TAILORING LOAN MODIFICATIONS:
When is Principal Reduction Desirable?

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ABSTRACT

The problem of underwater mortgage borrowers whose house is worth less than what they owe on it has defied solutions. The ability to reduce the amount owed through a loan modification has been proposed to address this issue. Unfortunately, not much is known about the impacts of principal reduction on redefault risks within the dynamic framework of continued house price changes. In this study, we examine the desirability of principal reduction in loan modifications using two different measures: redefault risks and net present value calculations. Overall, we find that tailoring loan modifications to the specific characteristics of the market and the borrower has the highest likelihood of succeeding in the long run. For instance, in several markets, loan modifications are more likely to be successful if they include principal reduction than if they rely on interest rate reductions exclusively. Our analysis suggests that it is possible to develop a set of criteria to guide loan modifications that make full use of all options, including principal reduction.

1. INTRODUCTION

Nationally, house prices increased 89 percent from 2001 to 2006 (Standard & Poor's 2009). In some markets, the increase was 150 percent or even higher during the same period. The price bubble burst in 2006 leading to a foreclosure crisis, a credit crunch, a financial crisis, and now an economic recession, nationally and globally, unseen since the 1930s. The causes behind the crisis are multiple but arguably the availability of nontraditional nonprime mortgages played a central role (Quercia and Rattcliffe 2009).

It has been well documented that flexible underwriting standards allow loan applicants to borrow more and thus bid more for houses (Quercia, McCarthy, and Wachter 2005). In a consistent manner, subprime and Alt-A adjustable rate mortgages allowed loan applicants to borrow more than under a traditional fixed rate mortgage that required amortizing, fixed monthly payments, escrows of taxes and insurance, and documentation of ability to repay. The widespread use of yield spread premiums rewarded mortgage brokers for originating these mortgages over the traditional fixed rate counterpart (Ernst, Bocian, and Li 2008). Lower returns elsewhere made investment in these mortgages very desirable to investors due to their higher interest rates thus attracting more capital to this market. Mortgage originators started offering non-traditional mortgages more widely encouraging ever more marginal loan applicants to borrow. At the extreme, originators even offered mortgages that allowed applicants to borrow more than the value of the house. This trend was capitalized by home sellers into higher and higher asking prices.

As the bubble burst, many borrowers fell into a so-called “underwater” situation, i.e., the house is worth less than what they owe to the bank. These borrowers are unable to refinance or sell the home when confronted with a crisis, such as an interest rate reset or job losses.

In response to the financial and economic crisis, the Federal Reserve, the Department of Treasury, and other agencies have put in place several initiatives to try to increase willingness of financial institutions to lend. They have reduced rates, increased access to capital, and have begun to buy mortgage backed securities and U.S. Treasury debt to further increase the liquidity in the market and hold interest rates low (Bernanke 2009).

Taken together, the initiatives are expected to reduce borrowing costs so that current borrowers with high interest mortgage are able to refinance and potential home buyers are able to enter the market and purchase down the oversupply of homes for sale. There seem to be indications that the initiatives are helping some borrowers refinance from higher interest mortgages. If lending resumes and the economic recovery gains traction, more potential home buyers will be in the market thus slowing down the continued decline in prices and ideally over the longer run, reversing the trend and leading to prices stability.

However, even at best, house prices are likely to stabilize at much lower levels than prior to the bubble burst. This is because these initiatives do not address the run up in prices attributable to the widespread use of nontraditional subprime and Alt-A mortgages. Absent these mortgages, borrowers will be able to borrow less and marginal borrowers will be unable to borrow at all, resulting in a sharp reduction in the potential demand for housing. Even with working credit markets, it will likely take many years before house prices can reach their pre-bust levels.

This presents a dilemma for policy makers. Is there a good solution for borrowers who bought close to the peak, say 2005 or after? For instance, what can policy makers do for borrower who bought a house for $300,000 with a zero down, no escrow, adjustable rate subprime mortgage with a teaser rate, and today the house worth is $200,000 and the mortgage payment on the now fully indexed mortgage is unaffordable? Borrowers in this condition are unable to refinance to take advantage of lower rates and they cannot sell their homes. And even if payments are lowered through a reduction in interest, the house is still worth less than the amount owed.

Recent regulatory changes have been announced in an attempt to address this issue directly for GSE and FHA loans. Fannie Mae and Freddie Mac were authorized to refinance loans with LTVs up to 125 percent (originally up to 105 percent LTV). However, such refinances will not allow for a write down. Similarly, as part of its Hope for Homeowners program (H4H), the Department of Housing and Urban Development (HUD) announced that starting August 15, 2009, servicers can reduce the principal amount of a troubled FHA-insured mortgage by up to 30% so the homeowners' monthly payments are reduced to 31% of income. (HUD 2009). Unfortunately, these initiatives have not been fully implemented to know the extent of their impacts.

Following the GSEs and FHA, should lenders broadly be required to reduce the outstanding principal balance, maybe in exchange for some future equity appreciation ("clawback")? Should bankruptcy judges be allowed to reduce the mortgage debt on a homeowner's primary residence ("cramdown")? Would such initiatives minimize the likelihood of borrowing walking away from their homes? Unfortunately, without additional research these questions are difficult to answer. If modifications that rely on principal reductions are successful in keeping borrowers now underwater in the home, thus reducing long term risks to lenders, investors, and others, then the answer to the questions ought to be based, at least in part, on whether the costs associated with principal reduction are less than the costs associated with foreclosure and who benefits. In this study, we examine the success rate of different types of loan modifications, with or without principal reduction, for different borrowers in different markets. We rely on two measures of long term success: redefault risks and a net present value calculation.

2. LITERATURE REVIEW

As a policy solution, principal reduction is appealing because it deals squarely with the central aspect of the housing crisis: the sharp decline in prices and what to do with borrowers underwater. In the section, we provide a simple anatomy of house price decline and review the literature on the impact of loan modifications.

The anatomy of house price decline

As stated above, the proliferation of subprime and Alt-A mortgages seems to be at the root of the boom and bust in housing prices. If this contention is accurate we can expect to see a higher boom and a sharper bust in markets with a higher incidence of toxic mortgages, mortgages with teaser rates and other loan characteristics that allow borrowers to borrow more.

An examination of recent trends at the state level supports this contention (Table 1). States with the highest share of subprime lending as of December 2007, also had the highest increased in pre-bust house prices and the sharpest price drop after the bust. In California, Arizona, Florida and Nevada, a lot of nontraditional subprime products helped a lot of people get into homes but these markets have been especially hard hit and they find it difficult to recover. Recent borrowers in these states have severe problems of concentrated foreclosures and significant negative equity. In the analysis below, we classify the markets primarily based on the share of subprime mortgages in different states.

Challenges of dealing with homeowners underwater

By providing troubled homeowners with relief, modifications have been regarded as a tool for foreclosure avoidance. The details of the government's Home Affordable Modification Program (HAMP) became available on March 4 2009 (U.S Department of

Treasury 2009).[1] Expanding on the loan modification experience of the Federal Deposit Insurance Corporation (FDIC) at Indy Mac, the government's plan relies on a net present value calculation to estimate whether a loan modification is more desirable than a foreclosure. Mortgage payments are brought down to an affordable level of 31 percent DTI through rate reduction, term extension, and principal forbearance. The plan is very explicit on how to use rate reductions and term extensions, but provides little clarity on the principal reduction approach. In the plan, principal reduction will only be considered if other means of making a mortgage payment affordable do not bring payments down to a reasonable level. In practice, principal reduction has been quite rarely used by servicers (White 2008, Credit Suisse 2009).

There are, no doubt, several obstacles to expanding the use of principal reduction modifications. First, there has been uncertainty with regard to market trends and likely government action and the government plan does not provide enough incentive for banks to prefer principal reduction over other alternatives. As a rule, market participants need clarity before acting. Furthermore, servicers do not have the incentive to prefer principal reduction over other options since they are paid less if the principal is reduced.[2] While a principal reduction is ideal for the borrower and may be the best choice for investors on a net present value basis, investors are reluctant to agree to an outright principal reduction loan mod because it forces them to take a write down on their books now and permanently.

