mortgage are $145,000 or about 55% of remaining loan balance. The distressed borrowers negatively impact the local economy as well. or example, the number of foreclosed homes increases the discount in sale price for nearby homes (Schuetz, Been and Ellen 2008). Harding, Rosenblatt and Yao (2009) show that homes were sold at discoun ㄷts up to 1% per nearby foreclosed homes. Rogers and Winter (2009), using Missouri data, also find a result similar to Harding et al. (2009) while the impact of foreclosures on sale price marginally decreases. Using Massachusetts transactions, Campbell, Giglio and Pathak (2011) find a 27% discount in foreclosed sales. They suggest the negative spillover effect that each foreclosure lowers nearby house prices by 1% within in 0.05 miles. Highly levered households also reduce their spending when facing home value loss (Mian, Rao and Sufi, 2011; Dynan, 2012).

The continuing flood of foreclosures gave rise to loan modification programs to prevent the deadweight losses. Most of the loan modification programs have focused on monthly payment reductions. As an example, the Home Affordable Modification Program (HAMP), which was introduced in 2009 by the U.S. government, provides at-risk borrowers with lower monthly payments. The Special Inspector General for the Troubled Asset Relief Program (SIGTARP, 2013) reports that the HAMP has helped about 865,000 troubled borrowers[3]. These programs have been found to be effective in the short-run (Agarwal, Amromin, Ben-David, Chomsisengphet, and Evanoff, 2011a; Quercia and Ding, 2009). However, the SIGTARP warns about the rising redefaults of modified loans in the long horizon reaching more than 306,000 as of 2013. They report an increasing redefault of HAMP loans as they age (up to 46%). According to the report, $ 815 million of taxpayers' money was spent on the redefaulted loans, as of April 30, 2013.

It is necessary to understand why the modified loans redefault more in the long-run. We investigate the effectiveness of the payment reduction in preventing defaults for up to 36 months after the modification. We find that the efficacy of the payment reduction fades as time passes and, in the long-run, the equity level in the house rises and becomes driving factor of defaults. This finding might suggest that we need to provide the principal reduction to prevent the redefault. In the average case (25% reductions), our analysis shows that the principal reduction minimizes the expected losses to the lenders only if the current loan-to-value (LTV) is over 220% when compared to the payment reduction.

The paper proceeds as follows. In the next section, we review the previous research on the loss mitigation efforts in mortgages. The following section introduces the methodology with variables. The data description follows. Then, empirical results are reported. As a further step, we conduct an analysis of expected losses to the lenders in the cases of payment reduction and principal reduction. The robustness check of the research is followed. The last section closes the paper with our concluding remarks.

II. Literature Survey

In an effort to mitigate the lender losses due

3) Rising Redefaults of HAMP Mortgage Modifications Hurt Homeowners, Communities, and Taxpayers (2013).

to foreclosure, defaulted borrowers are provided with alternatives to avoid foreclosure. Ambrose and Capone (1996) simulate the foreclosure alternatives (loss-mitigation programs) including deed-in-lieu of foreclosure, short-sale, loan modification and lender forbearance. They show that loss-mitigation programs save costs for both borrowers and lenders. Ambrose and Capone (2000) show that the redefault hazard of the reinstated loan is significantly different from the first default hazard of previously non-defaulted loans. Ambrose and Buttimer (2000) report the impact of various loss-mitigation programs. They find that the probability of reinstating the mortgage is a function of uncertainty in interest rates and house prices.

With the recent mass of loan modifications, various aspects of loan modification are examined. The first is the cure probability of delinquent loans. In the low- and moderate-income borrowers' mortgage study, Ding, Quercia and Ratcliffe (2010) show that opportune and appropriate proactive counseling leads delinquent borrowers to a higher cure rate. The friction in the modification negotiation caused by securitization is investigated as well. Piskorski, Seru and Vig (2010); Agarwal et al. (2011a, 2011b) find a significantly lower modification rate of securitized loans compared to the non-securitized loans. Agarwal et al. (2011b) also show that the bank-held loans show lower redefault rates than securitized loans after modifications. On the other hand, Adelino, Gerardi and Willen (2009a, 2009b) and Foote, Gerardi, Goette and Willen (2009) find no evidence of friction.

The second area of interest is the efficacy of the payment reductions. Quercia and Ding (2009) find that deeper payment reductions induce lower redefault rates. They also find a payment reduction resulting from a principal reduction is more effective in preventing redefault. In the subprime loan, Haughwout, Okah and Tracy (2009) find results consistent with Quercia and Ding (2009). Agarwal et al. (2011a) show that a greater payment reduction achieves lower redefault probability, while weaker borrowers receive more favorable modification terms. They also find that a 1% payment reduction in payment results in a 4% reduction in redefault probability.

Finally, the equity effect is examined. Foote, Gerardi and Willen (2008) investigate negative equity and default among the Massachusetts homeowners comparing the two periods 1991 and 2007. They conclude that negative equity is a necessary condition for default but not a sufficient condition. Thus, they suggest that, to lessen the default rate, the negative equity problem needs not be directly addressed but forbearance programs which defer full repayment may be a more recommendable strategy for reducing redefault. Cordell, Dynan, Lehnert, Liang and Mauskopf (2009) argue that HAMP is not well suited for unemployed homeowners because they require a great degree of payment reduction to stay current on payments. They also argue that the focus of HAMP only on the payment reduction limits its attractiveness to those borrows with negative equity.

Recently, the principal reduction alternative (PRA) has drawn attention. The U.S. government provides HAMP PRA even if it is not as popular as HAMP payment reductions[4]. Edmans (2010) suggests Responsible Homeowner Reward (RHR) as an incentive to prevent strategic (or "ruthless" in Ambrose and Capone, 1998) defaults. With RHR, the homeowners are rewarded with direct cash contingent upon the loan repayment. This reward has the effect of reducing the principal. Das (2012) studies the

4) For details, see http://www.makinghomeaffordable.gov/programs/lower-payments/Pages/pra.aspx.

optimal loan modification strategies. He argues that the payment reductions result in higher redefault probability if the borrowers experience negative equity, while the principal reductions maximize the value for the lenders. In contrast, Fannie Mae (2012) concludes that the current equity level has only a weak impact on the post-modification performance.

Nevertheless the vast majority of research on the efficacy of home loan modification programs have been limited to relatively short time periods (less than a year after modification) and conducted mostly on payment reductions. Our research focuses on why the modified loans redefault over the long term. Also, we examine the impact of principal reduction in preventing redefaults in the long-run and the economic implication of principal reduction to the lenders. To these ends, post-modification performance is investigated up to 36 months.

III. Methodology and data

1. Methodology

We follow the definitions of "delinquency" as missing payments due and "default" as the termination of the loan by stopping monthly payments without repayment after serious delinquency. Das (2012) emphasizes that an optimal modification must embrace both the borrower's ability-to-pay and willingness-to-pay. A payment reduction improves the borrower's ability-to-pay reducing the default hazard. However, if the borrowers are facing life adverse events, such as job loss, their funding resources will dry up eventually leaving them no option but to give up their home either by sale or default. In such a case, the equity level will become a major factor in their sale or default decision. Also, option theoretic models suggest that the borrowers will strategically default if they are experiencing negative equity which reduces the willingness-to-pay. Thus, even if the borrowers are relieved by a payment reduction initially, they will become vulnerable again to the equity level in their default decision. We expect that a payment reduction will exert a large impact in deterring default for a short period after the modification but the impact will decay in the long-run. On the contrary, the equity level of the home will emerge as the important factor in default decision over the long-run. To investigate these time varying effects, we divide the 36 months study period into three sub-periods: 1-12, 13-24 and 25-36 months after the modification.

