# Evaluating Loan Modifications: 2008 – 2014

Min Hwang
George Washington University

Inwon Jang[1]
Office of the Comptroller of the Currency

Susan Wachter
University of Pennsylvania

Dec 28, 2016

## I. Introduction

When the U.S. housing market was collapsing in 2007–08 with free falling housing prices and soaring delinquencies and defaults, loan modification was put forward as an important tool to help homeowners in serious loan delinquencies to avoid foreclosures and bankruptcies (Eggum Porter and Twomey, 2009), not only to help borrowers but also lenders, communities and neighborhoods and even local governments (Voicu et al. 2013). Loan modification is of course not new. Before the crisis, it had been a part of loss mitigation programs for residential mortgages and commercial mortgages.

Loans are usually modified on the following terms, often in combination of some of or all of them; interest rate reduction, maturity extension, principal deferment and principal write-down. Among the four potential terms for modification, the principal write-down, in particular, has been strongly advocated by academic and industry researchers and policy makers (Goodman et al, 2011), especially because it has been believed that many loan delinquencies are due to negative equity (under-water) problems for which principal reduction could directly address (Bernanke, 2008). However, lenders and servicers are reluctant to write-down principal as part of modification. First, lenders believe that, once lenders grant principal reductions for delinquent borrowers who are under water, they are more likely to be pressured for another principal reduction in case house price fall even further (Bernanke, 2008). Second, the principal reduction can potentially bring in perverse incentives for borrowers who are also under water, but current, to strategically default to reduce their loan amounts (Rosi, 2012; Mayer et. al., 2014). In a similar context, a report from Fannie Mae (2012) argued that the foreclosure reducing impact of reducing principal relative to other modifications is insufficient to justify their use given the moral hazard problem.

In this paper, we examine the effects of loan modification programs with a special focus on principal reduction. Evaluating the effects of loan modification program is not straightforward for the following two reasons. First, loan modification is usually granted on several loan terms simultaneously, and some loan terms are modified considerably more often (such as interest rate reduction) than others (such as principal reduction). Second, the loan terms being modified are in different measurement units. For example, maturity extension is given in terms of length of time (usually in number of months) while interest rate reduction is given in percentage and principal write-down and principal deferment in dollar terms. To make matters more complicated, the effects of those modified terms are asynchronous. Interest rate reduction and term extension have effects on payments over the remaining loan periods while principal reduction has immediate effects on the loan balance. Therefore, to accurately separate effects of modified terms, they have to be measured consistently across the different measurement units and in time value.

We propose to measure the magnitude of modification on a loan term by its relative marginal contribution to reduction of the present value of the loan. We then evaluate the effect of a modified loan term by estimating the impact on the probability of re-default of a 1% change in the present value of the loan due to the modified term while controlling for other modified terms in a regression context. In previous research, the modified terms are first measured in percentage and then used to estimate their effects on re-default rate. But it is not straightforward to compare an effect of modification of a loan term, say 1% increase in loan maturity, against an effect of another term, say, a 1% decrease in loan balance since two modified terms are in different units. In contrast, our method translates all modified terms into a common unit, percentage change in the present value of the loan, and their effects are directly comparable.

We find that, among the modified loans in our dataset, it is the principal deferment that has the largest effect on the probability of re-default for a 1% change in present value of a modified loan, followed by the interest rate reductions. Our results are surprising since, almost from the

start, the principal write-down has been advocated as the best approach to loan modification. We do find some evidence that the principal reduction has significantly stronger effects in reducing the re-default rates of modified loans. But when the effect is measured in terms of the 1% change in the present value of the loan, it is smaller than that of the principal deferment or of interest rate reduction. This implies that the strong effects of principal reduction might be due to the aggressiveness of modification (large reduction in present value), not because it directly addresses the problem of negative equity.

Our methodology has another advantage. Because it measures the aggressiveness of loan modification in terms of its present value, it provides a direct estimate of the impact of loan modifications on their balance sheet, the expected change in the present value of the loan. When a delinquent loan is modified to the extent that its present value is different, regardless of the modified terms, the change in the present value should be "recorded to the allowance for loan restructuring account and to provision for loan loss" (Federal Reserve 2016). This implies that our measure provide a direct estimate of effects of loan modification on lenders' balance sheets and their capital constraints.

In this study, we employ the datasets which covers a wider variety of loans on the national housing markets compared to the existing studies which are limited in terms of locality of loan origination (Voicu et. al. 2013) or type of mortgage loans (Schmeiser and Gross, 2015).

This paper is organized as follows. Section 2 provides a literature review. Section 3 details the methodology of measuring the effects of individual modification terms. Section 4 describes the data used in the empirical analysis while section 5 reports the empirical results. Section 6 discusses on lenders' incentives on loan modifications based on the empirical results, and section7 concludes.

## II.    Literature Review

Quercia, Ding and Ratcliff (2009), one of the earlier researches on modification, examined the factors for high re-default rates of modified loans using loan level information of privately securitized mortgage loans in Columbia collateral file.  They focused on loans originated in 2005 and 2006 which are believed to have been particularly poorly underwritten.  They found that only about half of modification had resulted in reduced monthly payments.  23% of the modified loans had higher monthly payments while the rest had roughly the same monthly payments.  For the modification terms, the majority of loans (53%) have only the interest rate reduction while a very small number of loans had principal reductions.  For performance of modified loans, they confirmed that the monthly payment reductions were strongly and positively related to decreases in re-default rates.  In particular, loans modified with interest rate reduction and principal reduction at the same time re-defaulted much less often than the loans modified only with interest rate reduction or only with principal reductions.

Agarwal et al. (2011) examined the loss mitigation process of delinquent loans using pre-HAMP loan level information from OCC Mortgage Metrics dataset.  They found that up to May 2009, within six months after becoming seriously delinquent, about 31% of the troubled loans are in liquidation, followed by 10.4% loans in modification process.  A small number of the loans are either on repayment plan (2.4%) or refinanced (2.2%).  The majority of the loans (54%) have no recorded actions.  They found that securitization plays an important role for the lack of modification, as suggested by Piskorski, Seru and Vig (2010).  Securitized mortgage loans are much less likely modified than portfolio loans directly held by lenders; the likelihood of modification is 70% lower for securitized loans compared to portfolio loans.  Among the securitized loans, loans securitized by GSEs tend to have lower modification rates than those privately securitized.  They also noted that modified loans had high re-defaults rate in the neighborhood of 34% which is substantially higher than the re-default rates of the loans modified in the later 1990s reported by

Crews-Cutt and Merrill (2008). One of their main finding is that the effects of servicer heterogeneity is as strong as borrower characteristics. They attributed servicer heterogeneity to institutional factors underlying servicers' modification choice as well as variations in borrower populations. Among the different modification terms, they found interest rate reductions were strongly associated with large decreases in re-default rates.

Voicu et al (2013), using MortgageMetrics dataset, investigated the effects of different modification arrangements while controlling for various loan, borrower, property, servicer and neighborhood characteristics. They focused on New York City which allowed them to include detailed micro level information on underlying properties and neighborhoods. They also examined how and why borrowers with HAMP perform better than borrowers with other proprietary programs. They confirmed that mortgages modified under HAMP perform much better than those under proprietary programs, but still unable to identify the sources of the difference in performance. With regards to the effectiveness of different modification arrangements, they found that principal deferment has larger effects on performance, but that the effect seems to come from its effects on monthly payment reductions. Once monthly payment reduction is controlled, there are no statistically different effects among the modification program.

In a similar vein, Schmeiser and Gross (2014) also examined the effect of different type of modifications of distressed subprime loans on the subsequent loan performance. They focused on securitized subprime loans reported in CoreLogic LoanPerformance dataset which provide more accurately estimated CLTV based on second lien information and AVM based house value estimation. In addition, it does not report whether a loan is modified under HAMP or non-HAM proprietary modification programs. Schmeiser and Gross inferred whether a loan was HAMP modified or not by whether modified terms followed the HAMP waterfall structure. They found that modifications that improve loan terms reduce the probability of re-default and entering foreclosures. On the other hand, capitalization tends to increase loan balances and does not help

borrowers much to avoid re-defaults and foreclosures. They also found that principal write-downs are the most effective since it affects loan performance by reduction in LTV as well as reduction in P&I. Consistently with Voicu et al. (2013), loans modified under HAMP performed substantially better than those under proprietary modification programs independent of actual modification terms.