A second obstacle is the issue of securitization. Mortgage servicers may be reluctant to modify loans for fear of being held liable by bond holders because contracts have restrictions on the kinds and numbers of loan modifications that can be made. Moreover, mortgage backed investment instruments often have credit enhancement that are supposed to make the investor whole in the case of a foreclosure. In these cases, the bond holder would have to agree to take less through a loan modification than the credit enhancement is expected to pay.

Recent studies have found some evidence that frictions because of the securitization may preclude efficient loan modifications thus increasing re-default risks. Conditional on a loan becoming seriously delinquent (60+day), the likelihood of foreclosure of a portfolio loan is lower in absolute terms than that of a securitized loan --19 percent to 33 percent, respectively, relative to the mean foreclosure rate (Piskorski, Seru, and Vig 2008). The authors suggest securitization may preclude effective loss mitigation efforts, including loan modifications, thus increasing foreclosure risks. A more recent study finds that once in default, portfolio loans are no more likely to get a modification than those held by securitization trusts, however, they are significantly less likely to redefault than modified loans held by securitization trusts, conditional on receiving a modification (Adelino,

[1] More detailed guideline for second-lien modification, home price decline protection incentive, and foreclosure alternative programs became available in May 2009.

[2] In the event of principal forgiveness, the payment reduction cost share continues to be based on the change in the borrower's monthly payment from 38 percent to 31 percent front-end DTI ratio and limited to five years. The government's strategy involves reducing their interest rate for five years and giving them, at most, $5,000 for principal reduction over five years.

Gerardi, and Willen 2009). The authors did not provide explanations behind this pattern. It may be possible that servicers are more careful when modifying their own loans than securitized loans or in post-modification servicing. In fact, the servicers have a conflict that all but guarantees they will not modify loans to maximize bondholder value. Once a homeowner is in default, the servicer must advance that homeowner's monthly payments to the bondholders, getting repaid itself only when the house is sold or the loan is modified. As a result, in order to get their money back fast, cash-strapped servicers may want to foreclose prematurely or do a quick modification without due diligence and without fully considering all the alternatives, including principal reductions. As a result, a higher default rate of securitized loans is not surprising. Unfortunately, none of these two studies considered the type of loan modification being implemented.

By introducing foreclosure alternatives that lower cost for the borrower, the lender/servicer encounters an implicit moral hazard issue: the willingness to negotiate a less costly solution for borrowers can itself lead to more defaults (Ambrose and Capone 1996). In other words, providing a less costly option by modifying the terms of a mortgage may signal to other borrowers that the costs associated with default have declined sufficiently, which would result in more defaults than otherwise would have occurred. To limit the moral hazard problems associated with lowering borrower default costs, Ambrose and Capone (1996) suggested that lenders or servicers should restrict foreclosure alternatives to liquidity-constrained borrowers. Ideally, such an approach dan also assist lenders deal with borrowers who may eventually work out their situation on their own, a so-called Type II error. In practice, the moral hazard and Type II problems have been addressed by the requirement of full financial disclosure by defaulted borrowers; only true hardship cases will receive assistance (Inside Mortgage Finance 2008).[3]

Overall, although lenders and servicers have scaled up their efforts and adopted a wider variety of loss-mitigation techniques, ever higher foreclosure rates suggest that more can, and should, be done. We need to understand better what type of modification is most appropriate for specific borrowers in given markets. The fact that many troubled borrowers have little or no equity suggests that greater use of principal writedowns or short payoffs, perhaps with shared appreciation features, could be in the best interest of all parties.

Principal reduction and redefault risks

Why do borrowers with modified mortgages redefault? Broadly, there are two complementary theories to explain why borrowers stop making mortgage payments: the "option" theory and the "trigger-event" theory. According to the option theory, the borrower exercises the put option when he has a negative equity in the property (Foster

[3] Even in the absence of the above obstacles, we believe that there is a lack of capacity in the servicing industry to undertake the large number of loan modifications required. Moreover, making sound modification decisions, especially when principal reduction may be involved, is costly; servicers do not want to spend the money and lack the personnel to do the job. It is likely that the industry will grow but it will take time to reach the needed scale.

and Van Order 1984, Vandell and Thibodeau 1985, Quercia and Stegman 1992, Kau, Keenan, and Kim 1993). When the property value has fallen below the amount owed on the loan, the borrower has the incentive to default and to let the lender take the property. Geanakoplos and Koniak (2009) shows the default rates for subprime mortgages and other non-prime mortgages are extremely sensitive to whether a homeowner has an ownership stake in his home: without controlling for other factors a borrower with a LTV of 160 percent is 8 times more likely to default than a borrower with significant equity in the property (with a LTV of 60 percent).

The trigger-event theory focuses on "life-changing" events that affect the homeowner's ability to make mortgage payments, because of either a sudden drop in or loss of income or an unforeseen increase in expenses (Vandell 1995). Income disruptions typically are associated with a loss of employment or adverse change in family circumstances, such as an illness, death or divorce. In addition, some environmental factors, such as local economic conditions and changes in underwriting standards, also influence a borrower's decision to default (Cutts and Merrill 2008). Since most borrowers with modified loans were delinquent to some degree before the loan modifications, most if not all of them should have had disruptions in income or unforeseen expenses. As a result, payment relief through a loan modification should help them keep current with required mortgage payments. However, the level of equity in the property is more important in many cases, because if there is sufficient equity in the home, borrowers can simply sell the property or refinance it if they cannot make the mortgage payment. In these cases, income disruptions are usually insufficient to cause severe default. More simply put, loan to value has always been the most consistent determinant of default. The conventional wisdom is that the trigger events explain delinquency while the option theory explains default; in this way, they are not really competing, but complementary, explanations.

One group of studies has examined whether a variety of loss mitigation efforts prove helpful to borrowers. For FHA loans, Capone and Metz (2003) found that loss mitigation programs successfully lowered the foreclosure rate; the probability of a FHA loan reaching foreclosure is dramatically reduced when the loans goes through a forbearance agreement (from 77.6 percent in 1998 to 14.5 percent in 2002). Cutts and Green (2005) provided an excellent review of servicing literature and Freddie Mac's innovations in loan servicing and loss mitigation. Using Cox's hazard model to investigate the impact of repayment plans on foreclosure incidence they found that borrowers who enter a repayment plan have a much lower probability of losing their home (80 percent lower for borrowers overall and 68 percent lower for low- to middle-income borrowers). They also found that borrowers who had previously had a loan modification but were again in default were significantly less likely to fail than those who had not previously been through a loan modification, perhaps because of the borrower's willingness to work with the servicers to reach a positive resolution.

There is scant evidence about the effectiveness of different types of loan modifications but several recent empirical studies and industry reports started to examine this issue. Cutts and Merrill (2008) documented that the success rate of modified loans varies by the amount of arrearage capitalized into the loan modification; not surprisingly, there is a

direct relationship between a lower arrearage and a lower failure rate. Credit Suisse (2008) reported that rate-freeze modifications and principal reduction modifications have lower redefault rates than traditional modifications, but the analysis does not control for borrowers' risk characteristics nor delinquency status at the time of modification. A recent study based on a sample of private-labeled securitized mortgages modified in the second quarter of 2008, Quercia and Ding (2009) found that modifications that significantly reduce mortgage payments generally reduce the short term redefault rate. They also found that loan modifications are more likely to succeed when made in early delinquency and that there are significant variations in the redefault performance across different servicers. These findings generally support the government's plan that aims to standardize the modification process, allowing troubled borrowers to get timely and consistent help.

Similarly, Credit Suisse (2009) found that subprime modifications with more significant payment relief have the lowest redefault rate. On the basis of the authors' assumptions, they suggest a loan modification with principal reduction has a higher net present value (NPV) than a rate-reduction loan modification, while a refinance into a low-cost FHA mortgage under the Federal Housing Administration's (FHA) Hope for Homeowners program(H4H) has the best NPV. However, some assumptions used in the NPV analysis, such as redefault rates, defy a precise quantification.