Two types of mortgage termination events, default and prepayment, have been modeled as competing risks (Deng, Quigley and Van Order, 2000; Ambrose and LaCour-Little, 2001; Clapp, Deng and An, 2006; Pennington-Cross and Ho, 2010). The nature of the competing risks arises when the subjects face the risk of termination from k different causes. The two types of terminations in the mortgage are default, d and prepayment, p with $k=d, p$. When a mortgage terminates with the default, it precludes the prepayment and vice versa. In such a case, we want to focus on the cumulative failure function of a specific cause, k also known as the cumulative incidence function (CIF). The CIF for a cause k, given a set of covariates x is given by

$$\begin{aligned} CIF_k(t;\mathbf{x}) &= P(T \le t, \varepsilon = k \mid \mathbf{x}) \\ &= \int_0^t \bar{h}_k(s;\mathbf{x}) \exp\left[-\int_0^s \left\{ \bar{h}_d(u;\mathbf{x}) + \bar{h}_p(u;\mathbf{x}) \right\} du \right] ds \end{aligned} \quad (1)$$

where T is the termination time, ε indicates the cause of termination and $\bar{h}_k(.;.)$ is the k th sub-distribution hazard function conditional on

x which is defined as

$$\bar{h}_k(t;\mathbf{x}) = \lim_{\Delta t \to 0} \frac{1}{\Delta t} P\{ t \le T \le t+\Delta t,\ \varepsilon = k \mid T \ge t \cup (T \le t \cap \varepsilon \ne k) \} \quad (2)$$

Fine and Gray (1999) model the CIF for a specific cause k by

$$CIF_k(t;\mathbf{x}) = 1 - \exp\{-\bar{H}_k(t;\mathbf{x})\} \quad (3)$$

where $\overline{H_k}(t;.) = \int_0^t \bar{h}_k(t;.)dt$ is the cumulative sub-hazard.

Here, the cause-specific subhazard function is modeled in a similar fashion to the Cox (1972) proportional hazard model by

$$\bar{h}_k(t;\mathbf{x}) = \bar{h}_{k0}(t)\exp(\mathbf{x}\beta) \quad (4)$$

where β is a regression coefficient vector. In the semiparametric model (3), the baseline subhazard function $\bar{h}_{k0}(t)$ is left unestimated while the effects of the covariates are proportional as in the Cox model. The risk set, R_i, at the time of failure for the individual i is defined as $\{j : (T_j \ge T_i) \sqcup (T_j \le T_i \cap \epsilon_j \ne k)\}$. Then the log partial likelihood function is given by

$$\log[L(\beta)] = \sum_{i=1}^{n} I(\epsilon_i = k) * (X_i^T(T_i)\beta - \log[\sum_{j \in R_i} \exp X_j^T(T_j)\beta]) \quad (5)$$

where $I(\epsilon_i = k)$ is an indicator function which returns one if the loan terminates with cause k and zero otherwise.

The subhazard ratio (SHR) is the ratio of the subhazard function evaluated at two different points,

$$\frac{\bar{h}_k(t;\mathbf{x}_1)}{\bar{h}_k(t;\mathbf{x}_0)} = \frac{\bar{h}_{k0}(t)\exp(\mathbf{x}_1\beta)}{\bar{h}_{k0}(t)\exp(\mathbf{x}_0\beta)} = \exp\big((\mathbf{x}_1 - \mathbf{x}_0)\beta\big) \quad (6)$$

The subhazard ratio can be interpreted as the proportional change in the termination hazard when a covariate moves from x_0 to x_1.

The default subhazard of the loans is modeled conditional on the loans being modified. In this setting, prepayment enters as a competing risk. However, prepayment can happen by refinancing or house selling which are resulted from different motivations. Data used in this paper does not identify the reason for prepayment. Previous studies also suffer from similar data limitation and do not distinguish between refinancing and house selling (Deng, Quigley and Van Order 2000, for example). We also do not distinguish refinancing and house selling. Thus, as a robustness check, we provide analyses using Cox (1972) proportional hazard model without competing risk. In Cox model, survival function is

$$S(t) = 1 - F(t) = \Pr(T > t) \quad (7)$$

where *F(t)* is cumulative distribution function of the failure. The density function of the failure can be derived as

$$f(t) = dF(t)/dt = d\{1-S(t)\}/dt = -S'(t) \quad (8)$$

The hazard function, *h(t)*, is the probability that the default occurs in a given time period conditional on that the mortgage has survived to the beginning of the period.

$$h(t) = f(t)/S(t) \quad (9)$$

The Cox proportional hazard regression model uses the hazard function for the j-th subject in the form of

$$h(t|X_j) = h_0(t)\exp(X_j\beta) \quad (10)$$

where, the base line hazard, $h_0(t)$, is same for every subject. Let t_1<t_2<・・・<t_j<・・・<t_k denote the observed discrete failure times and define the risk set $R(t_j)$ as the set of individuals who are at risk of default just before the j-th ordered failure time t_j. The coefficient vector β can be estimated by minimizing the log partial likelihood function

$$\log[L(\beta)]= \sum_{i=1}^{n} I(\epsilon_i = d)*(X_i^T\beta - \log[\sum_{j\in R(t_i)} \exp X_j^T\beta]) \quad (11)$$

We include two major concern-covariates which affect the default decision. The first is the payment reduction which increases the borrower's ability-to-pay. The payment reduction is defined as the percentage change in monthly payment at the time of the loan modification. The initial monthly payment is calculated using the unpaid principal balance (UPB), interest rate and loan term at the time of origination. The new monthly payment after the modification is calculated using the actual UPB at the time of modification, and the newly applied interest rate and the new loan term. The larger the decrease in the payment, the greater is the borrower's relief.

The second is the current equity level of the home which affects the borrower's willingness-to-pay. As a measure of the equity level, the current loan-to-value ratio (current LTV) is used. Current LTV is the current loan balance divided by the market value of the home. The market value of the home is appreciated by taking the home value at origination multiplied by the metropolitan statistical area (MSA) level home price index since loan origination. As the equity level on the home gets lower, borrowers have a stronger incentive to exercise default as a put option. Thus, a higher current LTV leads to a higher default probability (Alexander, Grimshaw, McQueen and Slade, 2002; Holden, Kelly, McManus, Scharlemann, Singer and Worth, 2012; Rose, 2012).

We also add control-covariates for local market conditions. The change in the local unemployment rate is used to proxy the borrower's financial distress. The change is calculated as the recent 12 month average of monthly change in unemployment rate at the MSA level with a two month lag. We expect more defaults during a high unemployment rate period. However, this is only a noisy proxy because the actual job status of the individual borrower is unknown. An expectation of a future home price rise may motivate a borrower to keep making mortgage payments. As a proxy for the future home price expectation, we add the recent 12 months average of monthly home price index return at the MSA level. Cutts and Merrill (2008) find that the states adopt various foreclosure processes and as the foreclosure process takes longer, a borrower is less likely to reinstate her delinquent loan. The judicial foreclosure procedure may decrease the willingness-to-pay because borrowers can enjoy a longer period of free rent during the judicial foreclosure procedure compared to non-judicial foreclosure.

Finally, we control for the general loan characteristics. As a credit history, the Fair Isaac Corporation (FICO) score bears ability-to-pay information. A high FICO score is expected to result in a lower default rate[5]. However, the FICO, being an origination time credit score, does not reflect the current credit-worthiness of the borrower. Following Haughwout et al. (2009), we add the months current in a year

5) For example, see Pennington-Cross and Ho, 2010 and Rose, 2012.

<Table 1> Covariates definitions

Ability-to-pay	
Payment Reduction (%)	The percentage change in monthly payment at the time of the loan modification. ; 100 * (initial monthly payment - monthly payment after the modification) / initial monthly payment
Willingness-to-pay	
Current LTV (%)	Current loan-to-value ratio (Current LTV) is defined as the current UPB divided by market value of the home. The market value of the home is appreciated as the home value at the time of origination multiplied by the MSA level home price index (HPI) appreciations since origination. ; current B / (home value at the origination * current HPI / HPI at the origination)
Market conditions	
Unemployment Change (%)	The recent 12 months average of monthly change in unemployment rate at the MSA level with two months lag.
HPI Return (%)	The recent 12 months average of monthly HPI return at the MSA level.
Judicial	1 if judicial foreclosure state; 0 otherwise.
General loan characteristics	
FICO	The Fair Isaac Corporation score at origination.
Currents	Months current in a year prior to the modification.
DTI (%)	Debt-to-income ratio at origination. The debt is the sum of the borrower's monthly debt payments including the mortgage payment.
PMI-covered	1 if the loan is covered by private mortgage default insurance; 0 otherwise.
TPO	1 if the loan is originated through third -party originators (brokers or correspondents); 0 if originated through a retail channel.
FTHB	1 if the borrower is first time home buyer; 0 otherwise.
Purchase	1 if the loan purpose is purchase; 0 otherwise.
Co-borrower	1 if the loan has co-borrower(s); 0 otherwise.
New Loan Term	The new loan term in months after the loan modification.
Servicers	Indicators of Big mortgage servicers. The big servicers with a total original unpaid principal balance (UPB) no less than 1% of the total UPB of all loans in the Freddie Mac database for a given calendar quarter are individually identified. Otherwise, the servicers are set to "other" category.
Property Type	Indicators of property type: Single family, condo, leasehold, planned unit development, manufactured housing, or cooperative share.
Multi-units	1 if the property has multiple units; 0 otherwise.