### III. Measurement of modified terms

When performance of a modified loan is estimated in a hazard model, we have

$$h_{it} = h(\Delta i, \Delta B, \Delta W, \Delta D, X_{it}, Y_t, Z_i), \tag{1}$$

where $\Delta i$ is the size of interest reduction, $\Delta W$ the size of principal reduction, $\Delta T$ maturity extension, $\Delta D$ the size of deferment, $X_{it}$ updated loan conditions, $Y_t$ updated local economic conditions and $Z_i$ origination loan conditions. Since $\Delta i$, $\Delta T, \Delta W$ and $\Delta D$ are all in different units, we are proposing to use

$$\Delta i^* = \frac{1}{PV} \frac{\partial PV}{\partial i} \Delta i \tag{1a}$$

$$\Delta T^* = \frac{1}{PV} \frac{\partial PV}{\partial T} \Delta T \tag{1b}$$

$$\Delta W^* = \frac{1}{PV} \frac{\partial PV}{\partial W} \Delta W \tag{1c}$$

$$\Delta D^* = \frac{1}{PV} \frac{\partial PV}{\partial D} \Delta D \tag{1d}$$

Note that, even though $\Delta i$, $\Delta T, \Delta W$ and $\Delta D$ are all in different units, $\Delta i^*$, $\Delta T^*, \Delta W^*$ and $\Delta D^*$ are in the same unit, that is, percentage of a change in the present value of the modified loan.

To measure $\Delta i^*$, $\Delta T^*, \Delta W^*$ and $\Delta D^*$, note that in a loan modification plan,

$$L = W + PMT \int_0^T e^{-it} dt + D \qquad (2)$$

where $L$ is the current loan balance (possibly delinquent), $W$ is the principal write-down, $D$ is the deferment, $T$ is the modified loan maturity and $i$ is the modified interest rate.

On the other hand, the market value of the modified loan is

$$PV = PMT \int_0^{T'} e^{-rt} dt + Be^{-rT'} \qquad (3)$$

Note that the discount rate, $r$, is not necessarily the same as $i$ in (2), the modified interest rate. Also, the loan can be prepaid before the modified maturity at $T'$ with the remaining balance $B$, where

$$B = PMT \int_0^{T-T'} e^{-it} dt + D = PMT \times F + D. \qquad (4)$$

Note that, in (4), before the modification, $W = 0, D = 0, i =$ interest rate at origination and $T=$remaining maturity term.

To separately gauge the effects of modification terms on the probability of re-defaults, we propose a measure based on the present value in (2). We will measure the net benefit of a loan modification program by the difference between the present value under the original loan terms and the present value under the modified terms. Then, the effects of each modified term can be calculated as contribution of the individual modified term to the net benefit of the mortgage program.

From (2), (3) and (4), we have

$$\Delta PV = \left(\frac{\partial PV}{\partial PMT}\right) \Delta PMT + \left(\frac{\partial PV}{\partial B}\right) \Delta B. \qquad (5)$$

Since

$$PMT = PMT(i, T, D, W) \ \ and \ B = B(i, T, D, W),$$

Now, (5) can be re-written as,

$$\Delta PV = \left(\frac{\partial PV}{\partial PMT}\right)\left\{\left(\frac{\partial PMT}{\partial i}\right)\Delta i + \left(\frac{\partial PMT}{\partial T}\right)\Delta T + \left(\frac{\partial PMT}{\partial D}\right)\Delta D + \left(\frac{\partial PMT}{\partial W}\right)\Delta W\right\}$$

$$+ \left(\frac{\partial PV}{\partial B}\right)\left\{\left(\frac{\partial B}{\partial i}\right)\Delta i + \left(\frac{\partial B}{\partial T}\right)\Delta T + \left(\frac{\partial B}{\partial D}\right)\Delta D + \left(\frac{\partial B}{\partial W}\right)\Delta W\right\}$$

$$= \left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial i}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial i}\right)\right\}\Delta i$$

$$+ \left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial T}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial T}\right)\right\}\Delta T$$

$$+ \left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial D}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial D}\right)\right\}\Delta D$$

$$+ \left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial W}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial W}\right)\right\}\Delta W,$$

where

$$\frac{\partial PV}{\partial PMT} = \int_0^{T'} e^{-rt} dt = \frac{1 - e^{-rT'}}{r}$$

$$\frac{\partial PV}{\partial B} = e^{-rT'}$$

$$\frac{\partial PMT}{\partial W} = -\frac{i}{1 - e^{-iT}},$$

$$\frac{\partial PMT}{\partial D} = -\frac{i}{1 - e^{-iT}},$$

$$\frac{\partial PMT}{\partial T} = -\frac{(i^2 e^{-iT})(L - W - D)}{(1 - e^{-iT})^2},$$

$$\frac{\partial PMT}{\partial i} = \frac{\left((1 - e^{-iT}) - i(Te^{-iT})\right)(L - W - D)}{(1 - e^{-iT})^2},$$

$$\frac{\partial B}{\partial i} = \left(\frac{1}{i}\right)\left(1 - e^{-i(T-T')}\right)\frac{\left(\left(1 - e^{-iT}\right) - i\left(Te^{-iT}\right)\right)(L - W - D)}{(1 - e^{-iT})^2}$$

$$+ PMT\frac{i(T - T')e^{-i(T-T')} - \left(1 - e^{-i(T-T')}\right)}{i^2}$$

$$\frac{\partial B}{\partial T} = \left(\frac{1}{i}\right)\left(1 - e^{-i(T-T')}\right) - \frac{\left(i^2 e^{-iT}\right)(L - W - D)}{(1 - e^{-iT})^2} + PMTe^{-i(T-T')}$$

$$\frac{\partial B}{\partial D} = \left(\frac{1}{i}\right)\left(1 - e^{-i(T-T')}\right)\left(-\frac{i}{1 - e^{-iT}}\right) + 1$$

$$\frac{\partial B}{\partial W} = \left(\frac{1}{i}\right)\left(1 - e^{-i(T-T')}\right)\left(-\frac{i}{1 - e^{-iT}}\right)$$

In turn, the contributions of individual modified term are

$$\frac{\partial PV}{\partial i}\Delta i = \left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial i}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial i}\right)\right\}\Delta i \ \ (interest\ rate\ reduction),$$

$$\frac{\partial PV}{\partial T}\Delta T = \left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial T}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial T}\right)\right\}\Delta T \ \ (term\ extension),$$

$$\frac{\partial PV}{\partial D}\Delta D = \left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial D}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial D}\right)\right\}\Delta D \ \ (principal\ deferment)$$

and

$$\frac{\partial PV}{\partial W}\Delta W = \left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial W}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial W}\right)\right\}\Delta W \ (principal\ writedown) \ \ (6)$$

Finally, by dividing by the present value, from (1a), (1b), (1c) and (1d), we have

$$\Delta i^* = \frac{\left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial i}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial i}\right)\right\}\Delta i}{PV},$$

$$\Delta T^* = \frac{\left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial T}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial T}\right)\right\}\Delta T}{PV},$$

$$\Delta D^* = \frac{\left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial D}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial D}\right)\right\}\Delta D}{PV}$$

and

$$\Delta W^* = \frac{\left\{\left(\frac{\partial PV}{\partial PMT}\right)\left(\frac{\partial PMT}{\partial W}\right) + \left(\frac{\partial PV}{\partial B}\right)\left(\frac{\partial B}{\partial W}\right)\right\}\Delta W}{PV} \ . \tag{7}$$

## IV.   Data Description

The main dataset used in the analysis of modified loan performance is Mortgage Metrics database from OCC which provides detailed loan level information on loan characteristics, borrower characteristics and performance of loans serviced by a number of national banks and a federal savings association.  More than 90% of loans in the database are not owned by the reporting servicers.  The database represents 49% of all first lien residential mortgages outstanding, and by the end of 2013, the reporting servicers investors serviced close to 25 million loans in $4.2 trillion in unpaid balance.  The loans in the database represent a large portion of the U.S. residential mortgage market, but might not represent a random sample of overall population of mortgages outstanding.

We focus on the first lien mortgages, originated between 2000 and 2008, and modified between 2008 and 2014 (3rd quarter).  The Mortgage Metrics database provides information on pre-modification loan balance, interest rates, remaining term, origination information, current FICO scores, loan delinquency status, mortgage type, product type, documentation, product class, investor type and servicer.

Further we only include modified loans as follows;

(1) loans modified for the first time after 2008;

(2) loans modified only once;

(3) loans with pre- and post-modification information available ;

(4) loans modified either under HAMP or non-HAMP proprietary programs.

Summary statistics on loan origination information from Mortgage Metrics are reported in Table 1. Most loans are prime with full documentation. They are either GSE loans (44.50%) or portfolio loans (37.11%) with a smaller share of loans in private label securities (17.61%). In terms of loan origination channel, they are more or less evenly divided among retail, wholesale, purchased accounts and correspondence mortgages. The majority of loans are owner-occupied, single-family fixed rate mortgages without private mortgage insurance. There are a smaller percentage of jumbo loans (8.44%), interest-only loans (4.66%) and option ARMs (1.61%).