Overall, there is some consensus that a significant payment relief is able to reduce the re-default rate and the government's plan aims to encourage servicers to lower mortgage payment and to standardize the modification process. However, besides reporting aggregate results, few studies have specified the types of modification implemented or have attempted to understand the impact of the modifications beyond aggregate measures. There is some evidence that modifications need to be tailored to the specific characteristics of borrowers, loans, and markets. Are some modifications, including principal reduction, better than others? What type? For whom? In what market? The data and methods used to examine these questions are described below.

3. DATA AND METHODOLOGY

Data

Loan-level data on individual mortgages are available for a national sample of private-label securitizations, known as Columbia collateral file (White 2008). The data is available through remittance reports produced by the trustee on several mortgage pools, altogether containing more than four million outstanding mortgages. During the 2007–2008 reporting period, the pools were serviced by many of the leading mortgage servicing companies.[4] The reports provide loan-level details on loan characteristics, property type, geography, and etc. The reports have information about the loan balance, mortgage payment, and interest rate, both before and after modification, which allows us

[4] As documented by White (2008), a subset of this dataset includes seven of the top ten subprime originators in 2006 and six of the top fifteen subprime servicers in 2007.

to identify whether total mortgage debt, interest rate, or mortgage payments are reduced for individual homeowners. The monthly performance reports provide rich details on individual mortgage delinquency and foreclosure and we are able to track the performance of the modified loans through February 2009. Unfortunately, borrower income or debt-to-income information is not available in the dataset.

This analysis focuses on a sample of mortgage loans derived from remittance reports for the 2005, 2006, and 2007 securitizations, which cover over three million loans mostly originated in 2005 and 2006. We chose to focus on the 2005 and 2006 originations in these deals only because it is generally accepted that recent nonprime vintages, especially subprime ARMs, have performed worse than earlier ones and as a result they constitute the majority of the troubled homeowners that need to be saved. Although our sample is national in scope, about half of the mortgages are concentrated in California, Florida, Texas, Arizona, and a few other states.

Though the data does not allow us to identify the loan types for all the loans (62% have missing values for the loan type variable), we are confident that a vast majority of the loans in this sample are nonprime since they are private-label securities and as shown in Quercia and Ding (2009), most of the loans (about 90%) had at least one risk characteristic that is more common in the subprime sector.[5] Of course, restricting the analysis to modified loans alleviates this concern to some degree.

Of course, this sample of loans does not represent a statistically random sample of all mortgage loans or all nonprime mortgage loans. The loans are securitized loans, and servicers of securitized loans may have different incentives than lenders who retain ownership of mortgage loans. So this sample of voluntary loan modifications may not be representative of loan modifications by portfolio lenders. Nevertheless, given that nonprime mortgages account for more than half of all foreclosures and that the vast majority of nonprime loans that led to the crisis were securitized, this sample provides important insights as to what voluntary loan modification programs have yielded to date in the nonprime market.

Characteristics of modified loans

We restricted the analysis to 51,674 loan modifications reported during the period from January 2008 to November 2008 only since not enough time has elapsed to observe the outcome of the more recent modifications. All these loans are owner-occupied first-lien mortgages originated in 2005 and 2006. The number of modifications is large considering that for the whole year of 2008 OCC and OTS (2009) reported about 447,000 modifications and HOPE NOW (2009) reported about 646,000 modifications for the whole industry. Although the majority of the modified loans in our study sample had experienced some delinquency, 31 percent had never experienced any delinquency during the 12 months prior to the modification. So the borrowers holding modified loans can be

[5] Features that are considered risky include 1) borrower FICO score less than 620; 2) interest-only mortgage; 3) negative amortization mortgages; 4) limited or no documentation; 5) original loan-to-value ratios higher than 90 percent.

divided into two basic groups: those with loans that were already past due under the current terms; and those that remained current but were considered to be in "imminent default", for example as a result of pending interest rate resets.

Descriptive statistics of the modified loans are listed in Table 2, which reports the average loan size, delinquency status, borrower credit score, location, and interest rate of each of the modified loans. The data confirm the heterogeneity of borrowers receiving loan modifications. Borrowers holding modified loans generally had quite low origination FICO scores, with an average of about 614. More than a half the loans were refinance loans (55%). A majority (87.6%) were adjustable rate mortgages. About 24 percent of them were interest-only mortgages and a small percentage (4.5%) were negative amortization loans. Over one-third of them (38.7%) had limited or no documentation at origination. About 53.5 percent were originated in 2006; the remainder in 2005.

Just over a half of the modifications (60%) led to reduced monthly principal and interest (P&I) payments (see Table 3). But 21 percent of reported modifications resulted in payment increases, likely a product of recasting arrears. The remaining 19 percent of modifications had roughly the same P&I payment (less than one percent change). On average, the monthly payment was reduced from $1,746 to $1,498 for all modified loans. But the reports do not disclose whether the payment changes and rate reduction are permanent or temporary for this sample.

These loan modifications actually increased the aggregate outstanding mortgage debt. The average unpaid balance on the modified loans went from $235,673 before modification to $240,659 after modification. A small share of modified loans (5.8%) did have their principal balance reduced, but only four percent reduced principal by more than 10 percent and they were primarily from one major servicer. The news is slightly better regarding the reduction in interest rates. More than half (about 66%) experienced an interest rate reduction. On average the interest rate of modified loans dropped from 8.89 percent to 6.82 percent after modification, still significantly higher than the prevailing 30-year fixed rate on prime mortgages during the period of lower than 6 percent.

The most common modifications were either interest reduction only (61%), in which the interest rate was cut but the principal remained the same or increased slightly, or a traditional modification (33%), in which the interest stayed the same but principal balance and mortgage payment increased (Table 3). These increases were likely because of capitalization of unpaid interest or other charges.

About 44.4 percent of these modifications had ever experienced 30+days delinquency on or before February 2009, lower than the 55 percent six-month redefault rate reported by OCC and OTS (2009). Over 17 percent had entered the foreclosure process. We will examine how redefault rates vary by the types of modifications in the next section.

Methodology

We used a mixed logit model to identify the determinants of the redefault of modified loans. Compared to the standard logit, this model allows us to capture the unobserved heterogeneity to investigate the borrowers' behavior after modification. We assume a sample of I respondents with the choice of J alternatives on T choice occasions. A homeowner is assumed to consider the full set of offered alternatives in choice situation t and to choose the alternative with the highest utility.[6] The utility that individual i derives from choosing alternative j on choice occasion t is given by:

$$U_{ijt} = \beta_i' x_{ijt} + \varepsilon_{ijt} \quad (1)$$

Where β_i is a vector of coefficients, x_{ijt} is a vector of observed attributes relating to individual i and alternative j on choice occasion t, and ε_{ijt} is a random term that is assumed to be an independently and identically distributed extreme value (IID).[7] In other words, within a standard logit context we impose the condition that ε_{ijt} is independent and identically distributed.

Because parameters are confined to be fixed and the error structure is treated as white noise (IID condition), the standard logit model does not allow the error components of alternative outcomes to be correlated, with little behavioral definition (Jones and Hensher 2004). The restrictive assumptions associated with the IID condition can result in significant information loss in model estimation. It is highly likely that the information relevant to making a choice that is unobserved may indeed be sufficiently rich in reality to induce correlation across the alternatives in each choice situation and indeed across choice situations.

The mixed logit model recognizes the role of such information and handles it by using a random parameter specification. The random parameter specification involves specifying each ß associated with an attribute of an alternative as having both a mean and a standard deviation.[8] The individual-specific coefficient, β, is treated as a random parameter which has a distribution, instead of a fixed parameter. The density for β is denoted as $f(\beta|\theta)$, where θ are the parameters of the distribution. That is, the distribution of β can be normal, lognormal, triangular etc. This specification allows us to capture the unobserved characteristics influencing the probability of redefault for modified loans. These characteristics are not measured or observed, nor are they measurement errors in the

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[6] Of course, we can also assume lender makes the decision (especially the decision of foreclosure) out of a set of alternatives in decision situation t, based on an evaluation of loan and borrower characteristics and other factors.