Notes: This table summarizes the covariates. Current LTV, HPI Return and Unemployment Change vary over time.

prior to modification as a measure of current credit. The debt-to-income ratio at origination (initial DTI) is another measure of ability-to-pay. Intuitively, a higher initial DTI increases the default risk. Holden et al. (2012) find the default rate increases with increasing initial DTI. However, they also find that the redefault rates after loan modifications generally decrease with the initial DTI level as the borrower with a higher initial DTI receives a greater deduction in payments. Phillips and VanderHoff (2004) find higher foreclosure probabilities in private mortgage default insurance (PMI) covered loans arguing that because losses are limited in PMI covered loans, lenders allocate the loan modification resources to non-PMI-covered loans. Alexander et al. (2002) study the origination channels and

defaults in the subprime mortgage market. They find that the loans originated by third-party originators (TPO), such as mortgage brokers, show higher default rates than the loans originated through retail channel because of an agency problem. They argue that agency problems arise as the TPOs are rewarded for loan writing and are not responsible for the performance of the loan. Rose (2012) also finds a similar result but is restricted to loans with prepayment penalties. Ambrose and Capone (1998), in their conditional foreclosure probability model, suggest that first time home-buyers (FTHB) are likely to be younger families with less savings and shorter credit histories, thus they are riskier than non-FTHBs. But they also argue that FTHBs may have a greater ability to get out of financial trouble due to fast reemployment. Thus we expect an ambiguous impact of FTHB on defaults.

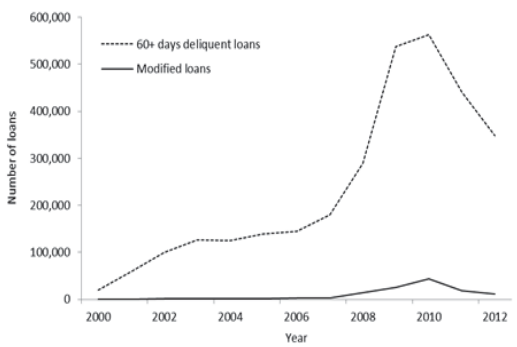
The loan purpose, for purchase, cash-out or refinance, may differently motivate borrowers. We include a dummy for the purchase purpose loan. A co-borrower(s) of a loan may imply more income sources to fund the payments than a single borrower. We expect a co-borrower reduces default risk. Even if a longer new loan term reduces the monthly payment, the borrowers may be discouraged by the fact that they are stuck in the mortgage for a longer period. If that is the case, borrowers with a longer new loan term will default more. We control for mortgage servicers. Stegman, Quercia, Ratcliffe, Ding and Davis (2007) find that the probability of a delinquent loan will ultimately default significantly varies across the servicers. We also control for property characteristics such as property type and number of units in the property. The summary of the covariates is provided in <Table 1>.

2. Data

We use Freddie Mac's Single-Family Loan-Level data set which provides loan origination information and monthly performance. The loans in the data are fully amortized 30-year fixed rate mortgages which originated from February 1999 through December 2011 and were sold to Freddie Mac or issued in Freddie Mac Participation Certificates. The loans are fully documented. The performance data runs to December 2012. Over all, the data contains 16 million loans and over 600 million performance records.

We collect the loans that meet the following conditions: 1) originated before Q2 2007 and 2) entered the modification program between the first quarter of 2009 and the last quarter of 2010. We hypothesize that the modification applicants are different than the non-applicants. Freddie Mac's data, in <Figure 1>, reveals that only 5-8% of the seriously (60+ days) delinquent loans were modified in 2009-2010. We assume that this small portion of applicants is highly motivated not to ruthlessly default. Thus, we limit the data only to modified loans.

<Figure 1> 60+ days delinquent loans and modified loans



Note: This figure displays the number of 60+ days delinquent and modified loans by year.

Possibly, some borrowers would default intentionally to get loan modification. Their motivation to default will be different from those who truly lack the ability to pay. It would be difficult for a borrower to plan an intentional default at the early stage of the program. So, by limiting the data period to initial stage (2009-1010) of HAMP program, we try to rule out this moral hazard problem and subsequent heteroscedasticity according to borrowers' motivation. However, we cannot totally rule out the possibility of moral hazard and it remains as research limitation.

The data contains various loan modification programs. The HAMP lowers the at-risk borrowers' monthly mortgage payments through interest rate reductions down to 2%, extends the loan term up to 480 months or provides principal forbearance. The HAMP targets a reduction in monthly mortgage payments down to 31% of the borrower's total monthly debt payment-to-income ratio[6]. One major difference in the HAMP loan modification compared to the mortgage reinstatement option is that while the reinstatement program simply resumes the delinquent loan payments to be current, the HAMP provides the borrower with a stronger incentive to avoid foreclosure through a significant monthly payment reduction.

In addition to HAMP, Freddie Mac provides alternative options to foreclosure[7]. With the forbearance option, the lender temporarily reduces or suspends the monthly payment up to six months. With a reinstatement program, the lender makes the loan current if the borrower has the funds to repay missed payments and any incurred charges and fees. The repayment plan allows the borrower to make up the missed payments and charges over a period of time together with the regular payments. The Freddie Mac standard loan modification program changes the loan contract by lowering the interest rate and/or increasing the term. This program is similar to HAMP and available for the borrowers who do not qualify for the HAMP. However, the data does not provide the types of the modification applied. We expect a large portion of the modifications are HAMP loans, but our analysis is not limited to HAMP loans. Once a loan is flagged with a modification, the monthly payment reduction after the modification is calculated using the newly applied interest rate and loan term. The initial home value is calculated as UPB at the origination divided by loan-to-value (LTV) at origination.

The loans are terminated with one of the following events: prepayment, 180 days delinquency (D180), third party sales prior to D180, short sales prior to D180, deed-in-lieu of foreclosure prior to D180 and real estate owned (REO) acquisition prior to D180.

It would be proper to model each termination mode as competing risks. However, terminations other than prepayment and default take small portion of terminations (2.24%) as shown in Panel D of Table 2. Thus we consider the termination with D180 as default. Since short sales and REO are alternative ways of default, we treat them as default events in the robustness check.

We limit the data to owner occupied homes and more than $ 50,000 property value at the time of origination[8]. There are 21,514 loans with records that run from January 2009 to December 2012 across the 50 states and the District of Columbia. <Table 2> reports the summary statistics. In panel B, the modified

6) For details, see http://www.makinghomeaffordable.gov/programs/lower-payments/Pages/hamp.aspx.

7) For details, see http://www.freddiemac.com/avoidforeclosure/alternatives_to_foreclosure.html.

8) Other than the owner occupied homes are less than 2%.