We supplement loan level information from Mortgage Metrics with ZCTA level demographic and neighborhood information on ethnic compositions, self-employment, education, immigrants, mobility rate, homeownership and poverty, all from Census, reported in Table 2. We also use unemployment rate from BLS and personal income from BEA, both at county level. The county level unemployment rate is monthly, but the county level personal income is originally annual, and linearly interpolated at monthly frequency. We calculate the changes in the unemployment rate and personal income at the loan level, from origination to modification. Table 3 reports that the unemployment rate rose by 4.39% on average and the personal income by 11%. Table 4 reports modification information. There are only a few modifications in 2008 (1.60%), followed by a dramatic increase up to 2010 when more than a third of the loans (37%) in the sample were modified. The number of modifications fell after 2010. Table 4 also reports how FICO and LTV changed between origination and modification. The median FICO at origination was 658, but the median FICO at modification was 563. The median LTV was 80% at origination, then 93% at modification. Among the modification terms, all the loans in our sample have interest rate

12

reduction and about two thirds had unpaid interest and fees capitalized. 52% of loans had their terms extended, but only 14% had some portion of their principal deferred. Only a small percentage (1.38%) of loans were given principal reduction.

### V.    Empirical Analysis

To measure the effects of individual modification terms, we use logistic regression analysis of loan performance on modification measures and various control variables. The censoring event is re-default of a modified mortgage loan which is defined as 60 day or longer delinquent for the first time after the modification[2].

Table 5 presents the baseline results from regressions with all control variables but without modification terms. Column I through IV have common control variables: current condition (LTV, FICO, unemployment rate and personal income), origination loan fixed effects, neighborhood demographic information, origination year fixed effects and servicer fixed effects. Each column differs in LTV and FICO at origination, LTV and FICO at modification and delinquency condition at modification. The main purpose of the four different specifications in Table 5 is to examine the degree to which all the control variables can explain the probability of re-default without specific modification terms and also to understand the effects of LTV and FICO at modification and origination that are not captured by current LTV and FICO.

The estimated effects of variables for the borrower's current conditions (LTV, FICO, unemployment and income) are consistent with prior expectations. Current LTV and changes in local unemployment rates from date of modification have positive effects on the probability of re-defaults while current FICO scores and changes in personal income from modification have

---

[2] There are a very few number of prepayments. But since they are so few, we dropped those observations from the sample.

negative effects on the probability of re-default. Origination LTV has a surprisingly large effect in Column II, but it quickly dissipates as modification LTV, modification FICO and delinquency condition at modifications are added to the regressions. On the other hand, FICO scores at origination have unexpected but consistent effects on loan performance; higher FICO scores at origination are associated with higher default rates.

Borrower conditions at the time of modification have strong effects, mostly consistent with expectations. The delinquency status at the time of loan modification is important, especially for those loans in serious delinquencies. In Column (VI) where all the control variables are included, loans that were seriously delinquent loans have 50% higher odds of re-defaulting after modification compared to the loans that were 30 day delinquent or less. On the other hand, loans with less serious delinquencies have 10% higher odds instead. LTV ratio at the modification has surprisingly strong effects while the current LTV ratios have relatively weak effects. When the current measured LTV goes up by 10% (for example, 80% to 90%), the odds of re-defaults go up only by 0.1%. We considered three FICO scores, scores at origination, scores at modification and the current scores. Among them, current scores have the strongest effects, followed by scores at modification, then by scores at origination. The effects of FICO at modification are positive as in the case of origination FICO; higher FICO scores at modification are related to higher re-default rates, not lower re-default rates. When the FICO at modification rises by 10%, the odds of re-defaults go up by 30%.

Fixed effects at origination loan features have strong effects as well. Prime loans perform better than Alt-A or non-prime loans consistently across different specifications. The level of loan documentation, on the other hand, has opposite effects; loans with low documentation at origination perform better than loans with full documentation at origination. In terms of securitization channel, modified GSE loans with mortgage insurance perform better than private label mortgages while they consistently perform worse than portfolio loans held by lenders or

GNMA loans. That is, GNMA loans perform best, portfolio next, then GSEs and finally PLS, all else equal. However, prime mortgages without mortgage insurance (mostly better quality GSE loans or high quality jumbo loans), perform better than loans with FHA, VA or conventional mortgages with mortgage insurance. This implies that LTV scores might not capture all the difference in performance between high LTV GSE loans (those with private insurance) and low LTV GSE loans (those without private insurance). Among different loan origination channels, retail loans tend to perform better than wholesale loans, correspondence loans or purchased loans even though retail, wholesale and purchased loans perform at par when the full information of origination and modification is included.

Many Census variables significantly affect performance of modified loans. To the contrary of common perceptions, loans by borrowers living in areas with more African Americans or Hispanic populations tend to perform better than loans from areas with a higher share of non-minority population. Modified loans of borrowers from areas with a higher percentage of foreign born, high mobility and a higher proportion of self-employment population tend to perform better. Also surprisingly, modified loans by borrowers in areas with higher poverty rates and lower homeownership tend to perform better. Origination year fixed effects are strong and consistent across different model specifications. Loans originated in later years tend to perform worse, consistent with previous findings.

Table 6 reports the regression results when modification programs are classified by indicator variables based on their modification term composition. Since there are five terms of a mortgage loan (interest rate, term, principal deferment, principal write-down and capitalization) that can be modified, there are 31 possible combinations. In our dataset, we find 16 combinations with 8 accounting for more than 98.5% of the modified loans in the sample. We report them in Table 4, ordered by use with the most used program at the top and the least at the bottom. . The most used modification is an interest rate reduction with capitalization of unpaid interest and late

fees. This program by itself accounts for more than one fifth of the total sample (21.57%). An almost equally popular program is an interest rate reduction and term extension combined with capitalization (21.17%). The next two programs are the same as the first two but without capitalization. All four count for more than 70% of modifications. The top eight programs included in the regression do not include a principal write-down as a part of their modification program. On the other hand, all the remaining (excluded) loan modification programs have the principal write-down as a part of their mortgage program. Therefore, the estimated effects of indicator variables for different modification programs can be interpreted as the difference in performance from the average effects of modification programs that havea principal reduction as a part of the modification program.

Table 6 shows that that the most used program, a modification program with interest rate reduction and capitalization, is indeed the worst performing program across different specifications. The difference between the most popular program and the excluded programs is substantial. Compared to the modification programs excluding the regression analysis (all of which have a principal write-down, as noted), the odds of re-default of the modification program only with interest rate reduction and capitalization is greater by more than 50%. This poor performance is not limited to the most popular program. For modification program 2 (capitalization-rate reduction-term extension) and modification program 6, the estimated coefficients exceed 0.2 (22% in the odds). In fact, most of the programs included in the regressions have larger probabilities of default than those excluded.

Our results also confirm the adverse effects of capitalization, documented in previous studies such as Agarwal et. al. (2011). All modification programs with capitalization perform worse than those without capitalization. In other words, any combination of interest rate reduction, term extension and principal deferment perform worse when unpaid interest and late fees are capitalized.

The results also indicate that loans modified at more terms tend to perform better. For example, loans only with interest rate reductions tend to have a higher probability of re-defaults than those with interest rate reductions and some other modification terms such as term extensions and deferment combined. One possible explanation is that loans with more modified terms might be those more aggressively modified resulting in lower payment burdens and lower loan balances which can lead to better performance. But this explanation cannot be applied for HAMP loans which were modified based on the "waterfall" rule; a loan is modified toward a new DTI at 31% with a certain order of medication terms, starting from interest rate reductions to term extensions, then toward principal deferment. Therefore, in principle, HAMP modified loans have the same post modification DTI regardless of how loan terms are modified so that the number of terms modified should have weak effects, which seems inconsistent with our results.

The results reported in Table 6 clearly show that not all the modification programs have similar effects; some programs tend to perform better than others, often in wide margins. In order to better identify which features of a modification program lead to better performance we divide modification programs into individual components and measure contributions of individual components separately. In Table 7, we first analyze and compare the effects of changes in monthly payments and that of changes in balances. Regardless of how loan terms are modified, the main effects of modifications for the borrower is through two channels, one through changes in monthly payments and the other through changes in indebtedness of the borrower (relative to property value, that is the change in negative equity). The literature, as discussed above, identifies mortgage defaulting borrowers as strategic or "ruthless" when the default is due to negative equity in the property in the absence of "income shocks" or "liquidity shocks" to the borrower's cash flows (Vandell 1995). Most of servicers' modification efforts, as we have seen above, have been concentrated on payment adjustments which mainly address the issue of liquidity shocks to borrowers, but not the issue of strategic defaults.

Table 7 provides the estimated effects of payment changes and the estimated effects of loan balance changes on performance of modified loans. Across the different specifications: a 1% decrease in monthly payment reduces the odds of re-default by 1% while a 1% decrease in loan balances does so by 2%. Note that even though both changes in payment and changes in loan balance are in percentage terms, they are not directly comparable since they are not adjusted for present value. Disregarding present value considerations, the estimated effects of a 1% change in loan balance are indeed larger than a 1% percent change in payment. Monthly payments can be reduced by either an interest rate reduction, a term extension, principal deferment or principal write-down while only a principal write-down reduces the loan balance. Since the principal write-down affects monthly payments and loan balance at the same time, it should be more effective in reducing the probability of re-default. We find that, a 5% write-down of a loan balance will reduce the odds of re-default by 15% while an interest rate reduction or term extension that leads to a 5% payment reduction reduces the odds by 5%.