[7] The IID condition assumes that each random variable in a HsequenceH or other collection of Hrandom variablesH has the same Hprobability distributionH as the others and all are mutually HindependentH.

[8] Another way that the mixed logit models handle the unobserved information is to treat unobserved heterogeneity as a separate error component in the random component. In this error components approach, the error term is partitioned into additive parts: one part is correlated over alternative outcomes and heteroskedastic, while the other is IID over alternative outcomes. However, since the standard deviation of a random parameter is essentially an additional error component, the estimation outcome of these two approaches is identical and they lead to the same model when the random effects model has a non-zero mean.

variables. For example, if we assume β follows a normal distribution, the presence of a standard deviation of a β parameter accommodates the presence of preference unobserved heterogeneity in the sampled population. Conditional on knowing β_i, the probability of respondent i choosing alternative j on choice occasion t is given by:

$$L_{ijt}(\beta_i) = \frac{\exp(\beta_i' x_{ijt})}{\sum_{j=1}^{J} \exp(\beta_i' x_{ijt})} \tag{2}$$

The unconditional probability of the observed sequence of choices is the conditional probability integrated over the distribution of β. The unconditional probability is thus a weighted average of a product of logit formulas evaluated at different values of β with the weights given by the density f.

$$P_i(\theta) = \int \prod_{t=1}^{T} L_{ijt} \beta_i \; f(\beta \mid \theta) d\beta \tag{3}$$

Overall, the mixed logit provides more information than a standard logit, in that the mixed logit estimates the extent to which borrowers differ in their decision on their mortgages. The mixed logit model does have some basis in the fact that individuals do not do the same thing all the time for a variety of reasons that analysts cannot fully observe or explain. It is, broadly speaking, aligning itself much more with the reality where each individual has their own inter-related systematic and random components for each alternative in their perceptual choice set. Of course, the challenges people face with mixed logit models include a better quality of data which allows for the consideration of a greater amount of true behavioral variability in choice making and the specification of the distribution of the parameters (McFadden and Train 2000).

In this case, the dependent variable is an indicator variable for a modified loan i that takes a value of 1 if the loan redefaults. A loan is considered in default if it enters the foreclosure process or is in delinquent status in month t.[9] The model can be specified as following:

$$\Pr(Y_{it} = 1 | Modify) = f(\alpha + \beta * Mod\_type_i + \gamma * X_{it} + \eta * S_i + \kappa * M_i + \lambda * T_i + \varepsilon_{it}) \tag{4}$$

where Mod_type_i is the type of modification, X_{it} contains a set of loan and borrower characteristics, S_i contains a group of servicer dummies, M_i is a set of market dummies, and T_i is a control for time dummies, all further described below. Specifically, we tried one set of indicators of different loan modifications (Mod_type_i) by focusing on the different level of payment relief induced by a loan modification. We are interested in testing how the mortgage payment reduction affects the redefault probability of modified mortgages. While we are interested in including the loan mod types in the model directly,

[9] The number of loans that were prepaid after modification is quite small (about 1%). So we focus on two outcomes only here and include prepayments in the non-default category.

principal reductions have not yet been used to an extent which allows a clear determination on their success.[10]

X_{it} is a vector of factors that may influence the outcome of a modified loan. Specifically, we controlled for the following loan and borrower characteristics: FICO score at origination, documentation type, loan types (adjustable rate; interest-only, or fixed-rate), loan balance (in log), loan purpose (purchase or refinance), and duration after loan modification. We further controlled for the delinquency status and prior delinquency history of the borrower *at the time* of modification. We expect the delinquency severity represented by the delinquency status at the time of modification and the number of months in delinquency during the preceding 12 months to capture some of the information regarding quality of the borrower that is revealed *between* origination and modification.

We considered the impact of home equity based on the current loan-to-value (CLTV) ratio in each month, which was estimated by dividing the unpaid balance by the estimated house price in each month, using the original house price and the house price index (HPI) at the metropolitan statistical area (MSA) level provided by the Office of Federal Housing Enterprise Oversight (OFHEO). If the property is located outside an MSA, we used the state HPI. When second liens are in place, the estimated combined loan-to-value ratio is used, assuming the second liens had been paid off with a same speed as the first lien. We used the county unemployment rate to represent local economic conditions.

We included three dummies for different markets (M_i) based on the share of outstanding subprime mortgages as of December 2007 to account for variation of housing market conditions across regions. The first group (*market1*) includes the four "sand states," California, Nevada, Arizona and Florida, which had the highest share of subprime mortgages among all states. The housing markets in these states have severe problems of the concentrated foreclosures and the persuasiveness of significant negative equity in properties. The 17 states with the least subprime activity are set as the reference group.[11]

To capture the unobservable soft information of the practices of servicers and the changes in policy environment and macroeconomic conditions during the study period, we created a series of dummies (S_i) for major servicers and time dummies (T_i) for each observation quarter and the quarters in which the loans were modified. These controls should reduce the bias in the estimation.

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[10] We are able to construct four mutually exclusive dummy variables for the combinations of the interest rate change and principal change. The results suggest the types of loan mods with both a rate reduction and a principal reduction has the lowest redefault risk and rate reduction mods also have a lower redefault risk than traditional loan mods. But we cannot conclude on the relative effectiveness of different loan modifications here because these variables do not account for the magnitude of loan modifications.

[11] Based on the share of subprime mortgages, *Market1* includes NV, FL, CA, and AZ. *Market2* includes MI, UT, RI, TN, CT, IN, MD, OH, CO, and GA. *Market3* includes IL, HI, DE, TX, NH, MO, WA, MN, OR, NJ, MA, PA, MS, LA, ID, VA, OK, SC, AL, NY, and ME. And *market4* includes all other states.

4. EMPIRICAL RESULTS

The model was estimated using the mixed logit models. The command of *mixlogit* in Stata developed by Hole (2007) has been used to estimate the mixed logit models and it is assumed that random coefficients have a normal distribution here. Specification tests confirm the heterogeneity of the redefault behavior of borrowers with modified loans and the appropriateness of the mixed logit: the LR test confirms for the joint significance of the standard deviation is quite small (<0.001), implying rejection of the null hypothesis that all the standard deviations are equal to zero. The standard deviations of many coefficients enter significantly, suggesting a mixed logit provides a significantly better representation of the choice situation than standard logit.

To better understand the effect of mortgage payment relief and home equity on redefault, we first ran a model (*mixed1)* in which the mortgage payment variables and CLTV variables were treated as random variables, where the coefficients of these variables follow a normal distribution in the mixed logit model. As to other variables, the standard deviation parameters are statistically significant for the FICO score variables, the dummy for the "sand states" (*market1*), and duration after modification (*logdur*), indicating that these coefficients do indeed vary in the population. In model *mixed2*, these variables enter the model as random parameters, along with the payment relief and CLTV variables, while other variables enter the model with a single fixed parameter. Simulation was performed using ten random draws for each record and the mean and standard deviation of the random variables are estimated. Results of regressions are summarized in Table 4 and 5, in which entering foreclosure process and 30+day delinquency are used as the dependent variable respectively.

The findings are quite consistent when we use either foreclosure initiation or 30+day delinquency as the outcome measure. However there are some noticeable differences across different models. First of all, the sign of credit score variables changed from positive in the delinquency model to negative in the foreclosure model. As several recent studies have shown, the origination FICO score may not be a good predictor of the foreclosure behavior for delinquent borrowers. Piskorski, et al. (2008) found FICO score of serious delinquent borrowers is negatively associated with foreclosure and some possible explanations include the larger credit shock and the lack of soft information available for those high FICO loans. Stegman et al. (2007) found the origination FICO score variables are insignificant in predicting the redefault risk of delinquent loans. In this case, there might be some selection bias in the process of modification that has not fully captured by the model. Second, the magnitude of most CLTV variables is bigger in the foreclosure model, which suggests the impact of the home equity level (CLTV) is greater on foreclosure than on delinquency. This is consistent with the literature that home equity is best predictor of default while delinquency can be partly explained by some trigger events. It is somewhat counterintuitive that the coefficient of the unemployment variable is negative. We would like to attribute the mixed results on the unemployment rate variable to the sharp increase in the unemployment rate after late 2008 and the foreclosure moratorium adopted by government agencies and many major servicers during that period.