<Table 2> Summary Statistics

Panel A: Loan characteristics at the time of origination				
	Mean	Std. Dev.	Min	Max
Original Loan Amount ($)	196,088	84,014	25,000	475,000
Original Interest Rate (%)	6.21	0.52	4.5	10.38
Original Loan Term (months)	360	1.09	309	404
LTV (%)	79.07	11.23	8	100
FICO	682.55	52.7	476	835
DTI (%)	41.3	10.67	1	65
PMI-covered	0.29			
TPO	0.66			
FTHB	0.08			
Purchase	0.33			
Co-borrower	0.52			
Origination Date			Q1. 1999	Q2. 2007
Number of loans	21,514			

Panel B: Loan characteristics at the time of modification				
	Mean	Std. Dev.	Min	Max
Payment Reduction (%)	23.71	16.57	-16.65	72.47
Current LTV (%)	101.92	28.71	3.44	228.85
Currents (months)	6.1	3.46	0	12
Loan Age (months)	52.43	19.48	19	142
Unpaid Principal Balance($)	188,435	81,837	26,773	458,292
New Interest Rate (%)	4.25	1.67	2	9.38
New Loan Term (months)	393	78	182	494
Number of loans	21,514			

Panel C: Time varying variables				
	Mean	Std. Dev.	Min	Max
Current LTV (%)	104.65	30.78	0.18	419.96
Unemployment Change (%)	0	0.14	-0.66	1.2
HPI Return (%)	-0.31	0.55	-3.94	2.04
Number of observations	537,735			

Panel D: Decomposition of termination types (in 36 months)		
Termination Type	N	%
Prepaid	668	3.2
Third Party Sale	29	0.13
Short Sale	217	1.01
Repurchase	113	0.53
Real Estate Owned (REO)	123	0.57
Default (180+Days Delinquency)	6,604	30.7
Not terminated	13,740	63.87
Number of loans	21,514	100

Panel E: Pearson correlation							
	FICO	Currents	DTI	Payment Reduction	Current LTV	Unemp. Change	HPI Return
FICO	1						
Currents	0.27	1					
DTI	0.08	0.09	1				
Payment Reduction	0.16	0.21	0.08	1			
Current LTV	0.11	0.14	0.16	0.11	1		
Unemployment Change	-0.09	0	0	-0.11	0.03	1	
HPI Return	0.04	-0.01	0.01	0.04	-0.21	-0.35	1
New Loan Term	-0.05	-0.02	-0.04	0.39	0.09	0.14	-0.08

Panel F: FMHPI cumulative monthly returns by MSA				
	Mean	Std. Dev.	Min	Max
FMHPI returns (%)	-6.92	9.14	-36.79	24.71

Notes: This table reports the summary statistics. The variables are defined as Table 1. Panel A corresponds to the loan characteristics at the time of origination. Panel B reports the loan characteristics at the time of modification. Panel C reports time varying variables. Panel D decomposes the loan termination events into numbers (N) and proportion (%). Panel E reports the Pearson correlation matrix. Panel F reports cumulative Freddie Mac House Price Index monthly return by MSA during January 2009 to December 2012.

loans have new interest rates down to 2% and new loan terms up to 494 months. As a result, the borrowers receive an average monthly payment reduction of approximately 24%. Some loans show a negative payment reduction indicating that the monthly payment increased after the modification. This is because those loans are simply reinstated. For those loans, the missed payments including the incurred fees due to delinquency are added on top of the UPB leaving the interest rate and loan term unchanged. Possibly these borrowers were offered payment schedule options for the missed payments but we implement the additional financial burden by simply assuming that the borrowers pay the additional cost in the form of increased monthly payments. Panel D shows that 31% of the loans ultimately default after the modifications.

For home prices, the Freddie Mac House Price Index (FMHPI) is used at the MSA level[9]. Unemployment rate data is from the U.S. Bureau of Labor Statistics also at the MSA leve l[10]. Rao and Walsh (2009) provide a comprehensive survey of foreclosure laws across the states. Following their results, 30 states and the District of Columbia are coded as non-judicial foreclosure states[11].

Ⅳ. Empirical Analysis

1. Estimation Results

As a preliminary step, we analyze the full 36-month study period. <Table 3> reports the competing risk regression estimates for the

9) http://www.freddiemac.com/finance/fmhpi/

10) http://www.bls.gov/

11) Non-judicial foreclosure states include Alabama, Montana, Alaska, Nebraska, Arkansas, Nevada, Arizona, New Hampshire, California, New Mexico, District of Columbia, Oklahoma, Georgia, Oregon, Hawaii, Rhode Island, Idaho, South Dakota, Maryland, Tennessee, Massachusetts, Texas, Michigan, Utah, Minnesota, Virginia, Mississippi, Washington, Missouri, West Virginia and Wyoming.

<Table 3> Competing risk regression for default subhazard (36-month study period)

Variables	Coefficient	Sub-Hazard Ratio (SHR)	z-statistic
Payment Reduction	-0.049***	0.952	-47.17
Current LTV	0.008***	1.008	18.67
Unemployment Change	1.097***	2.995	11.17
HPI Return	0.114***	1.121	4.94
Judicial	0.151***	1.163	5.59
FICO	-0.001***	0.999	-2.28
Currents	0.002	1.002	0.54
DTI	0.004***	1.004	2.79
PMI-covered	-0.024	0.977	-0.81
TPO	0.099***	1.104	3.49
FTHB	-0.006	0.994	-0.13
Purchase	-0.02	0.981	-0.62
Co-borrower	-0.162***	0.85	-6.26
New Loan Term	0.004***	1.004	19.91
Controls (Servicer, Property Type, Multi-units)		Please, see below table.	

Subjects	21,514
Failure	6,604
Competing	688
Observations	537,735
Pseudo-likelihood	-61,704
Significance code: *P<10%;**P<5%;and***P<1%.	

Competing risk regression for default subhazard (Controls only)

Variables	Coefficient	Sub-Hazard Ratio (SHR)	z-statistic
Multi-units	0.258	1.295	1.12
Property Type: Condo	-0.003	0.997	-0.04
Leasehold	-0.399	0.671	-0.54
Manufactured Housing	-0.032	0.969	-0.28
Planned Unit	0.050	1.051	1.48
Servicers: BACHOMELOANSERVICING	1.770***	5.870	22.10
BANKOFAMERICA,NA	1.148***	3.151	28.06
BRANCHBANKING&TRUSTC	0.564***	1.757	5.03
CHASEHOMEFINANCELLC	2.303***	10.000	11.50
CITIMORTGAGE,INC	-0.062	0.940	-1.37
FIFTHTHIRDBANK	0.031	1.031	0.30
FLAGSTARCAPITALMARKE	0.388	1.474	1.36
GMACMORTGAGE,LLC	-0.055	0.946	-0.92
JPMORGANCHASEBANK,NA	0.702***	2.017	14.45
NATIONSTARMORTGAGE,L	0.742***	2.101	4.37
OCWENLOANSERVICING,L	0.788***	2.198	2.61
Other servicers	0.527***	1.694	12.39

Variables	Coefficient	Sub-Hazard Ratio (SHR)	z-statistic
PNCBANK, NATL	0.992***	2.698	11.12
PNCMTGESERVICES, INC	1.374***	3.950	7.86
PROVIDENTFUNDINGASSO	-0.146	0.864	-0.88
SUNTRUSTMORTGAGE, INC	1.511***	4.532	9.46
TAYLOR, BEAN & WHITAKER	-0.149	0.862	-0.27
USBANKNA	1.324***	3.759	23.39

Notes: This table reports the competing risk regression for the default subhazard function <equation (4)>. Covariates are defined as <Table 1>. The model estimates the default subhazard of the loan after the modification using Freddie Mac's single-family 30-year fixed rate mortgages originated in 1999-2007 and modified in 2009-2010. The loan performance data runs from 2009 to 2012. The subhazard ratio is the exponent of the coefficient and indicates proportional hazard rate change with one unit change in the corresponding covariate. The covariates in Controls indicate that we control the covariates and report the coefficients in separate section.

<Table 4> Average loan characteristics at the beginning of each period

Three Sub-Periods	1-12 months	13-24 months	25-36 months
Payment Reduction (%)	23.71	26.06	27.16
New Interest Rate (%)	4.25	3.99	3.87
New Loan Term (months)	393	392	392
Current LTV (%)	101.92	106.64	104.55
Number of loans	21,514	17,282	14,076

default sub-hazard. The payment reduction reduces the default hazard. The hazard ratio of 0.952 implies that a 1% payment reduction reduces the default hazard by 5%. For the average payment reduction of 25%, the hazard is reduced by 63% relative to the loans without any payment reduction[12]. It is worth noting that this does not mean that the absolute default probability is reduced to 37% but means that the default probability of the loans with a 25% payment reduction is 70% less than the probability of default among loans without payment reductions. A high current LTV appears to reduce the willingness-to-pay. A 1% increase in the current LTV induces a 0.8% higher default hazard. An increase in the unemployment rate also raises the default hazard. Rather counter-intuitively, borrowers default regardless of rising home prices (HPI Return). However, this is an overall result for the full 36 months period and the sub-periods test. If a state requires the judicial foreclosure process, borrowers are 16% more likely to default. Borrowers with higher initial FICO scores suffer less default. A proxy for the current credit-worthiness (Currents) is not significant, however.A higher initial DTI leads to higher default rates. In line with Alexander et al. (2002), third-party originated (TPO) loans default more often. First time home-buyers do not default more or less often than non-FTHB. Loan purpose (purchase) does not affect the default rate. Loans with co-borrower(s) default less by 15% supporting our expectation that they have more funding sources compared to single borrowers. Finally, the loans which receive a longer new loan term default more.