This also explains the potentially adverse effects of capitalization. Capitalization is a "reverse principal reduction," thus the adverse effects of capitalization can dominate the beneficial effects of other modified terms. Capitalization is often used in our data. Across all the loans in our dataset, the median percentage change in payment is 28% while the median percentage change in balance is -3%. This reflects the scarcity of principal reduction and the popularity of capitalization. Two-thirds of the loans had unpaid interest and late fees capitalized as a part of modification and the median amount of capitalization is $9,315, about 5% of the median loan balance prior to modification. For a "median" loan given a 28% reduction in payment and a 3% increase in balance due to capitalization, the reduction in the odds of re-default is decreased to 19%. Without capitalization, the odds are reduced by 28%.

Table 8 presents the estimated effects of individual terms in the modification plans. To calculate the marginal effects of individual terms, we first provide the estimated total effects of

modified terms based on indicator variables. One obvious disadvantage of this approach is that the effects of the interest rate reduction cannot be separately measured since all the modified loans in our sample include the interest rate reduction as a part of their modification programs.

Table 8 shows that the principal write-down has the largest effects consistently across the specifications. Principal write-downs are estimated to reduce the odds of re-defaults by 18%. Term extension reduces the odds by 17%, and principal deferments do so by 13%. The results are consistent with the findings in Table 7.

We now turn our attentions to measuring the effects of individual modification terms. It is an important question since mortgage servicers in offering a modification program to a delinquent borrower need to decide with not only which term to modify but also how much they are willing to modify. Large concessions would help a modified loan to perform better, but at the same time, reduce the value of the loan on their loan book which will affect the balance sheet of the lender.

Table 9 presents estimated effects of individual modification terms in a similar way as in Voicu et al. (2013). Each modified term is measured as a percentage change (the interest rate reduction and the term extension) or a percentage of the pre-modification loan balance (the principal deferment and the principal write-down). This approach is easy to understand, but it is not clear how one can compare the effects of different modified terms. Even though they are all given in percentage terms, they are not readily comparable. For example, a 1% reduction in the interest rate is measured against the pre-modification interest rate while a 1% principal write-down is measure against the pre-modification principal, they are not comparable to each other since they will have different present value impacts. A principal write-down reduces the loan balance right away; the present value of the principal reduced is the same as the amount written down. The principal deferment postpones some portion of the current balance as a balloon

payment into the future.  Therefore, it is the present value of the foregone interest payments of the deferred amount that matters, not the deferred amount itself.

Table 9 shows that, in contrast to previous estimation results, the estimated effects of modification display a considerable variation across different specifications, especially for interest rate reductions.  The effects of principal reduction also vary but not as substantially as the effects of interest rate reduction.  On the other hand, the effects of term extension and the effects of principal deferment are relatively constant over different specifications.  The variations in effects of modification terms appear to result from borrowers' conditions at the time of modification, especially LTV and FICO.  With LTV and FICO at modification included in the regression, the estimated effects of interest rate change from 0.68% to 1.14% while the effects of principal reduction change from 1.09% to 0.79%.  The delinquency status at the time of modification is important, especially for principal reduction; the effect of principal reduction increases from 0.79% to 0.94% when delinquency status of the loan is considered.

Table 10 presents the estimated effects of individual modified terms based on their contribution to the present value of the loan following the methodology in Section III.  Contrary to the traditional approach in Table 9, by using (7) , one can directly compare the effects of an individual modified term against the effect of another term.  Each modified term is measured in terms of its contribution to changes in the present value of the modified loan.  Therefore, in Table 10 the coefficient of an individual modification term measures the effect on the probability of re-default when the individual term changes as much as to decrease the present value of the loan by 1%.

Table 10 shows that the individual modification term with the largest effect is surprisingly the principal deferment rather than the principal write-down.  Across the specifications, the principal deferment has consistently the largest effects on the probability of re-defaults.  When a

mortgage loan is modified by deferring a portion of the principal as much as to decrease the present

value of the loan by 1%, then the odds of re-default will fall more than 4%. In contrast, when a

mortgage loan is modified by writing down a portion of the principal as much as to decrease the

present value of the loan by 1%, then the odds of re-default will fall only about 1%. Does this result

contradict to the results from Table 8 which reports the seemingly large effects of the principal

write-down on the probability of re-defaults? It seems puzzling since Table 9 shows that $1

(without adjustment for time value) deferred in principal will bring a similar change on the re-

default probability as $1 written down in principal. But Table 4 reports that the average amount of

the principal write-down is smaller than the average amount of principal deferment. Therefore, a

smaller amount written down seems to have similar effects on reducing the re-default rate,

inconsistent with the results in Table 10. But note that we are estimating the effects in present

values. Even though the dollar amount of the principal write-down is a little smaller, its present

value will be much greater. Note that the principal write-down is done now while the principal

deferment reduces the monthly payments equal to interest payments for the balance pushed in to

the future. Indeed, the results in Table 9 is consistent with those in Table 10; given the effects on

the probability of re-default, the larger the present value of the amount written down, the smaller

the estimated effects are.


## VI.     The effects of loan modification on balance sheets

When a lender considers possible loan modification for a borrower, it will consider and

weigh many different options. One important criteria could be the present value of the loan which

directly affects the lender's balance sheet and capital constraints. Since the value of a loan on the

balance sheet is the lender's best estimate of the loan's present value, the lender will have an

incentive to choose a modification program that maximizes the present value of the loan. Roughly, the present value of the loan can be written as

$$PV^* = p(m) \times R + \big(1 - p(m)\big) \times PV(m). \qquad (7)$$

where $PV^*$ is the present value of the loan on the lender's loan book, $p(m)$ is the probability of re-default which is a function of a modification program, $m$, $R$ is the recovery value of the mortgage when it default and $PV(m)$, the present value of the loan assuming there is no re-default. When a modification program is chosen, it has two effects; one on $p(m)$ and the other on $PV(m)$. The lender maximizes $PV^*$ by choosing $m$ that minimizes $p(m)$ and maximizes $PV(m)$. Using the results reported in Table 10, it is straightforward to see why the principal deferment is a better option for the lender. The estimated coefficient on a modified term gives the change in $p(m)$ while keeping the change in $PV(m)$ constant at \$1. According to Table 8 and 9, the principal write-down might make $p(m)$ small, but also makes $PV(m)$ too small at the same time so that $PV^*$ is smaller than other modification terms, such as principal deferment or interest rate reduction.

When the principal of a loan is written down, the effect on the present value is large since the reduction of the balance takes place immediately. Since the principal write-down has large effects on the present value, the estimated effects per percentage change in the present value is small. In contrast, the principal deferment might have smaller effects on the probability of re-defaults, but the effects on the present value are also small. Indeed, it is small enough that the estimated per percentage change in the present value is larger than the principal write-down.

A loan modification involves a trade-off between the probability of re-default and the size of concessions. It turns out that the principal write-down might have larger effects on the probability of re-default, but also needs to provide larger concessions.

## VII.  Conclusion

In this paper, we address the following two questions.  First, how have various loan modification programs performed since 2008?  After the nationwide housing market collapse, there were many policy efforts by various government agencies as well as private proprietary programs on loan modification.  Even though this is one of the most important developments in the U.S. mortgage markets since financial crisis,  there are not many studies that examine modification performance across different loan groups on a national scale.  We use Mortgage Metrics database which, covering 70% of the U.S. mortgage market, includes various loan groups such as FHA, GSE and portfolio loans to review the performance of modified mortgage loans.  Second, how did individual components of loan programs work?  A mortgage loan is typically modified on several terms at the same time such as interest rates, loan maturities and principal payments. Since all the loan modification come with all the different combinations of modified loan terms, it is important to separately assess the effects of all the individual components of loan modifications.  However, it is difficult to do since all the loan terms have measurement units that are difficult to compare each other.  We develop a methodology to individually assess the effects of each modified term measured by impact on present value of the mortgage.  We find that, principal deferments have the largest effect on the probability of re-default for a 1% change in present value of a modified loan, followed by interest rate reductions.    We find evidence that the principal reduction has strong effects as well.  But when the effect is measured in terms of a 1% change in the present value of the loan, it is smaller than the effect of a principal deferment or of an interest rate reduction.

# References

Agarwal, S., Amromin, G., Ben-David, I., Chomsisengphet, S., & Evanoff, D. D. (2011). Market-based loss mitigation practices for troubled mortgages following the financial crisis. Federal Reserve Bank of Chicago.