Based on the results from the mixed logit model (*mixed1* in Table 4), we estimated the cumulative redefault rate for a borrower holding a typical subprime mortgage in Table 6. Similar to Credit Suisse (2009), we assume the subprime borrower holding a mortgage with a CLTV of 114 percent, a front-end DTI of 50 percent, and being 90+day delinquent before modification. To compare the relative effectiveness of different loan modification alternatives, we further calculated the net present values for different loan modifications in different markets (Table 10). We consider three scenarios in which pre-modification front-end DTIs of 50 percent, 55 percent, or 40 percent are reduced to 31 percent post modification (consistent with HAMP). We took the need for intervention for granted and focused on examining ways of making the current intervention more effective. So whether a loan should be modified and what is the ideal debt level are not the focus of this study. Of course, we need to caveat that out results on redefault rates and NPVs are based on payment relief and home equity variables, without fully controlling for actual household debt ratios. The same level of payment reduction may have different impact for borrowers with different affordability. Further studies using more complete borrower income data are needed. Keeping that in mind, here we discuss the findings as to the impact of payment relief, type of loan modifications, and home equity primarily based on these estimation results.

Payment relief, home equity, and borrower heterogeneity

Consistently, on average, loan modifications that lower mortgage payment (P&I) have significantly lower redefault risks relative to those that result in an increased payment. The nine-month cumulative foreclosure rate for a typical loan mod with an increased mortgage payment is about 59.4 percent (Table 6). Though the foreclosure rate looks high, it is not surprising given the serious delinquency status (90+day) and the negative equity level at the time of modification. In sharp contrast, when payments are significantly reduced by more than 40 percent, the foreclosure rate is cut by more than a half (28.4%). Similarly, when the payment relief is reduced by 20-30 percent, the probability of foreclosure is reduced to about 45.1 percent. Even a payment relief of less than 10 percent results in a smaller but still significant reduction in redefault probabilities (to about 51%).

However, payment relief only is not as effective in all cases. Considered together, the estimated means and standard deviations of the coefficients provide information on the share of the population for whom payment relief is effective. For example, in the foreclosure model (*mixed1* in Table 4), the distribution of the coefficient of the 20-30 percent payment relief variable has an estimated mean of -0.329 with an estimated standard error of 0.359, such that 82 percent of the distribution is less than zero and 18 percent is greater than zero. This implies that when the mortgage payment is reduced by 20-30 percent, 82 percent of the modified loans have a lower foreclosure risk, while the other 18 percent do not. Unobserved heterogeneity may help explain why payment relief does not have significant impact on some borrowers. In fact, when we include in the model as random parameters borrower credit scores, the dummy for different markets,

and duration after modification, the standard deviations of the payment relief variables become insignificant (*mixed2*). This suggests some unobserved heterogeneity associated with borrower credit score buckets, market conditions, and duration after modification.

Consistent with the premises of the option-based theory, the level of equity--loan to value—is found to be a very consistent predictor of redefault (Table 4 and 5). For example, based on our estimation, when there is significant negative equity (CLTV>120%), a typical modified subprime loan with a 50 percent DTI exhibits a redefault rate of 70.1 percent (Table 6). In contrast, when there is significant equity present (CLTV<70%), the redefault rate is 34.9 percent, or 35 percent lower. Even when there is little equity present (CLTV of 95-100%), the rate is 49.6 percent or 20 percent lower. More importantly, unlike the payment relief variables, the standard deviations of the home equity variables are insignificant and their magnitude is quite small (*mixed1* in Table 4 and 5). This pattern is consistent with the view that loan modifications that lower the principal are likely to have the same positive effect for (almost) all borrowers. This is especially important during a prolonged period of economic downturn, which heightens the likelihood of job loss and continued house price declines.

Overall, these results suggest that loan modifications that reduce mortgage payment and/or increase home equity can reduce the redefault rate. But while a payment relief only reduces redefaults risk on average, it does not have a consistent effect on all modifications. In contrast, modifications that rely on increasing home equity are found to reduce redefaults risk for (almost) all borrowers. Here we examine below the type of modification most appropriate for different borrowers in specific markets.

Tailoring loan modifications in different markets

Payment relief can result from a reduction in interest rate, extension of the loan term, principal forbearance, and/or forgiveness of the principal owed. At the one end, loan modifications that rely on rate-reductions only lower the mortgage payment without changing the level of home equity. At the other end, loan modifications that rely on principal reduction impact redefault probabilities by increasing short term affordability and strengthening the borrower's long term equity position (lowered loan-to-value ratios). For example, for a typical subprime loan with a LTV of 114 percent and an interest rate of 8.5 percent, loan modifications that rely on rate reduction to lower DTI from 50 percent to 31 percent will result in a lower interest rate of 4.0 percent, a reduced payment (by 38 percent), and an unchanged loan-to-value ratio. Instead, a loan modification that relies on principal reduction results in a lowered LTV ratio (from 114% to about 70%),[12] in addition to the same level of payment reduction. Of course, it is also possible to reduce payments with a combination of the two. For instance, we can first reduce the interest rate market rate levels (5 percent) and then reduce the principal (to a LTV of about 101%) to achieve the desired 31 percent DTI threshold.

[12] To simplify the analysis, we do not include fees and other costs in the simulation.

Redefault rates vary greatly on the basis of the type of loan modification (Table 7). Among the approaches that can lower the payment from 50 percent DTI to 31 percent, the redefault rate of a principal reduction only is 27.5 percent, 13 percent lower than the one based on an interest rate cut only, and 32 percent lower than that of a traditional loan modification (59.4%). Redefault rates for modifications that combine rate and principal reductions are between those resulting from the rate-reduction only and the principal reduction only. Because modifications that rely on principal reduction address both the payment burden and home equity issues (option based considerations), it is not surprising that it exhibits the lowest redefault rate, even when they result in the same level of mortgage payment relief as the other types of modifications.

Because of some unobserved characteristics in different markets, the effect of the same type of loan modification may be quite different in different markets. The dummy for the sand states, those with higher share of subprime mortgages, is positive and highly significant while the other two dummies are insignificant. This suggests that modified loans in the four sand states are much more likely to redefault, even when they received the same type of modification. The difference is large: the foreclosure rate in these states is almost 90 percent relatively higher than that in other states. For example, for a modification that reduces the payment by 38 percent (from 50% DTI to 31%), a rate reduction only modification in sand states has a foreclosure rate of 60 percent, almost twice as high as that resulting from the same modification for a similar borrowers in other states (32%). For a principal reduction modification that can achieve the same level of payment reduction, the pattern is quite similar with a 42 percent foreclosure rate in the sand states and a 21 percent in other markets. Other markets exhibit similar redefault risks for the same type of modification (*market2* to *market4*).

There are two possible explanations for these findings. First, the sand states have experienced significant house price decline and as a result most foreclosures have been concentrated in California, Florida, Nevada, Arizona, and a few other metropolitan areas (Immergluck 2008). The problem of negative equity and the negative spillover effects from foreclosures may be more serious than what has been captured by the model.[13] Second, borrowers in these markets may be more vulnerable to foreclosures because of high debt ratios, a steep economic slowdown, and the corresponding sharp increases in unemployment rates.