Next we analyze the sub-periods. <Table 4>

12) 1-exp(-0.049*25).

shows the average loan characteristics at the beginning of each period. Over the periods, the loans with larger payment reductions survive. The regression results for each sub-period are in <Table 5>. The payment reduction loses its efficacy in preventing default as time passes. At the initial period (1-12 months), a 1% payment reduction reduces the default hazard rate by 6% compared to the no payment reduction. However, the efficacy reduces to 3.3% in the second period (13-24 months) and finally 2.3% in the last period (25-36 months). Also, the significance (z-statistics) of the payment reduction decreases over the periods. In contrast, current LTV strengthens its influence in the default decision over the periods. A 1% increase in current LTV impacts the default hazard by 0.5% higher rate during the first period. In the second period, the impact increases to 1.0% and reaches to 1.3% in the third period.

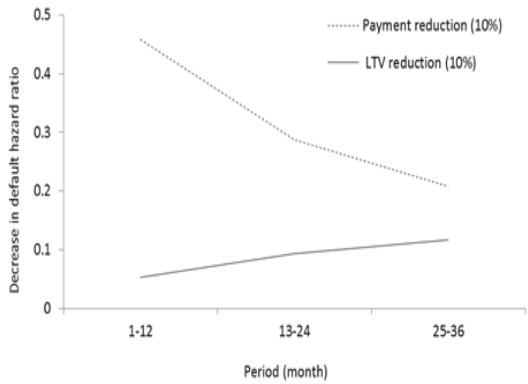
As the degree of payment reduction is a major factor in default decision immediately after the modification, borrowers tend to default regardless of the rising home price during the first period. However, in the second and third period, the borrowers default less as home price rises.

<Figure 2> shows the impact of payment reductions and LTV reductions on the default hazard ratio over the periods. With coefficient β and a $\triangle x$ change in the covariate,

$$\text{Decrease in default hazard ratio} = 1-\exp(\beta' \triangle x) \quad (12)$$

A greater decrease in default hazard ratio means a greater impact of a covariate. We see the decaying efficacy of a payment reduction while the current LTV becomes more powerful over time. The results suggest that in the beginning, borrowers are relieved by the payment reduction and their default decisions are mainly influenced by their ability-to-pay. However, as time passes, the influence of the ability-to-pay decays. Instead, borrowers become more swayed by their willingness- to-pay (current equity level).

<Figure 2> Decrease in the default hazard ratio: Payment reduction(10%) vs. LTV reduction(20%)



Note: This figure displays the impacts of payment reduction and LTV reduction on decrease in the default hazard ratio, over the periods. For both payment and LTV, 10% reductions are assumed. With a coefficient and a change in the covariate, the decrease in default hazard ratio is calculated.

One may concern that probability of default will obviously decrease over time because the borrower pays off principal every month such that current loan balance gets smaller. However default option value is determined by current home value as well as current loan balance. As shown in <Table 2>, the modified loan terms were reset to 393 months on average. If we apply average modified interest rate of 4.25%, the borrowers pay out around 4.4% principal during the first three years after loan modification. However, during our study period, house prices decline by 6.29% on average as well, as shown in Panel F in <Table 2>. As a result, default option value (current LTV) does not necessarily decrease. Table 4 shows that average current LTV moves from 102% to 107%

<Table 5> Competing risk regression for default subhazard (sub-periods)

Three Sub-period	(1) 1-12months			(2) 13-24months			(3) 25-36months		
Variables	Coefficient	SHR	z-stat.	Coefficient	SHR	z-stat.	Coefficient	SHR	z-stat.
Payment Reduction	-0.061***	0.941	-42.13	-0.034***	0.967	-20.17	-0.023***	0.977	-9.16
Current LTV	0.005***	1.005	9.29	0.01***	1.01	13.46	0.012***	1.013	10.23
Unemployment Change	1.044***	2.842	9.51	2.819***	16.761	10.2	-1.775**	0.17	-2.31
HPI Return	0.118***	1.125	3.85	-0.116*	0.891	-1.88	-0.408***	0.665	-4.95
Judicial	0.091***	1.095	2.6	0.249***	1.283	5.14	0.201***	1.223	2.66
FICO	0.001**	1.001	2.02	-0.003***	0.997	-5.72	-0.001	0.999	-1.29
Currents	0.007	1.007	1.54	-0.016**	0.984	-2.33	-0.022**	0.978	-2.02
DTI	0.005***	1.005	3.12	0.000	1.000	-0.12	-0.001	0.999	-0.18
PMI-covered	-0.081	0.922	-2.1	0.044	1.045	0.84	0.09	1.094	1.15
TPO	0.119**	1.126	3.29	0.044	1.045	0.86	0.143*	1.154	1.8
FTHB	0.029	1.029	0.43	-0.028	0.972	-0.32	-0.116	0.89	-0.81
Purchase	0.009	1.009	0.23	-0.012	0.988	-0.21	-0.054	0.947	-0.62
Co-borrower	-0.131***	0.877	-3.97	-0.18***	0.835	-3.85	-0.17**	0.843	-2.35
New Loan Term	0.004***	1.004	17.62	0.003***	1.003	8.32	0.002***	1.002	2.91
Control (Servicer, Property type, Number units)	Please, see below table.								
Subjects	21,514			17,282			14,076		
Failure	3,899			1,901			804		
Competing	127			283			278		
Observations	230,928			193,271			113,536		
Pseudo-likelihood	-35,938			-17,840			-7,216		

Significance code: *P<10%;**P<5%;and***P<1%.

Competing risk regression for default subhazard (Controls only)

Variables	Coefficient	SHR	z-stat	Coefficient	SHR	z-stat	Coefficient	SHR	z-stat
Multi-units	0.272	1.313	0.99	-0.461	0.631	-0.66	0.924*	2.52	1.66
Property Type:									
Condo	0.021	1.021	0.2	0.074	1.077	0.55	-0.476	0.621	-1.78
Leasehold	0.256	1.291	0.4	-14.16***	0	-36.46	-15.37***	0	-34.03
Manufactured Housing	-0.012	0.988	-0.09	-0.132	0.876	-0.63	-0.082	0.922	-0.26
Planned Unit	0.058	1.06	1.36	0.054	1.055	0.9	0.002	1.002	0.02
Servicers:									
BACHOMELOANSERVICING	2.036***	7.66	20.25	2.026***	7.583	13.02	2.544***	12.733	2.86
BANKOFAMERICA,NA	1.645***	5.181	32.25	0.33***	1.391	3.73	0.302**	1.353	2.3