Bernanke, Ben. (2008). Reducing Preventable Mortgage Foreclosures. Speech at the Independent Community Bankers of American Annual Convention, Orlando, Florida.

Fannie Mae. (2012) "Fannie Mae's Analysis Regarding Principal Forgiveness and Treasury's HAMP Principal Reduction Alternative (HAMP PRA) Program,"

Goodman, L. S., Ashworth, R., Landy, B., & Yang, L. (2011). Modification Success—What Have We Learned? *The Journal of Fixed Income, 21*(2), 57-67.

Goodman, L. S., Ashworth, R., Landy, B., & Yang, L. (2012). Mortgage Modification Activity—Recent Developments. *The Journal of Fixed Income, 21*(4), 55-68.

Mayer, C., Morrison, E., Piskorski, T. & Gupta, A. (2014). Mortgage Modification and Strategic Behavior: Evidence from a Legal Settlement with Countrywide. American Economic Review, 104(9), 2830-57.

Quercia, R. G., & Stegman, M. A. (1992). Residential mortgage default: a review of the literature. *Journal of Housing Research, 3*(2), 341-379.

Rossi, C. (2012). Principal Reductions for Liar Loans? American Banker, 177(F318), 9-9.

Schmeiser, M. & Gross, M. (2015). The Determinants of Subprime Mortgage Performance Following a Loan Modification, Journal of Real Estate Finance and Economics.

Vandell, K. (1995) How Ruthless is Mortgagae Default?  A Review and Synthesis of the Evidence. Journal of Housing Research, 6 (2), 245-264.

Voicu, I., Been, V., Weselcouch, M., & Tschirhart, A. (2012a). Loan Modifications: What Works. *Working Paper*: New York University Furman Center.

# Table 1.  Summary Statistics: Mortgage Metrics*

### Credit Class of Mortgages

| | |
|---|---|
| Prime | 64.99% |
| Alt-A | 11.74% |
| Non-prime | 23.27% |

### Documentation

| | |
|---|---|
| Full | 55.03% |
| Low | 16.00% |
| Stated | 28.97% |

### Mortgage Investor

| | |
|---|---|
| GSE | 44.50% |
| GNMA | 0.79% |
| Private | 17.61% |
| Portfolio | 37.11% |

### Loan Origination Channel

| | |
|---|---|
| Retail | 28.23% |
| Wholesale | 24.79% |
| Correspondent | 24.05% |
| Purchased | 22.93% |

### Mortgage Insurance

| | |
|---|---|
| FHA | 19.97% |
| VA | 1.82% |
| Conventional with PMI | 15.60% |
| Conventional without PMI | 62.62% |

### Miscellaneous loan features

| | |
|---|---|
| FRM | 87.19% |
| Jumbo Mortgage | 8.44% |
| Interest Only Mortgage | 4.66% |
| Option ARM | 1.61% |
| Owner Occupied | 91.39% |
| Single Family House | 89.15% |

* The sample includes first lien mortgages, originated between 2000 and 2008, and modified between 2008 and 2014 (3rd quarter) from Mortgage Metrics database which were only once modified for the first time after 2008 and  pre- and post-modification information is available for.  They were modified either under HAMP or non-HAMP proprietary programs.

## Table 2.  Demographic Information (all in percentage)

| Variable | Mean | Std Dev | First Quartile | Median | Third Quartile |
|---|---|---|---|---|---|
| Asian | 4.70 | 6.94 | 1 | 2 | 6 |
| Black | 15.40 | 21.12 | 2 | 7 | 19 |
| Hispanic | 19.95 | 21.75 | 4 | 11 | 28 |
| Self Employed | 5.92 | 2.70 | 4 | 6 | 7 |
| Bachelor or higher | 25.71 | 13.21 | 16 | 23 | 33 |
| Born native | 84.96 | 13.14 | 78 | 89 | 95 |
| Has not moved | 85.14 | 5.69 | 82 | 86 | 89 |
| Home ownership | 68.26 | 14.90 | 59 | 70 | 79 |
| Poverty | 10.47 | 7.29 | 5 | 8.8 | 14 |

All the demographic information is from Census based on ZCTA based on the zip code information of loans in MortgageMetrics database.

## Table 3. Local Macroeconomic Conditions
## (Change from origination to modification, in percent)

| Changes in Variable | Mean | Std Dev | 25% | Median | 75% |
|---|---|---|---|---|---|
| ΔCounty Unemployment Rate | 4.39 | 2.30 | 2.8 | 4.2 | 5.9 |
| ΔCounty Personal Income | 10.9 | 12 | 2 | 9 | 17 |
| ΔZip Code House Price Index | -23 | 28 | -39 | -18 | -4 |

Unemployment rate is from BLS, personal income from BEA and zip code level house price from CoreLogic database.

## Table 4. Proportion of Modification Terms

### Modification Year

| Year | % of loans modified |
|------|---------------------|
| 2008 | 1.60% |
| 2009 | 11.89% |
| 2010 | 36.98% |
| 2011 | 19.55% |
| 2012 | 14.75% |
| 2013 | 11.09% |
| 2014 | 4.14% |

### FICO and LTV at origination and at modification

| Variable | Mean | Std Dev | 25% | Median | 75% |
|----------|------|---------|-----|--------|-----|
| FICO at origination | 658.10 | 67.17 | 613 | 658 | 706 |
| FICO at modification | 573.44 | 77.30 | 518 | 563 | 619 |
| LTV at origination | 0.82 | 0.18 | 0.75 | 0.80 | 0.95 |
| LTV at modification | 0.97 | 0.29 | 0.80 | 0.93 | 1.07 |

## Changes in Modification Terms

| Mortgage Term | Frequency | Mean | Std Dev | 25% | Median | 75% |
|---|---|---|---|---|---|---|
| Interest Reduction | 100% | 2.88% | 1.52% | 1.63% | 2.63% | 4.12% |
| Term Extension (Month) | 52.11% | 102 | 67 | 42 | 98 | 159 |
| Principal Deferment | 13.95% | $38,924 | $28,931 | $15,466 | $32,803 | $56,925 |
| Principal Writedown | 1.38% | $37,125 | $23,214 | $17,675 | $34,744 | $54,925 |
| Capitalization | 66.14% | $13,975 | $14,497 | $5,043 | $9,315 | $17,348 |

## Distribution of Modification Program*

| Capitalization | Interest Rate Reduction | Maturity Extension | Principal Deferment | Principal Reduction | Percentage of loans modified |
|---|---|---|---|---|---|
| Y | Y | N | N | N | 21.57% |
| Y | Y | Y | N | N | 21.17% |
| N | Y | Y | N | N | 14.65% |
| N | Y | Y | N | N | 12.80% |
| Y | Y | Y | Y | N | 12.36% |
| Y | Y | N | N | N | 10.20% |
| N | Y | Y | Y | N | 3.42% |
| N | Y | N | Y | N | 2.45% |
| Y | Y | N | Y | Y | 0.40% |
| N | Y | Y | Y | Y | 0.30% |
| Y | Y | N | N | Y | 0.26% |
| Y | Y | Y | Y | Y | 0.13% |
| N | Y | N | Y | Y | 0.13% |
| N | Y | N | N | Y | 0.10% |
| Y | Y | Y | N | Y | 0.05% |
| N | Y | Y | N | Y | 0.02% |

*  Y: YES (modified) N: No (not modified)