These results highlight the importance of finding more innovative approaches to help borrowers in these troubled housing markets. For borrowers in markets which have experienced significant house price decline, payment relief without principal reduction addresses short-term affordability concerns but does not address the fundamental problem

[13] The OFHEO house price index used in the analysis is based primarily on repeated sales of conventional mortgages. It is likely that the index underestimates the house price decline in the sand states, where there was a concentration of subprime lending. Lucy and Herlitz (2009) state that “66 percent of potential housing value losses in 2008 and subsequent years may be in California, with another 21 percent in Florida, Nevada and Arizona, for a total of 87 percent of national declines.” California had only 10 percent of the nation's housing units but it had 34 percent of foreclosures in 2008.

of negative equity. It is difficult to see how such a modification alone can reduce long term redefault risks without dealing with the issue of negative equity directly.

NPV analysis

Redefault rates are critical to evaluating the desirability of different loan modification options. Government agencies, servicers, investors and others have been using a net present value test to compare the effectiveness of different loss mitigation options. They compare the NPV of one type of modification to others, and in particular to the expected foreclosure costs, based on different redefault rates assumptions. To complement the redefault rate analysis, we used a NPV test to estimate the desirability of various modification alternatives for a typical subprime loan. This is an important complement because, according to the government's HAMP program, the NPV test applies to the standard waterfall only and does not require consideration of principal forgiveness. However, under the plan, the servicers may choose to forgive principal if they determine that principal forgiveness improves the likelihood of loan performance and the value of modification.

Similar to Credit Suisse (2009), foreclosure costs are assumed to be 25 percent of the unpaid balance and the discount rate is assumed as 7.5 percent in the NPV test (Table 8). The interest rate before modification is assumed to be 8.5 percent. The payment reduction or principal reduction is assumed to be permanent.[14] We assume that a rate reduction modification prepays far more slowly (in 15 years) than a principal forgiveness modification (8 years) and the difference in the prepayment speed improves the NPV outcome for a principal reduction modification. We used the estimated nine-month foreclosure rates (entering foreclosure process) as a proxy for the cumulative foreclosure rates for rate-reduction only, principal reduction only, and a combination of rate and principal reduction (Table 7).[15]

In our baseline scenario, although slightly favoring modifications that combine both principal and rate reductions, the net present values of the three modification alternatives are quite similar (Table 9). The NPV from modifications with principal and rate reductions is about 60.6 percent of the outstanding loan balance, similar to 60.5 percent for the rate-reduction only, but slightly higher than the 59.6 percent for the principal

[14] The payment reduction assumption is generally consistent with the HAMP program in which if the resulting interest rate is at or above the current interest rate (Interest Rate Cap), the modified rate will the new note rate for the remaining loan term. If the resulting rate is below the current rate, it may be increased after five years. So our analysis may underestimate the NPV of some loan modification alternatives, such as the rate reduction mod mentioned early with a reduction of interest rate from 8.5 percent to about 4.0 percent.

[15] This may be questionable since modified loans may continue to redefault after 9 months and not all loans in the foreclosure process eventually end up in foreclosure. But as we checked, the cumulative redefault rate as measured by 30+day delinquency usually starts to stabilize after 9-12 months. More important, we are more interested in the relative effectiveness of different alternatives, than the absolute value of any particular option.

reduction only.[16] All compared favorably with the NPV associated with foreclosure sales which was about 42 percent.[17] In general, results of our NPV analysis are consistent with those of our redefault analysis. When the desired payment reduction is large (a 46 percent reduction) and when the property is in markets other than the sand states, the NPV tests generally suggest a combination of rate reduction and principal reduction or rate-reduction only has the highest NPV.

However, the principal reduction only modification becomes the best choice for investors when trying to achieve more modest payment reductions. For example, to achieve a reduction from 40 percent DTI to 31 percent (roughly 20-30 percent reduction in mortgage payment), a principal reduction only modification has a NPV of 68.6 percent, about 1.2 percent higher than that of a rate reduction only modification.

The principal reduction modifications (with or without a rate reduction) are also preferred over rate-reduction modifications in the sand states. In these states, loan modifications that rely on principal reduction generally have higher NPVs than modifications that rely on rate reduction only. For example, to achieve a reduction from 50 percent DTI, principal reduction has the highest NPV of all modification alternatives. When the front-end DTI is reduced from 40 percent to 31 percent through principal reduction, the NPV in the sand states is about four percent higher than that of a rate reduction only.

5. CONCLUSIONS AND IMPLICATIONS

In this study, we examined the impacts of incorporating principal reduction in loa modifications. More narrowly, we examined what types of modifications are most successful for what type of borrowers in what markets. The findings provide empirical support to several aspects of the government's plan, which aims to lower the mortgage payment to an affordable level through a waterfall process. Our results confirm that one key component to making modified loans more sustainable is that the mortgage payments are reduced enough to be truly affordable to the borrowers. The current government plan which focuses on rate reduction and payment relief primarily should address the problem faced by many troubled borrowers. The HAMP program also improves the net present value for investors significantly.

However, except for the recently announced GSE and FHA initiatives, the absence of specific guidelines for principal forgiveness and judicial foreclosure in the current plan is likely to limit the success of the program. This is an important omission because the current crisis is characterized by the pervasiveness of homeowners "underwater." When

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[16] Thus, without principal forgiveness, the simulation suggests that the DTI subsidy in the President's plan improves the NPV by 1.5 to 2 percentage points. Credit Suisse (2009) shows that house price decline insurance can further improve the NPV by about 5 percent.

[17] Of course, the results of the NPV calculation may be sensitive to some assumptions we made. But as we checked the relative effectiveness of different types of modifications has been generally consistent with the change of the discount rate, foreclosure costs, and the prepayment speed in a reasonable range. Results are available upon request.

borrowers have some equity in their homes, rate-reduction, term-extension, or principal forbearance that can lower the mortgage payment enough usually are capable of keeping them in their homes. But can this be a long term solution for someone who owes significantly more to the bank than what the house is worth, particularly in weak job markets that may result in temporary loss of income or reduction in earning capacity? We find that modifications that rely on rate reduction exclusively are not effective for all borrowers in all markets. In contrast, modifications that increase the level of home equity have more consistent impacts. More narrowly, we find that loan modifications with a principal reduction have the lowest redefault risks and can create even better cash flow for investors in many cases, especially in the states with more subprime lending, steepest price declines, and highest foreclosure rates. Probably, this is because such modifications do not only address short term affordability concerns but also longer term equity considerations.

Overall, the results emphasize the importance of developing guidelines to tailor modifications to the particulars of individual borrowers with specific loan products in specific housing markets. Despite being at the core of the current plan, the results show that payment relief based on rate reduction or term extension exclusively do work, but not in all the situations. We believe that more structured guidelines are specially needed with regard to the use of principal reduction which seems to work in most situations. Although the study findings are relatively robust, the data used in the analysis is not ideal. With more detailed information, government agencies, servicers, and investors should be able to develop more precise estimates and clear criteria for the use of principal reduction based on borrower segmentation, taking into consideration FICO scores, DTI, and LTV ratios, payment affordability, and the local market conditions.

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Table 1 An Anatomy of Different Markets based on Their Subprime Activity