Variables	Coefficient	SHR	z-stat	Coefficient	SHR	z-stat	Coefficient	SHR	z-stat
BRANCHBANKING&TRUSTC	1.117***	3.054	8.26	-0.088	0.916	-0.4	-0.229	0.796	-0.69
CHASEHOMEFINANCELLC	2.482***	11.965	9.39	2.815***	16.68	6.32	-	-	-
CITIMORTGAGE,INC	-0.31***	0.733	-3.96	0.062	1.064	0.88	0.048	1.049	0.45
FIFTHTHIRDBANK	0.29*	1.336	1.94	-0.102	0.903	-0.56	-0.193	0.825	-0.78
FLAGSTARCAPITALMARKE	0.677*	1.968	1.68	0.41	1.507	0.88	-0.747	0.474	-0.8
GMACMORTGAGE,LLC	-0.131	0.877	-1.33	-0.07	0.932	-0.73	-0.05	0.951	-0.37
JPMORGANCHASEBANK,NA	0.922***	2.514	13.17	0.517***	1.676	6.65	0.356***	1.428	2.64
NATIONSTARMORTGAGE,L	1.451***	4.265	8.86	-0.54	0.583	-1.18	-0.83	0.436	-1.2
OCWENLOANSERVICING,L	1.386***	4.000	5.37	-0.152	0.859	-0.21	-15.79***	0.000	-43.2
Other servicers	1.128***	3.089	21.04	-0.301***	0.74	-3.5	-0.45***	0.636	-3.37
PNCBANK,NATL	1.584***	4.875	16.87	-0.187	0.829	-0.79	-0.061	0.941	-0.19
PNCMTGESERVICES,INC	1.634***	5.122	8.16	1.215***	3.371	3.68	1.543***	4.679	2.84
PROVIDENTFUNDINGASSO	-0.232	0.793	-0.82	-0.142	0.867	-0.54	0.067	1.069	0.2
SUNTRUSTMORTGAGE,INC	2.028***	7.599	15.25	0.591	1.805	1.11	-15.70***	0.000	-51.34
TAYLOR,BEAN&WHITAKER	0.633	1.883	1.000	-0.852	0.427	-0.83	-16.17***	0.000	-42.76
USBANKNA	2.007***	7.443	32.21	-0.059	0.943	-0.4	-0.498**	0.608	-2.01

Notes: This table reports the competing risk regression for the default sub-hazard function, <equation (4)>. Covariates are defined as <Table 1>. The default decision is assumed to be made at the first month of the series of delinquency, 1 to 6 months. The model estimates the default subhazard of the loan after the modification using Freddie Mac's single-family 30-year fixed rate mortgages originated in 1999-2007 and modified in 2009-2010. The loan performance data runs from 2009 to 2012. The subhazard ratio is the exponent of the coefficient and indicates proportional hazard rate change with one unit change in the corresponding covariate. The covariates in Controls indicate that we control the covariates and report the coefficients in separate section.

and to 105% during our study sub-periods. Thus, we exclude possibility that our findings simply come from principal pay-off over time.

2. Robustness Check

As a robustness check, we apply Cox (1972) proportional regression model, without competing risks, for sub-periods. Estimates are reported in <Table 6>. The results are almost identical to Fine and Gray (1999) competing risk model. In <Table 7>, we include short-sale and REO as default event and apply Cox proportional model. The results remain very similar to other model settings.

<Table 6> Cox default hazard (sub-periods).

Three Sub-period	(1) 1-12months			(2) 13-24months			(3) 25-36months		
Variables	Coefficient	HR	z-stat.	Coefficient	HR	z-stat.	Coefficient	HR	z-stat.
Payment Reduction	-0.061***	0.941	-43.6	-0.034***	0.966	-19.51	-0.024***	0.976	-8.97
Current LTV	0.005***	1.005	9.19	0.01***	1.01	12.73	0.012***	1.012	10.06
Unemployment Change	1.054***	2.868	9.45	2.843***	17.172	10.14	-1.731**	0.177	-2.18
HPI Return	0.118***	1.126	3.87	-0.114*	0.892	-1.88	-0.397***	0.672	-4.75
Judicial	0.09***	1.094	2.59	0.251***	1.285	5.17	0.203***	1.225	2.7
FICO	0.001**	1.001	2.08	-0.003***	0.997	-5.28	-0.001	0.999	-1.21
Currents	0.007	1.007	1.51	-0.016***	0.984	-2.2	-0.022*	0.978	-1.95
DTI	0.005***	1.005	3.19	0.000	1	-0.14	-0.001	0.999	-0.17
PMI-covered	-0.08**	0.923	-2.1	0.04	1.041	0.76	0.089	1.093	1.11
TPO	0.118***	1.125	3.32	0.042	1.043	0.82	0.143*	1.154	1.79
FTHB	0.03	1.031	0.46	-0.035	0.965	-0.39	-0.118	0.888	-0.82
Purchase	0.01	1.01	0.26	-0.005	0.996	-0.08	-0.051	0.95	-0.57
Co-borrower	-0.13***	0.878	-3.98	-0.176***	0.839	-3.74	-0.164**	0.849	-2.27
New Loan Term	0.004***	1.004	17.51	0.003***	1.003	8.28	0.002***	1.002	2.87
Control (Servicer, Property type, Number units)	Please, see below table.								
Subjects	21,514			17,282			14,076		
Failure	3,899			1,901			804		
Observations	230,928			193,271			113,536		
Pseudo-likelihood	-35,929			-17,820			-7,205		

Significance code: *P<10%;**P<5%;and***P<1%.

Cox default subhazard (Controls only)

Variables	Coefficient	Hazard Ratio (HR)	z-stat	Coefficient	Hazard Ratio (HR)	z-stat	Coefficient	Hazard Ratio (HR)	z-stat
Multi-units	0.268	1.308	0.96	-0.437	0.646	-0.62	0.916	2.5	1.58
Property Type:									
Condo	0.02	1.021	0.2	0.071	1.073	0.51	-0.479*	0.619	-1.76
Leasehold	0.251	1.285	0.35	-	-	-	-	-	-
Manufactured Housing	-0.015	0.985	-0.11	-0.135	0.873	-0.62	-0.09	0.914	-0.28
Planned Unit	0.057	1.059	1.36	0.057	1.058	0.93	0.002	1.002	0.03
Servicers:									
BACHOMELOANSERVICING	2.042***	7.702	21.34	2.09***	8.086	12.54	3.234***	25.372	3.21
BANKOFAMERICA,NA	1.642***	5.163	31.29	0.33***	1.391	3.74	0.305**	1.356	2.29
BRANCHBANKING&TRUSTC	1.12***	3.066	8.24	-0.096	0.909	-0.44	-0.224	0.799	-0.69

Variables	Coefficient	Hazard Ratio (HR)	z-stat	Coefficient	Hazard Ratio (HR)	z-stat	Coefficient	Hazard Ratio (HR)	z-stat
CHASEHOME FINANCELLC	2.483***	11.978	8.13	2.824***	16.845	5.56	-	-	-
CITIMORTGAGE,INC	-0.31***	0.733	-3.86	0.063	1.065	0.87	0.065	1.067	0.61
FIFTHTHIRD BANK	0.294**	1.342	1.96	-0.104	0.901	-0.57	-0.191	0.826	-0.75
FLAGSTARCAPITALMARKE	0.674	1.962	1.64	0.411	1.508	0.91	-0.741	0.477	-0.74
GMACMORTGAGE,LLC	-0.135	0.874	-1.34	-0.068	0.934	-0.7	-0.048	0.953	-0.35
JPMORGANCHASEBANK,NA	0.918***	2.504	13.39	0.53***	1.698	6.68	0.376***	1.457	2.81
NATIONSTARMORTGAGE,L	1.447***	4.249	8.33	-0.541	0.582	-1.2	-0.832	0.435	-1.17
OCWENLOANSERVICING,L	1.383***	3.985	5.11	-0.156	0.856	-0.22	-	-	-
Other servicers	1.125***	3.08	20.99	-0.30***	0.739	-3.48	-0.45***	0.636	-3.37
PNCBANK, NATL	1.579***	4.852	16.45	-0.197	0.821	-0.82	-0.067	0.935	-0.21
PNCMTGESERVICES,INC	1.631***	5.11	8.29	1.425***	4.158	3.99	2.05***	7.767	2.88
PROVIDENTFUNDINGASSO	-0.231	0.794	-0.82	-0.142	0.867	-0.52	0.066	1.069	0.19
SUNTRUSTMORTGAGE,INC	2.046***	7.733	12.64	0.59	1.804	1.17	-	-	-
TAYLOR,BEAN &WHITAKER	0.628	1.874	1.08	-0.854	0.426	-0.85	-	-	-
USBANKNA	2.004***	7.417	33.62	-0.049	0.952	-0.33	-0.484*	0.616	-1.93

Notes: This table reports the Cox proportional hazard regression for the default hazard function. D180 is considered as default. HR column reports sub-hazard rate. Covariates are defined as Table 1. Reference Property Type is single family home and reference Servicer is WELLSFARGOBANK,NA. The model estimates the default hazard of the loan after the modification using Freddie Mac's single-family 30-year fixed rate mortgages originated in 1999-2007 and modified in 2009-2010. The loan performance data runs from 2009 to 2012. The hazard ratio is the exponent of the coefficient and indicates proportional hazard rate change with one unit change in the corresponding covariate. The covariates in Controls indicate that we control the covariates and report the coefficients in separate section.