## Table 5. Loan Performance: No Mod Information

| VARIABLE | I | II | III | IV |
|---|---|---|---|---|
| Intercept | 1.2073 | 0.9134 | 0.8429 | 0.2830 |
| HAMP | -0.2150 | -0.2117 | -0.1516 | -0.1563 |
| Current LTV | 0.0001 | 0.0001 | 0.0002 | 0.0002 |
| Current FICO | -0.0091 | -0.0092 | -0.0112 | -0.0113 |
| County Unemployment Rate | 0.0510 | 0.0505 | 0.0616 | 0.0662 |
| County Personal Income | -2.4769 | -2.6144 | -2.4673 | -2.7333 |
| Origination LTV | | 0.2492 | -0.0033* | 0.0348* |
| Origination FICO | | 0.0003 | 0.0001 | 0.0001 |
| Pre-mod LTV | | | 0.2026 | 0.1681 |
| Pre-mod FICO | | | 0.0022 | 0.0028 |
| SATO at modification | | | 5.3681 | 6.1366 |
| Pre-mod Delinquency (90 day or below) | | | | 0.0871 |
| Pre-mod Delinquency (longer than 90 day) | | | | 0.4018 |
| Origination Loan Class: Alt-A | 0.0574 | 0.0499 | 0.0382 | 0.0342 |
| Origination Loan Class: Non-Prime | 0.1216 | 0.1402 | 0.1181 | 0.1220 |
| Origination Documentation: Low | -0.0490 | -0.0331 | -0.0429 | -0.0466 |
| Origination Documentation: Stated | -0.0120 | 0.0184 | 0.0146 | 0.0056* |
| ARM at Origination | 0.1133 | 0.1071 | 0.1115 | 0.1105 |
| Securitization at Origination: GNMA | -0.1381 | -0.1772 | -0.1817 | -0.1028 |
| Securitization at Origination: Private Label | 0.0270 | 0.0085* | 0.0144* | 0.0354 |
| Securitization at Origination: Portfolio | -0.0162 | -0.0540 | -0.1353 | -0.0458 |
| Origination Channel: Wholesale | 0.0563 | 0.0462 | 0.0225 | 0.0099* |
| Origination Channel: Correspondence | 0.0411 | 0.0444 | -0.0028* | -0.0257 |
| Origination Channel: Purchased Account | 0.0714 | 0.0655 | 0.0113* | 0.0108* |
| Interest Only ARM at Origination | 0.0595 | 0.0581 | 0.0440 | 0.0740 |
| Option ARM at Origination | -0.3523 | -0.3307 | -0.5395 | -0.4747 |
| Investment Property | 0.0811 | 0.0846 | 0.0434 | 0.0418 |
| Insurance: FHA | 0.4207 | 0.4273 | 0.4160 | 0.3289 |
| Insurance: VA | 0.3023 | 0.2847 | 0.3300 | 0.2249 |
| Insurance: Private MI | 0.1752 | 0.1375 | 0.1392 | 0.1282 |
| Multifamily Property | -0.0861 | -0.0676 | -0.0776 | -0.0865 |
| Proportion of African American population | -0.0017 | -0.0016 | -0.0020 | -0.0020 |
| Proportion of Hispanic population | -0.0015 | -0.0014 | -0.0016 | -0.0017 |
| Proportion of Asian population | 0.0013 | 0.0010 | 0.0013 | 0.0013 |
| Proportion of Population with Bachelor or Higher | -0.0018 | -0.0016 | -0.0016 | -0.0018 |
| Proportion of Population Born Native | 0.0028 | 0.0025 | 0.0023 | 0.0026 |
| Proportion of Population Not Moved | 0.0013 | 0.0014 | 0.0032 | 0.0027 |

| | | | | |
|---|---|---|---|---|
| Homeownership Rate | -0.0001* | -0.0002* | -0.0009 | -0.0007 |
| Poverty Rate | -0.0010 | -0.0015 | -0.0028 | -0.0023 |
| Proportion of Population Self-Employed | -0.0062 | -0.0059 | -0.0039 | -0.0041 |
| Sand States | 0.0669 | 0.0793 | 0.0301 | 0.0372 |
| Number of Months since Modification | 0.0066 | 0.0074 | 0.0084 | 0.0103 |
| Origination Year=2000 | -0.2112 | -0.1935 | -0.1612 | -0.1820 |
| Origination Year=2001 | -0.2306 | -0.2348 | -0.2033 | -0.2215 |
| Origination Year=2002 | -0.2270 | -0.2184 | -0.1754 | -0.1916 |
| Origination Year=2003 | -0.2033 | -0.1960 | -0.1561 | -0.1724 |
| Origination Year=2004 | -0.1703 | -0.1591 | -0.1242 | -0.1335 |
| Origination Year=2005 | -0.0937 | -0.0850 | -0.0858 | -0.0860 |
| Origination Year=2006 | -0.0549 | -0.0488 | -0.0698 | -0.0675 |
| Origination Year=2007 | -0.0303 | -0.0201 | -0.0374 | -0.0358 |

Logistic regressions with 60 day default indicator for loans originated between 2000 and 2008, and modified between 2008 and 2014 (3rd quarter) from Mortgage Metrics database. Servicer fixed effects are included in all of the regressions reported, but coefficients are omitted.

*: P-value > 0.05

# Table 6.  Loan Performance: Modification Program

| VARIABLE | I | II | III | IV |
|---|---|---|---|---|
| Intercept | 1.0665 | 0.7972 | 0.6520 | 0.0849* |
| Modification Program 1 (C-R) | 0.4488 | 0.4341 | 0.3997 | 0.4159 |
| Modification Program 2 (C-R-T) | 0.2301 | 0.2229 | 0.2240 | 0.2202 |
| Modification Program 3 (N-R-T) | 0.1237 | 0.1223 | 0.1079 | 0.1167 |
| Modification Program 4 (N-R) | 0.2469 | 0.2211 | 0.1356 | 0.2294 |
| Modification Program 5 (C-R-T-D) | 0.0885 | 0.0551 | 0.0776 | 0.0329* |
| Modification Program 6 (C-R-D) | 0.3252 | 0.2948 | 0.2786 | 0.2998 |
| Modification Program 7 (N-R-T-D) | -0.0071* | -0.0164* | -0.0117* | 0.0051* |
| Modification Program 8 (N-R-D) | 0.1875 | 0.1650 | 0.1965 | 0.3194 |
| HAMP | -0.2228 | -0.2171 | -0.1609 | -0.1658 |
| Current LTV | 0.0001 | 0.0001 | 0.0002 | 0.0002 |
| Current FICO | -0.0091 | -0.0092 | -0.0112 | -0.0113 |
| County Unemployment Rate | 0.0511 | 0.0508 | 0.0615 | 0.0638 |
| County Personal Income | -2.3194 | -2.4726 | -2.2548 | -2.4997 |
| Origination LTV | | 0.2225 | -0.0199* | 0.0247* |
| Origination FICO | | 0.0003 | 0.0001 | 0.0001 |
| Pre-mod LTV | | | 0.2264 | 0.1934 |
| Pre-mod FICO | | | 0.0024 | 0.0029 |
| SATO at modification | | | 4.9663 | 5.4913 |
| Pre-mod Delinquency (90 day or below) | | | | 0.0896 |
| Pre-mod Delinquency (longer than 90 day) | | | | 0.4174 |
| Origination Loan Class: Alt-A | 0.0226 | 0.0185 | 0.0100* | 0.0077* |
| Origination Loan Class: Non-Prime | 0.0465 | 0.0690 | 0.0564 | 0.0541 |
| Origination Documentation: Low | -0.0484 | -0.0376 | -0.0466 | -0.0514 |
| Origination Documentation: Stated | -0.0163 | 0.0102 | 0.0103* | 0.0021* |
| ARM at Origination | 0.0869 | 0.0836 | 0.0935 | 0.0955 |
| Securitization at Origination: GNMA | -0.1377 | -0.1677 | -0.1602 | -0.0979 |
| Securitization at Origination: Private Label | 0.0163 | -0.0008* | -0.0107* | -0.0046* |
| Securitization at Origination: Portfolio | -0.0049* | -0.0395 | -0.1004 | -0.0319 |
| Origination Channel: Wholesale | 0.0438 | 0.0348 | 0.0201 | 0.0069* |
| Origination Channel: Correspondence | 0.0278 | 0.0305 | -0.0063* | -0.0241 |
| Origination Channel: Purchased Account | 0.0664 | 0.0599 | 0.0177 | 0.0200 |
| Interest Only ARM at Origination | 0.0747 | 0.0722 | 0.0621 | 0.0841 |
| Option ARM at Origination | -0.3201 | -0.3060 | -0.5306 | -0.4779 |
| Investment Property | 0.0798 | 0.0821 | 0.0422 | 0.0383 |
| Insurance: FHA | 0.4315 | 0.4313 | 0.4086 | 0.3509 |
| Insurance: VA | 0.3038 | 0.2778 | 0.3099 | 0.2285 |
| Insurance: Private MI | 0.1677 | 0.1340 | 0.1353 | 0.1232 |
| Multifamily Property | -0.0867 | -0.0695 | -0.0784 | -0.0857 |

| | | | | |
|---|---|---|---|---|
| Proportion of African American population | -0.2244 | -0.2071 | -0.1559 | -0.1756 |
| Proportion of Hispanic population | -0.2403 | -0.2450 | -0.2007 | -0.2197 |
| Proportion of Asian population | -0.2373 | -0.2282 | -0.1749 | -0.1914 |
| Proportion of Population with Bachelor or Higher | -0.2114 | -0.2055 | -0.1594 | -0.1757 |
| Proportion of Population Born Native | -0.1806 | -0.1686 | -0.1293 | -0.1391 |
| Proportion of Population Not Moved | -0.1031 | -0.0958 | -0.0909 | -0.0924 |
| Homeownership Rate | -0.0673 | -0.0628 | -0.0799 | -0.0759 |
| Poverty Rate | -0.0341 | -0.0245 | -0.0407 | -0.0390 |
| Proportion of Population Self-Employed | -0.5643 | -0.4947 | -0.7807 | -0.7924 |
| Sand States | 0.5711 | 0.6195 | 0.7445 | 0.6651 |
| Number of Months since Modification | 0.0000* | 0.0000* | 0.0000* | 0.0000* |
| Origination Year=2000 | -0.0163* | -0.0602 | -0.0089* | -0.0187* |
| Origination Year=2001 | 0.0345 | -0.0014* | -0.0049* | -0.0283* |
| Origination Year=2002 | 0.1240 | 0.0968 | 0.1075 | 0.0362* |
| Origination Year=2003 | -0.1109 | -0.1442 | -0.0617 | -0.0850 |
| Origination Year=2004 | -0.1897 | -0.2147 | -0.1481 | -0.2210 |
| Origination Year=2005 | 0.0755* | 0.0344* | 0.1373 | 0.1076 |
| Origination Year=2006 | -0.2997 | -0.3418 | -0.2122 | -0.2287 |
| Origination Year=2007 | -0.0862 | -0.1267 | -0.1551 | -0.1268 |

Logistic regressions with 60 day default indicator for loans originated between 2000 and 2008, and modified between 2008 and 2014 (3rd quarter) from Mortgage Metrics database. Servicer fixed effects are included in all of the regressions reported, but coefficients are omitted.