state	% Subprime '07*	%Subprime '01-'06**	House Price Change '01-'06***	House Price Change '06-'08***	Market Coding
NV	4.83	26.00	106.99	-26.91	1
FL	4.45	27.80	119.75	-24.01	1
CA	4.10	22.30	116.37	-27.23	1
AZ	3.68	25.30	102.53	-17.94	1
MI	3.64	23.10	17.71	-11.07	2
UT	3.40	17.10	44.38	5.63	2
RI	3.26	21.30	97.23	-11.08	2
TN	3.25	15.30	32.01	5.25	2
CT	3.21	18.30	65.76	-4.04	2
IN	3.20	21.90	18.01	1.11	2
MD	3.14	27.80	110.29	-7.41	2
OH	3.11	18.90	18.00	-2.14	2
CO	3.08	17.00	25.78	1.45	2
GA	3.07	19.90	31.30	-0.14	2
IL	3.00	25.60	47.03	-1.43	3
HI	2.94	20.10	118.11	-3.44	3
DE	2.86	14.80	78.06	-2.91	3
TX	2.86	18.20	26.55	7.81	3
NH	2.72	17.00	64.78	-6.00	3
MO	2.70	21.10	36.14	1.41	3
WA	2.60	18.70	69.71	1.28	3
MN	2.59	21.00	50.54	-5.34	3
OR	2.53	17.30	72.12	-1.02	3
NJ	2.42	20.30	90.46	-5.83	3
MA	2.35	18.00	58.38	-6.77	3
PA	2.35	14.30	59.57	1.92	3
MS	2.34	18.80	32.84	4.43	3
LA	2.27	18.60	43.64	4.50	3
ID	2.24	19.20	64.97	2.14	3
VA	2.22	20.00	88.98	-4.14	3
OK	2.18	17.00	29.00	6.42	3
SC	2.06	12.80	35.84	4.49	3
AL	2.02	16.80	34.22	5.85	3
NY	2.01	20.10	77.10	-3.36	3
ME	1.94	17.60	66.85	0.11	4
WI	1.91	21.00	38.94	0.74	4
KY	1.89	16.20	25.94	4.41	4
NC	1.89	12.60	32.18	6.30	4
DC	1.88	21.70	133.76	-4.66	4
NE	1.79	16.90	22.21	1.90	4
WY	1.70	15.50	68.75	9.59	4
KS	1.68	16.10	26.68	3.03	4
AR	1.67	15.80	34.47	3.30	4
NM	1.66	14.80	56.76	2.86	4
IA	1.61	17.00	25.58	3.26	4
AK	1.42	20.60	58.25	2.69	4
MT	1.16	14.50	65.21	6.94	4
VT	1.16	15.50	71.05	2.30	4
SD	1.00	12.90	35.31	7.87	4
WV	0.87	11.60	37.28	2.41	4
ND	0.69	14.80	40.33	11.02	4

* Percentage of subprime in 2007 represents the share of outstanding subprime loans per 100 housing units as of December 2007 based on the Loan Performance data. ** The change in subprime share is is based on the HUD list approach for the year 2001 and the high-cost approach for 2006. ***Changes in house price is based on the OFHEO house price index.

Table 2 Descriptive Statistics of Loan Modifications

Characteristics	Value (mean or percent)
Original FICO	613.5
Appraisal Value	$267,662
OLTV	81.46%
CLTV at origination	84.94%
Home purchase	45.40%
ARM	87.57%
Interest Only	24.42%
Negative Amort	4.47%
Full-doc/Alt-doc	61.29%
30- or 60-day delinquent	18.50%
90-day delinquent	42.30%
Loan Modification	
Principal before mod	$235,673
Principal after mod	$240,659
Interest rate before mod	8.88%
Interest rate after mod	6.82%
P&I payment before mod	$1,746.0
P&I payment after mod	$1,498.6
Origination Year	
2005	46.51%
2006	53.49%
Property Location	
CA	22.55%
FL	11.86%
TX	4.93%
NY	4.17%
MI	3.96%
IL	3.85%
AZ	3.60%
Others	45.10%
Servicer	
Servicer 1	28.84%
Servicer 2	16.13%
Servicer 3	13.87%
Servicer 4	7.87%
Others	33.30%
Redefault as of Feb 09 (30+day)	44.42%
Redefault as of Feb 09 (Foreclosure initiated)	16.75%
N	51,674

Table 3 Types of Loan Modifications

Loan mod type		Percent
By rate/principal reduction	rate reduction and principal reduction	4.72%
	rate reduction only	61.44%
	principal reduction only (rare)	1.07%
	no rate reduction and no principal reduction (traditional)	32.77%
By payment relief	>40% reduction	8.9%
	30-40% reduction	10.4%
	20-30% reduction	15.6%
	10-20% reduction	15.6%
	5-10% reduction	5.7%
	1-5% reduction	3.7%
	No reduction	19.1%
	Increase	21.0%
Total		51,674

Note: Based on the 2005 and 2006 originations in the 2005, 2006 and 2007 deals of the Wells Fargo remittance reports. All second-liens, non-owner-occupied, and loans with missing information have been excluded.

Table 4 Payment Relief and Redefault (Entering Foreclosure)

		Mixed 1			Mixed 2		
	status	Coef.	z	P>z	Coef.	z	P>z
Mean	time_in_del in 12 mons	0.057	11.930	0.000	0.070	12.150	0.000
	30-60 day del at mod	0.153	3.690	0.000	0.179	3.740	0.000
	90+day del at mod	0.616	13.730	0.000	0.723	13.510	0.000
	log_amt	-0.526	-53.480	0.000	-0.621	-49.270	0.000
	Arm	0.146	3.880	0.000	0.228	4.980	0.000
	Io	0.280	6.320	0.000	0.379	7.160	0.000
	full_doc	-0.203	-7.970	0.000	-0.240	-7.920	0.000
	home purchase	0.066	2.700	0.007	0.126	4.340	0.000
	unemployment	-0.048	-7.330	0.000	-0.044	-5.820	0.000
	cred<580	-0.257	-3.750	0.000	-0.726	-8.830	0.000
	cred 580-620	-0.122	-1.860	0.063	-0.448	-5.880	0.000
	cred 620-660	-0.137	-2.110	0.035	-0.467	-6.180	0.000
	cred 660-720	-0.225	-3.300	0.001	-0.388	-4.560	0.000
	mkt1	0.740	13.890	0.000	0.918	14.080	0.000
	mkt2	-0.026	-0.500	0.616	-0.055	-0.870	0.384
	mkt3	-0.028	-0.570	0.571	-0.065	-1.100	0.273
	mons after mod (in log)	1.916	39.080	0.000	2.247	35.150	0.000
	>40% pmt red	-0.852	-9.000	0.000	-1.108	-14.270	0.000
	30-40% pmt red	-0.441	-8.260	0.000	-0.562	-9.990	0.000
	20-30% pmt red	-0.329	-6.210	0.000	-0.370	-7.820	0.000
	10-20% pmt red	-0.171	-3.840	0.000	-0.148	-3.440	0.001
	5-10% pmt red	-0.193	-2.850	0.004	-0.119	-2.000	0.045
	1-5% pmt red	-0.073	-1.020	0.309	-0.034	-0.490	0.624
	No pmt red	-0.118	-3.220	0.001	-0.149	-3.360	0.001
	CLTV<70%	-0.831	-14.170	0.000	-0.481	-7.010	0.000
	CLTV 70-80%	-0.654	-12.940	0.000	-0.392	-7.590	0.000
	CLTV 80-90%	-0.501	-10.960	0.000	-0.254	-5.440	0.000
	CLTV 90-95%	-0.391	-7.770	0.000	-0.136	-2.600	0.009
	CLTV 95-100%	-0.426	-8.180	0.000	-0.178	-3.280	0.001
	CLTV 100-110%	-0.301	-6.560	0.000	-0.067	-1.400	0.162
	CLTV 110-120%	-0.208	-4.060	0.000	-0.010	-0.180	0.856
	_cons						
Standard Deviation	cred580				1.282	17.170	0.000
	cred620				1.099	16.570	0.000
	cred660				1.127	16.210	0.000
	cred720				-0.772	-6.660	0.000
	mkt1				0.173	1.960	0.050
	mons after mod (in log)				0.134	2.240	0.025
	>40% pmt red	0.252	0.710	0.478	-0.242	-1.270	0.204
	30-40% pmt red	0.164	0.710	0.478	0.112	1.090	0.275
	20-30% pmt red	-0.359	-2.310	0.021	-0.052	-0.710	0.480
	10-20% pmt red	0.478	4.100	0.000	0.012	0.210	0.832
	5-10% pmt red	0.681	5.250	0.000	0.001	0.010	0.989
	1-5% pmt red	-0.532	-3.020	0.002	0.257	2.570	0.010
	No pmt red	-0.044	-0.420	0.673	-0.027	-0.530	0.596
	CLTV<70%	0.016	0.150	0.881	0.108	1.280	0.201
	CLTV 70-80%	0.131	2.030	0.043	-0.072	-1.420	0.154
	CLTV 80-90%	0.006	0.140	0.885	0.085	2.360	0.018
	CLTV 90-95%	-0.079	-1.310	0.189	0.020	0.400	0.693
	CLTV 95-100%	0.102	1.680	0.093	0.019	0.350	0.726
	CLTV 100-110%	0.050	1.100	0.270	-0.014	-0.310	0.753
	CLTV 110-120%	0.080	1.370	0.170	-0.055	-1.020	0.309
		Log likelihood = -35,280			Log likelihood = -35,238		

Note: N=313,701 loan months of 51,674 loans. Other controlled variables in the model not listed here include observation quarter dummies, quarter dummies when the loan was modified, dummy for originations in 2006, and dummies for major servicers. The sign of all standard deviations should be positive and it is negative for some of them here just because of the estimation algorithm of the mixlogit command in Stata (Hole, 2007).