<Table 7> Cox default (D180, Short-sales, and REO) hazard (sub-periods).

Three Sub-period	(1) 1-12months			(2) 13-24months			(3) 25-36months		
Variables	Coefficient	HR	z-stat.	Coefficient	HR	z-stat.	Coefficient	HR	z-stat.
Payment Reduction	-0.06***	0.941	-44.3	-0.03***	0.967	-20.1	-0.02***	0.975	-9.89
Current LTV	0.005***	1.005	9.32	0.01***	1.01	13.74	0.013***	1.013	11.31
Unemployment Change	1.007***	2.736	9.15	2.524***	12.48	9.26	-1.502*	0.223	-1.95
HPI Return	0.112***	1.119	3.71	-0.059	0.943	-1.01	-0.24***	0.781	-3.24
Judicial	0.062*	1.064	1.8	0.179***	1.196	3.79	0.126*	1.135	1.74
FICO	0.001**	1.001	2.49	-0.002***	0.998	-4.72	0.00	1.00	-0.47
Currents	0.009*	1.009	1.94	-0.014*	0.986	-1.94	-0.017	0.983	-1.56
DTI	0.005***	1.005	2.99	-0.001	0.999	-0.36	-0.001	0.999	-0.28
PMI-covered	-0.079**	0.924	-2.1	0.046	1.047	0.92	0.092	1.096	1.2
TPO	0.125***	1.133	3.56	0.045	1.046	0.92	0.132*	1.141	1.72
FTHB	0.064	1.066	0.99	0.027	1.027	0.32	-0.078	0.925	-0.58
Purchase	0.017	1.017	0.43	0.017	1.017	0.3	-0.035	0.965	-0.41
Co-borrower	-0.12***	0.879	-4.01	-0.18***	0.834	-4	-0.129*	0.879	-1.86
New Loan Term	0.004***	1.004	17.89	0.003***	1.003	8.54	0.002***	1.002	3.02
Control (Servicer, Property type, Number units)	Please, see below table.								
Subjects	21,514			17,282			14,076		
Failure	4,016			2,045			883		
Observations	230,928			193,271			113,536		
Pseudo-likelihood	-37,103			-19,202			-7,924		

Significance code: *P<10%;**P<5%;and***P<1%.

Cox default (D180, Short-sales and REO) subhazard (Controls only)

Variables	Coefficient	HR	z-stat	Coefficient	HR	z-stat	Coefficient	HR	z-stat
Multi-units	0.251	1.285	0.9	-0.117	0.89	-0.2	0.835	2.305	1.44
Property Type:									
Condo	0.03	1.031	0.3	0.057	1.059	0.43	-0.264	0.768	-1.12
Leasehold	0.219	1.245	0.31	-	-	-	-	-	-
Manufactured Housing	-0.031	0.97	-0.23	-0.164	0.849	-0.77	-0.079	0.924	-0.26
Planned Unit	0.059	1.061	1.42	0.1*	1.105	1.73	0.045	1.046	0.5
Servicers:									
BACHOMELOAN SERVICING	1.994***	7.343	21.15	2.147***	8.557	13.45	3.251***	25.828	3.23
BANKOFAMERICA,NA	1.576***	4.836	30.6	0.309***	1.362	3.57	0.306**	1.357	2.38
BRANCHBANKING&TRUSTC	1.078***	2.938	8.01	-0.002	0.998	-0.01	-0.248	0.78	-0.77
CHASEHOMEFINANCELLC	2.505***	12.238	8.56	3.205***	24.646	7.67	-	-	-

Variables	Coefficient	HR	z-stat	Coefficient	HR	z-stat	Coefficient	HR	z-stat
CITIMORTGAGE, INC	-0.28***	0.754	-3.67	0.08	1.083	1.15	0.062	1.064	0.6
FIFTHTHIRDBANK	0.295**	1.344	2.03	-0.082	0.921	-0.47	-0.152	0.859	-0.61
FLAGSTARCAPITALMARKE	0.6	1.823	1.46	0.528	1.695	1.28	-0.829	0.437	-0.83
GMACMORTGAGE,LLC	-0.087	0.917	-0.91	0.024	1.024	0.26	0.05	1.051	0.4
JPMORGANCHASEBANK,NA	0.876***	2.401	13.01	0.524***	1.689	6.76	0.387***	1.472	2.98
NATIONSTARMORTGAGE,L	1.373***	3.949	7.92	-0.608	0.544	-1.35	-0.895	0.408	-1.26
OCWENLOANSERVICING,L	1.309***	3.703	4.84	-0.209	0.811	-0.29	-	-	-
Other servicers	1.072***	2.922	20.41	-0.24***	0.781	-2.99	-0.41***	0.661	-3.23
PNCBANK,NATL	1.514***	4.546	15.86	-0.248	0.781	-1.04	-0.143	0.867	-0.44
PNCMTGESERVICES,INC	1.567***	4.791	7.97	1.611***	5.008	5.04	1.965***	7.138	2.76
PROVIDENTFUNDINGASSO	-0.104	0.901	-0.41	0.07	1.072	0.3	0.504*	1.656	1.94
SUNTRUSTMORTGAGE,INC	1.993***	7.337	12.34	0.574	1.774	1.14	-	-	-
TAYLOR,BEAN&WHITAKER	0.564	1.758	0.97	-0.889	0.411	-0.89	-	-	-
USBANKNA	1.94***	6.955	33.03	-0.059	0.943	-0.41	-0.517**	0.596	-2.13

Notes: This table reports the Cox proportional regression for the default hazard function. D180 is considered as default. HR column reports sub-hazard rate. Default includes D180, short-sale and REO. Covariates are defined as Table 1. Reference Property Type is single family home and reference Servicer is WELLSFARGOBANK,NA. The model estimates the default hazard of the loan after the modification using Freddie Mac's single-family 30-year fixed rate mortgages originated in 1999-2007 and modified in 2009-2010. The loan performance data runs from 2009 to 2012. The hazard ratio is the exponent of the coefficient and indicates proportional hazard rate change with one unit change in the corresponding covariate. The covariates in Controls indicate that we control the covariates and report the coefficients in separate section.

Ⅴ. Conclusion

After the mortgage market crash, preventing mortgage foreclosures became a serious issue among investors and policy makers. Foreclosure incurs costs to the investors of about 30-60% of remaining loan balance and negatively impacts the economy. At-risk borrowers were able to modify their loans to reduce the monthly payments. However, there are concerns about the rising redefaults of the modified loans. We investigate what drives the redefaults. In the short-run, the borrowers are relieved by payment reduction. But we find that the efficacy of payment reduction decays rapidly during the 36 months following the loan modification. In contrast, the current equity level becomes more important in the default decision in the long-run.

Even if the equity level becomes important factor in default decision, whether it maximizes the lenders' wealth is another question. Our case analysis shows that the principal reduction minimizes the expected losses to the lenders only when the current LTV is high (over 220% on average). Otherwise, the payment reduction is a better option to the lenders.