* P-value > 0.05

## Table 7. Loan Performance: Payment vs Balance

| VARIABLE | I | II | III | IV |
|---|---|---|---|---|
| Intercept | 1.4341 | 1.0111 | 0.8238 | 0.5143 |
| Change in Monthly Payment | -0.0105 | -0.0102 | -0.0120 | -0.0129 |
| Change in Loan Balance | -0.0181 | -0.0196 | -0.0247 | -0.0173 |
| HAMP | -0.1166 | -0.1139 | -0.1068 | -0.1192 |
| Current LTV | 0.0001 | 0.0001 | 0.0002 | 0.0002 |
| Current FICO | -0.0090 | -0.0091 | -0.0112 | -0.0112 |
| County Unemployment Rate | 0.0520 | 0.0522 | 0.0595 | 0.0612 |
| County Personal Income | -2.7198 | -2.8932 | -3.0106 | -3.1625 |
| Origination LTV | | 0.2877 | 0.0493 | 0.0856 |
| Origination FICO | | 0.0004 | 0.0001 | 0.0001* |
| Pre-mod LTV | | | 0.2879 | 0.2544 |
| Pre-mod FICO | | | 0.0024 | 0.0028 |
| SATO at modification | | | -1.8132 | -1.8345 |
| Pre-mod Delinquency (90 day or below) | | | | 0.0654 |
| Pre-mod Delinquency (longer than 90 day) | | | | 0.3211 |
| Origination Loan Class: Alt-A | 0.0351 | 0.0301 | 0.0130* | 0.0134* |
| Origination Loan Class: Non-Prime | 0.0859 | 0.1109 | 0.1023 | 0.1084 |
| Origination Documentation: Low | -0.0359 | -0.0248 | -0.0505 | -0.0539 |
| Origination Documentation: Stated | -0.0011* | 0.0249 | 0.0143 | 0.0094* |
| ARM at Origination | 0.1032 | 0.0980 | 0.0738 | 0.0765 |
| Securitization at Origination: GNMA | -0.1714 | -0.2004 | -0.1611 | -0.1079 |
| Securitization at Origination: Private Label | 0.0007* | -0.0158 | -0.0036* | 0.0180 |
| Securitization at Origination: Portfolio | -0.0466 | -0.0820 | -0.1062 | -0.0489 |
| Origination Channel: Wholesale | 0.0587 | 0.0472 | 0.0210 | 0.0121* |
| Origination Channel: Correspondence | 0.0544 | 0.0523 | 0.0087* | -0.0077* |
| Origination Channel: Purchased Account | 0.0868 | 0.0760 | 0.0323 | 0.0335 |
| Interest Only ARM at Origination | 0.1240 | 0.1202 | 0.1085 | 0.1298 |
| Option ARM at Origination | -0.2823 | -0.2543 | -0.4908 | -0.4726 |
| Investment Property | 0.0740 | 0.0782 | 0.0303 | 0.0308 |
| Insurance: FHA | 0.2959 | 0.2935 | 0.2673 | 0.2063 |
| Insurance: VA | 0.1825 | 0.1526 | 0.1395 | 0.0697 |
| Insurance: Private MI | 0.1831 | 0.1376 | 0.1246 | 0.1168 |
| Multifamily Property | -0.0737 | -0.0597 | -0.0724 | -0.0743 |
| Proportion of African American population | -0.0015 | -0.0015 | -0.0019 | -0.0018 |
| Proportion of Hispanic population | -0.0013 | -0.0012 | -0.0015 | -0.0016 |
| Proportion of Asian population | 0.0011 | 0.0009 | 0.0013 | 0.0011 |
| Proportion of Population with Bachelor or Higher | -0.0022 | -0.0021 | -0.0021 | -0.0021 |
| Proportion of Population Born Native | 0.0019 | 0.0018 | 0.0024 | 0.0024 |
| Proportion of Population Not Moved | 0.0008 | 0.0010 | 0.0028 | 0.0027 |

| | | | | |
|---|---|---|---|---|
| Homeownership Rate | 0.0000* | -0.0001* | -0.0009 | -0.0008 |
| Poverty Rate | -0.0011 | -0.0017 | -0.0026 | -0.0021 |
| Proportion of Population Self-Employed | -0.0058 | -0.0053 | -0.0027 | -0.0031 |
| Sand States | 0.0978 | 0.1104 | 0.0366 | 0.0390 |
| Number of Months since Modification | 0.0078 | 0.0088 | 0.0097 | 0.0106 |
| Origination Year=2000 | -0.1891 | -0.1781 | -0.0902 | -0.0817 |
| Origination Year=2001 | -0.2211 | -0.2299 | -0.1707 | -0.1710 |
| Origination Year=2002 | -0.2326 | -0.2244 | -0.1620 | -0.1653 |
| Origination Year=2003 | -0.2281 | -0.2209 | -0.1805 | -0.1896 |
| Origination Year=2004 | -0.1956 | -0.1843 | -0.1496 | -0.1540 |
| Origination Year=2005 | -0.1060 | -0.0987 | -0.1028 | -0.1030 |
| Origination Year=2006 | -0.0404 | -0.0377 | -0.0600 | -0.0547 |
| Origination Year=2007 | -0.0017* | 0.0072* | -0.0099* | -0.0064* |

Logistic regressions with 60 day default indicator for loans originated between 2000 and 2008, and modified between 2008 and 2014 (3rd quarter) from Mortgage Metrics database. Servicer fixed effects are included in all of the regressions reported, but coefficients are omitted.

*: P-value > 0.05

## Table 8. Loan Performance: Modification Terms (Dummy Variables)

| VARIABLE | I | II | III | IV |
|---|---|---|---|---|
| Intercept | 1.4825 | 1.1915 | 1.0397 | 0.4626 |
| Indictor for Term Extension | -0.2066 | -0.1972 | -0.1530 | -0.2025 |
| Indicator for Principal Deferment | -0.1264 | -0.1435 | -0.1088 | -0.1178 |
| Indicator for Principal Write-down | -0.2161 | -0.1918 | -0.1766 | -0.2063 |
| HAMP | -0.2158 | -0.2104 | -0.1586 | -0.1684 |
| Current LTV | 0.0001 | 0.0001 | 0.0002 | 0.0002 |
| Current FICO | -0.0091 | -0.0092 | -0.0112 | -0.0113 |
| County Unemployment Rate | 0.0480 | 0.0477 | 0.0587 | 0.0627 |
| County Personal Income | -2.3819 | -2.5160 | -2.4207 | -2.7035 |
| Origination LTV | | 0.2318 | -0.0188* | 0.0196* |
| Origination FICO | | 0.0003 | 0.0001 | 0.0002 |
| Pre-mod LTV | | | 0.2211 | 0.1883 |
| Pre-mod FICO | | | 0.0022 | 0.0028 |
| SATO at modification | | | 4.6115 | 5.2501 |
| Pre-mod Delinquency (90 day or below) | | | | 0.1201 |
| Pre-mod Delinquency (longer than 90 day) | | | | 0.4469 |
| Origination Loan Class: Alt-A | 0.0397 | 0.0342 | 0.0253 | 0.0167* |
| Origination Loan Class: Non-Prime | 0.0711 | 0.0945 | 0.0848 | 0.0764 |
| Origination Documentation: Low | -0.0460 | -0.0342 | -0.0461 | -0.0514 |
| Origination Documentation: Stated | -0.0115 | 0.0166 | 0.0146 | 0.0037* |
| ARM at Origination | 0.0946 | 0.0896 | 0.0968 | 0.0926 |
| Securitization at Origination: GNMA | -0.1611 | -0.1927 | -0.1846 | -0.1020 |
| Securitization at Origination: Private Label | -0.0023* | -0.0197 | -0.0123* | -0.0006* |
| Securitization at Origination: Portfolio | -0.0441 | -0.0804 | -0.1476 | -0.0536 |
| Origination Channel: Wholesale | 0.0522 | 0.0437 | 0.0264 | 0.0128* |
| Origination Channel: Correspondence | 0.0392 | 0.0418 | 0.0017* | -0.0225 |
| Origination Channel: Purchased Account | 0.0683 | 0.0651 | 0.0181 | 0.0198 |
| Interest Only ARM at Origination | 0.0712 | 0.0696 | 0.0532 | 0.0862 |
| Option ARM at Origination | -0.3247 | -0.3044 | -0.5170 | -0.4485 |
| Investment Property | 0.0839 | 0.0862 | 0.0445 | 0.0431 |
| Insurance: FHA | 0.4750 | 0.4764 | 0.4596 | 0.3786 |
| Insurance: VA | 0.3454 | 0.3210 | 0.3584 | 0.2525 |
| Insurance: Private MI | 0.1714 | 0.1361 | 0.1367 | 0.1241 |
| Multifamily Property | -0.0843 | -0.0670 | -0.0759 | -0.0851 |
| Proportion of African American population | -0.0017 | -0.0016 | -0.0020 | -0.0019 |
| Proportion of Hispanic population | -0.0015 | -0.0014 | -0.0017 | -0.0017 |
| Proportion of Asian population | 0.0011 | 0.0008 | 0.0012 | 0.0011 |
| Proportion of Population with Bachelor or Higher | -0.0018 | -0.0017 | -0.0016 | -0.0017 |