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References

1. Adelino, Manuel, Gerardi, Kristopher and Willen, Paul S., Renegotiating Home Mortgages: Evidence from the Subprime Crisis. Federal Reserve Bank of Boston, Working Paper, 2009a
2. Adelino, Manuel, Gerardi, Kristopher and Willen, Paul S., Why Don't Lenders Renegotiate More Home Mortgages? Redefaults, Self-Cures, and Securitization. Federal Reserve Bank of Boston, Public Policy Discussion Papers No. 09-4, 2009b
3. Agarwal, S., Amromin, G., Ben-David, I., Chomsisengphet, S., and Evanoff, D. D., Market-Based Loss Mitigation Practices for Troubled Mortgages Following the Financial Crisis, Federal Reserve Bank of Chicago, Working Paper WP 2011-03, 2011a
4. Agarwal, S., Amromin, G., Ben-David, I., Chomsisengphet, S., and Evanoff, D. D., "The Role of Securitization in Mortgage Renegotiation," *Journal of Financial Economics*, Vol. 102, 2011b, pp. 559-578
5. Alexander, William P., Grimshaw, Scott D., McQueen, Grant R. and Slade, Barrett A., "Some Loans Are More Equal than Others: Third-Party Originations and Defaults in the Subprime Mortgage Industry," *Real Estate Economics*, Vol. 30, 2002, pp. 667-697
6. Ambrose, Brent W. and Buttimer Richard J., "Embedded Options in the Mortgage Contract," *Journal of Real Estate Finance and Economics*, Vol. 21, 2000, pp. 95-111
7. Ambrose, Brent W. and Capone, Charles A., "Cost-Benefit Analysis of Single-Family Foreclosure Alternatives," *Journal of Real Estate Finance and Economics*, Vol. 13, 1996, pp. 105-120
8. Ambrose, Brent W. and Capone, Charles A., "Modeling the Conditional Probability of Foreclosure in the Context of Single-Family Mortgage Default Resolutions," *Real Estate Economics*, Vol. 26, 1998, pp. 391-429.
9. Ambrose, Brent W. and Capone, Charles A., "The Hazard Rates of First and Second Defaults," *Journal of Real Estate Finance and Economics*, Vol. 20, 2000, pp. 275-293
10. Ambrose, Brent W. and LaCour-Little, Michael, "Prepayment Risk in Adjustable Rate Mortgages Subject to Initial Year Discounts: Some New Evidence," *Real Estate Economics,* Vol. 29, 2001, pp. 305-327
11. Campbell, John Y., Giglio, Stefano and Pathak, Parag, "Forced Sales and House Prices," *American Economic Review*, Vol. 101, 2011, pp. 2108-2131.
12. Capone, Jr., Charles A., Providing Alternatives to Mortgage Foreclosure: A Report to Congress, 1996,

(http://www.huduser.org/Publications/pdf/alt.pdf)
13. Clapp, John M., Deng, Yongheng, and An, Xudong, "Unobserved Heterogeneity in Models of Competing Mortgage Termination Risks," *Real Estate Economics*, Vol. 34, 2006, pp. 243-273
14. Cordell, Larry, Dynan, Karen, Lehnert, Andreas, Liang, Nellie, and Mauskopf, Eileen, Designing Loan Modifications to Address the Mortgage Crisis and the Making Home Affordable Program. Finance and Economics Discussion Series, Divisions of Research & Statistics and Monetary Affairs Federal Reserve Board, Washington, D.C., 2009
15. Cox, D. R., "Regression Models and Life-Tables with discussion," *Journal of the Royal Statistical Society*, B Vol. 30, 1972, pp. 248-275
16. Cutts, Amy Crews and Green, Richard K., Innovative Servicing Technology: Smart Enough to Keep People in Their Houses? Freddie Mac Working Paper, # 04-03, 2004
17. Cutts, Amy Crews and Merrill, William A., Interventions in Mortgage Default: Policies and Practices to Prevent Home Loss and Lower Costs. Freddie Mac Working Paper, # 08-01, 2008
18. Das, Sanjiv R., "The Principal Principle," *Journal of Financial and Quantitative Analysis*, 47, 2012, pp. 1215-1246
19. Deng, Yongheng, John M. Quigley, and Robert Van Order. "Mortgage terminations, heterogeneity and the exercise of mortgage options." *Econometrica*, 2000, pp. 275-307
20. Ding, Lei, Quercia, Roberto G. and Ratcliffe, Janneke, "Post-purchase Counseling and Default Resolutions among Low- and Moderate-Income Borrowers," *The Journal of Real Estate Research,* Vol. 30 No. 3, 2010, pp. 315-344
21. Deng, Yongheng, Quigley, John M., and Van Order, Robert, "Mortgage Terminations, Heterogeneity and the Exercise of Mortgage Options," *Econometrica*, Vol. 68, 2000, pp. 275-307
22. Dynan, Karen, Is a Household Debt Overhang Holding Back Consumption? Brookings Papers on Economic Activity, 2012, pp. 299-344
23. Edmans, Alex, The Responsible Homeowner Reward: An Incentive-Based Solution to Strategic Mortgage Default, The Wharton School Working Paper, 2010
24. Fannie Mae, Fannie Mae's Analysis Regarding Principal Forgiveness and Treasury's HAMP Principal Reduction Alternative HAMP PRA Program, 2012
25. Fine, Jason P., Gray, Robert J., "A Proportional Hazards Model for the Subdistribution of a Competing Risk," *Journal of the American Statistical Association*, Vol. 94, 1999, pp. 496-509
26. Foote, Christopher L., Gerardi, Kristopher and Willen, Paul S., "Negative equity and foreclosure: Theory and evidence," *Journal of Urban Economics*, Vol. 64, 2008, pp. 234-245
27. Foote, Christopher, Gerardi, Kristopher, Goette, Lorenz and Willen, Paul, Reducing Foreclosures: No Easy Answers, NBER Macroeconomics Annual 2009, Vol. 24, 2009, pp. 89-138
28. Harding, John P., Rosenblatt, Eric and Yao, Vincent W., "The Contagion Effect of Foreclosed Properties," *Journal of Urban Economics*, Vol. 66, 2009, pp. 164-178
29. Hatcher, Desiree, Foreclosure Alternatives: A Case for Preserving Home ownership, 2006, (http://www.chicagofed.org/digital_assets/publications/profitwise_news_and_views/2006/02_2006_foreclosure_alt.pdf)
30. Haughwout, Andrew, Okah, Ebiere and Tracy, Joseph, Second Chances: Subprime Mortgage Modification and Re-Default, Federal Reserve Bank of New York Staff Reports, No. 417, 2009
31. Holden, Steve, Kelly, Austin, McManus, Douglas, Scharlemann, Therese, Singer, Ryan and Worth, John D., "The HAMP NPV Model: Development and Early Performance," *Real Estate Economics,* Vol. 40, 2012, pp. 32-64
32. Mian, Atif, Rao, Kamalesh, and Sufi, Amir, Household Balance Sheets, Consumption, and the Economic Slump. Working paper, 2013
33. Pennington-Cross, Anthony and Ho, Giang, "The Termination of Subprime Hybrid and Fixed-Rate Mortgages," *Real Estate Economics*, Vol. 38, 2010, pp. 399-426
34. Phillips, Richard A. and VanderHoff, James H., "The Conditional Probability of Foreclosure: An Empirical Analysis of Conventional Mortgage Loan Defaults," *Real Estate Economics,* Vol. 32, 2004, pp. 571-587
35. Piskorski, Tomasz, Seru, Amit and Vig, Vikrant, "Securitization and distressed loan renegotiation: Evidence from the subprime mortgage crisis," *Journal of Financial Economics*, Vol. 97, 2010, pp. 369-397
36. Quercia, Roberto G. and Ding, Lei, "Loan Modifications and Redefault Risk: An Examination of Short-Term Impacts," *A Journal of Policy Development and Research,* Vol. 11, 2009, pp. 171-194
37. Rao, John and Walsh, Geoff Foreclosing a Dream: State Laws Deprive Homeowners of Basic Protections. National Consumer Law Center Inc®, 2009
38. Rogers, William H, and Winter, William, "The Impact of Foreclosures on Neighboring Housing Sales," *The Journal of Real Estate Research*, Vol. 31 No. 4, 2009, pp. 455-479

39. Rose, Morgan J. Origination Channel, "Prepayment Penalties and Default," *Real Estate Economics,* Vol. 40, 2012, pp. 663-708
40. Schuetz, Jenny, Been, Vicki and Ellen, Ingrid Gould, "Neighborhood effects of concentrated mortgage foreclosures," *Journal of Housing Economics*, Vol. 17, 2008, pp. 306-319
41. Special Inspector General for the Troubled Asset Relief Program, Rising Redefaults of HAMP Mortgage Modifications Hurt Homeowners, Communities, and Taxpayers, 2013
42. Stegman, Michael A., Quercia, Roberto G., Ratcliffe, Janneke, Ding, Lei and Davis, Walter R., "Preventive Servicing Is Good for Business and Affordable Homeownership Policy," *Housing Policy Debate*, Vol. 18, 2007, pp. 243-278
43. White, Alan M., "Deleveraging the American Homeowner: The Failure of 2008 Voluntary Mortgage Contract Modifications," *Connecticut Law Review*, Vol. 41, 2009, pp. 1107-1131