| | | | | |
|---|---|---|---|---|
| Proportion of Population Born Native | 0.0024 | 0.0021 | 0.0020 | 0.0023 |
| Proportion of Population Not Moved | 0.0014 | 0.0015 | 0.0034 | 0.0028 |
| Homeownership Rate | -0.0002* | -0.0002* | -0.0010 | -0.0008 |
| Poverty Rate | -0.0010 | -0.0016 | -0.0029 | -0.0024 |
| Proportion of Population Self-Employed | -0.0061 | -0.0058 | -0.0038 | -0.0040 |
| Sand States | 0.0729 | 0.0844 | 0.0301 | 0.0380 |
| Number of Months since Modification | 0.0059 | 0.0067 | 0.0078 | 0.0096 |
| Origination Year=2000 | -0.2211 | -0.2023 | -0.1550 | -0.1750 |
| Origination Year=2001 | -0.2346 | -0.2387 | -0.1979 | -0.2152 |
| Origination Year=2002 | -0.2304 | -0.2217 | -0.1713 | -0.1870 |
| Origination Year=2003 | -0.2049 | -0.1991 | -0.1546 | -0.1710 |
| Origination Year=2004 | -0.1745 | -0.1625 | -0.1238 | -0.1331 |
| Origination Year=2005 | -0.0977 | -0.0905 | -0.0871 | -0.0874 |
| Origination Year=2006 | -0.0588 | -0.0539 | -0.0716 | -0.0689 |
| Origination Year=2007 | -0.0302 | -0.0199 | -0.0366 | -0.0347 |

Logistic regressions with 60 day default indicator for loans originated between 2000 and 2008, and modified between 2008 and 2014 (3rd quarter) from Mortgage Metrics database. Servicer fixed effects are included in all of the regressions reported, but coefficients are omitted.

*: P-value > 0.05

## Table 9. Loan Performance: Modification Terms (Percent Change)

| VARIABLE | I | II | III | IV |
|---|---|---|---|---|
| Intercept | 1.6870 | 1.3672 | 1.4532 | 0.8586 |
| Percentage Change in Interest Rate | -0.0070 | -0.0068 | -0.0115 | -0.0122 |
| Percentage Change in Loan Term | -0.0039 | -0.0038 | -0.0032 | -0.0041 |
| Deferred Amount in Percentage of Loan Balance | -0.0090 | -0.0094 | -0.0087 | -0.0096 |
| Written Down Amount in Percentage of Loan Amount | -0.0118 | -0.0110 | -0.0079 | -0.0094 |
| HAMP | -0.1213 | -0.1177 | -0.1205 | -0.1263 |
| Current LTV | 0.0001 | 0.0001 | 0.0002 | 0.0002 |
| Current FICO | -0.0091 | -0.0092 | -0.0111 | -0.0112 |
| County Unemployment Rate | 0.0460 | 0.0457 | 0.0525 | 0.0564 |
| County Personal Income | -2.2991 | -2.4444 | -2.5984 | -2.9202 |
| Origination LTV | | 0.2388 | 0.0481 | 0.0904 |
| Origination FICO | | 0.0003 | -0.0001 | -0.0001 |
| Pre-mod LTV | | | 0.2383 | 0.2037 |
| Pre-mod FICO | | | 0.0022 | 0.0029 |
| SATO at modification | | | -7.2567 | -7.1586 |
| Pre-mod Delinquency (90 day or below) | | | | 0.1136 |
| Pre-mod Delinquency (longer than 90 day) | | | | 0.4635 |
| Origination Loan Class: Alt-A | 0.0452 | 0.0420 | 0.0306 | 0.0234 |
| Origination Loan Class: Non-Prime | 0.0827 | 0.1058 | 0.1006 | 0.0988 |
| Origination Documentation: Low | -0.0390 | -0.0255 | -0.0586 | -0.0636 |
| Origination Documentation: Stated | 0.0075* | 0.0332 | 0.0192 | 0.0090* |
| ARM at Origination | 0.0990 | 0.0962 | 0.0855 | 0.0802 |
| Securitization at Origination: GNMA | -0.2354 | -0.2623 | -0.1859 | -0.1080 |
| Securitization at Origination: Private Label | -0.0399 | -0.0523 | 0.0078* | 0.0207 |
| Securitization at Origination: Portfolio | -0.1072 | -0.1399 | -0.1403 | -0.0464 |
| Origination Channel: Wholesale | 0.0683 | 0.0581 | 0.0265 | 0.0134 |
| Origination Channel: Correspondence | 0.0619 | 0.0627 | 0.0172 | -0.0061* |
| Origination Channel: Purchased Account | 0.0899 | 0.0812 | 0.0334 | 0.0358 |
| Interest Only ARM at Origination | 0.0763 | 0.0741 | 0.0189* | 0.0548 |
| Option ARM at Origination | -0.3894 | -0.3685 | -0.7379 | -0.6631 |
| Investment Property | 0.0753 | 0.0788 | 0.0311 | 0.0278 |
| Insurance: FHA | 0.3371 | 0.3434 | 0.2556 | 0.1470 |
| Insurance: VA | 0.2512 | 0.2334 | 0.1704 | 0.0393 |
| Insurance: Private MI | 0.1735 | 0.1375 | 0.1170 | 0.1043 |
| Multifamily Property | -0.0684 | -0.0527 | -0.0631 | -0.0708 |
| Proportion of African American population | -0.0016 | -0.0015 | -0.0019 | -0.0019 |
| Proportion of Hispanic population | -0.0016 | -0.0015 | -0.0018 | -0.0019 |
| Proportion of Asian population | 0.0005* | 0.0003* | 0.0004* | 0.0004* |
| Proportion of Population with Bachelor or Higher | -0.0019 | -0.0018 | -0.0020 | -0.0022 |
| Proportion of Population Born Native | 0.0014 | 0.0012 | 0.0017 | 0.0019 |

| | | | | |
|---|---|---|---|---|
| Proportion of Population Not Moved | 0.0016 | 0.0018 | 0.0036 | 0.0030 |
| Homeownership Rate | -0.0001* | -0.0002* | -0.0009 | -0.0006 |
| Poverty Rate | -0.0008 | -0.0015 | -0.0017 | -0.0011 |
| Proportion of Population Self-Employed | -0.0064 | -0.0061 | -0.0041 | -0.0043 |
| Sand States | 0.0797 | 0.0904 | 0.0146 | 0.0224 |
| Number of Months since Modification | 0.0054 | 0.0063 | 0.0069 | 0.0088 |
| Origination Year=2000 | -0.1058 | -0.0941 | 0.0269* | 0.0242* |
| Origination Year=2001 | -0.1502 | -0.1611 | -0.0944 | -0.0980 |
| Origination Year=2002 | -0.1738 | -0.1678 | -0.1121 | -0.1172 |
| Origination Year=2003 | -0.1828 | -0.1770 | -0.1689 | -0.1795 |
| Origination Year=2004 | -0.1610 | -0.1505 | -0.1420 | -0.1469 |
| Origination Year=2005 | -0.0900 | -0.0845 | -0.1085 | -0.1055 |
| Origination Year=2006 | -0.0371 | -0.0348 | -0.0595 | -0.0525 |
| Origination Year=2007 | -0.0087* | -0.0007* | -0.0192 | -0.0141 |

Logistic regressions with 60 day default indicator for loans originated between 2000 and 2008, and modified between 2008 and 2014 (3rd quarter) from Mortgage Metrics database. Servicer fixed effects are included in all of the regressions reported, but coefficients are omitted.

*: P-value > 0.05