Table 5 Loan Modification Type and Redefault (30+day delinquency)

		Mixed 1			Mixed 2		
	status	Coef.	z	P>z	Coef.	z	P>z
Mean	time_in_del in 12 mons	0.072	24.450	0.000	0.082	23.900	0.000
	30-60 day del at mod	0.320	13.150	0.000	0.340	12.880	0.000
	90+day del at mod	0.539	19.540	0.000	0.575	18.860	0.000
	log_amt	-0.261	-49.140	0.000	-0.277	-45.740	0.000
	Arm	0.107	4.670	0.000	0.125	4.890	0.000
	Io	0.154	5.640	0.000	0.177	5.860	0.000
	full_doc	-0.153	-9.540	0.000	-0.165	-9.280	0.000
	home purchase	0.093	6.040	0.000	0.103	6.100	0.000
	unemployment	-0.016	-4.080	0.000	-0.018	-4.130	0.000
	cred<580	0.092	2.170	0.030	0.060	1.360	0.174
	cred 580-620	0.147	3.570	0.000	0.122	2.850	0.004
	cred 620-660	0.085	2.100	0.035	0.056	1.310	0.189
	cred 660-720	-0.070	-1.670	0.095	-0.067	-1.530	0.127
	mkt1	0.380	11.390	0.000	0.407	10.890	0.000
	mkt2	0.014	0.430	0.669	0.010	0.290	0.772
	mkt3	0.005	0.180	0.859	0.002	0.050	0.958
	mons after mod (in log)	0.524	25.030	0.000	0.632	23.800	0.000
	>40% pmt red	-0.902	-21.340	0.000	-0.968	-25.760	0.000
	30-40% pmt red	-0.558	-19.570	0.000	-0.624	-19.450	0.000
	20-30% pmt red	-0.443	-17.940	0.000	-0.495	-17.930	0.000
	10-20% pmt red	-0.313	-13.500	0.000	-0.346	-13.450	0.000
	5-10% pmt red	-0.187	-5.710	0.000	-0.198	-5.640	0.000
	1-5% pmt red	-0.137	-3.580	0.000	-0.138	-3.340	0.001
	No pmt red	-0.209	-9.010	0.000	-0.227	-8.840	0.000
	CLTV<70%	-0.311	-8.240	0.000	-0.332	-8.130	0.000
	CLTV 70-80%	-0.191	-6.850	0.000	-0.202	-6.660	0.000
	CLTV 80-90%	-0.164	-6.370	0.000	-0.181	-6.460	0.000
	CLTV 90-95%	-0.112	-3.760	0.000	-0.114	-3.590	0.000
	CLTV 95-100%	-0.085	-2.810	0.005	-0.094	-2.910	0.004
	CLTV 100-110%	-0.087	-3.220	0.001	-0.096	-3.310	0.001
	CLTV 110-120%	-0.055	-1.750	0.080	-0.067	-2.010	0.044
	_cons						
Standard Deviation	cred580				-0.668	-14.270	0.000
	cred620				-0.581	-11.710	0.000
	cred660				0.595	10.560	0.000
	cred720				-0.267	-2.090	0.037
	mkt1				0.053	0.840	0.401
	mons after mod (in log)				0.103	3.150	0.002
	>40% pmt red	0.243	1.140	0.253	0.004	0.040	0.966
	30-40% pmt red	0.036	0.360	0.720	0.001	0.020	0.987
	20-30% pmt red	0.068	0.490	0.622	-0.007	-0.170	0.863
	10-20% pmt red	-0.191	-2.170	0.030	-0.051	-1.510	0.130
	5-10% pmt red	0.363	3.690	0.000	-0.065	-1.300	0.195
	1-5% pmt red	0.349	2.670	0.008	0.061	1.040	0.299
	No pmt red	0.092	1.640	0.101	-0.009	-0.300	0.761
	CLTV<70%	0.114	1.430	0.151	-0.037	-0.730	0.464
	CLTV 70-80%	0.053	1.330	0.183	-0.011	-0.380	0.707
	CLTV 80-90%	0.002	0.090	0.928	0.034	1.520	0.128
	CLTV 90-95%	-0.070	-1.810	0.071	0.026	0.820	0.412
	CLTV 95-100%	-0.004	-0.100	0.921	-0.004	-0.110	0.909
	CLTV 100-110%	0.005	0.160	0.872	0.019	0.710	0.477
	CLTV 110-120%	0.048	1.260	0.208	-0.012	-0.360	0.721
		Log likelihood = -73227			Log likelihood = -73160		

Note: N=255,137 loan months of 51,674 loans. Other controlled variables in the model not listed here include observation quarter dummies, quarter dummies when the loan was modified, dummy for originations in 2006, and dummies for major servicers. The sign of all standard deviations should be positive and it is negative for some of them here just because of the estimation algorithm of the mixlogit command in Stata (Hole, 2007).

Table 6 Estimated Nine-month Redefault Rate by Loan Mod Types

	Loan mod type	Foreclosure
By payment relief	>40% pmt red	28.39%
	30-40% pmt red	40.94%
	20-30% pmt red	45.09%
	10-20% pmt red	51.54%
	5-10% pmt red	50.61%
	1-5% pmt red	55.91%
	No reduction	53.86%
	Increase	59.36%
By CLTV (P&I increased)	CLTV<70%	34.89%
	CLTV 70-80%	40.77%
	CLTV 80-90%	46.52%
	CLTV 90-95%	51.04%
	CLTV 95-100%	49.56%
	CLTV 100-110%	55.02%
	CLTV 110-120%	59.36%
	CLTV>120%	70.10%

Note: it is assumed that the borrower was 90+day delinquent and had a LTV of 114 percent and 50% DTI when modified. For details about other assumptions, see Table 8.

Table 7 Estimated Nine-month Redefault Rate in Different Markets

		Overall	Market1	Market2-4
DTI50toDTI31	Traditional	59.36%	85.08%	47.13%
	Rate reduction	40.94%	60.45%	32.05%
	Principal reduction	27.52%	41.58%	21.32%
	Rate and principal red	37.76%	56.05%	29.48%
DTI40 toDTI31	Traditional	59.36%	85.08%	47.13%
	Rate reduction	45.09%	66.12%	35.41%
	Principal reduction	34.93%	52.10%	27.21%
	Rate and principal red	-	-	-
DTI55 toDTI31	Traditional	59.36%	85.08%	47.13%
	Rate reduction	28.39%	42.83%	22.01%
	Principal reduction	15.91%	24.54%	12.21%
	Rate and principal red	21.70%	33.12%	16.73%

Note: For the rate and principal reduction mod, we first drop the interest rate to the market level of 5% and then reduce principal to achieve the 31 percent of DTI. For details about other assumptions, see Table 8. Based on the share of outstanding subprime mortgages, Market 1 includes NV, FL, CA, and AZ. Market 2 includes MI, UT, RI, TN, CT, IN, MD, OH, CO, and GA. Market 3 includes IL, HI, DE, TX, NH, MO, WA, MN, OR, NJ, MA, PA, MS, LA, ID, VA, OK, SC, AL, NY, and ME. And Market 4 includes all other states.

Table 8 Assumptions for the NPV Analysis

Facts	DTI50toDTI31	DTI40 toDTI31	DTI55 toDTI31
initial house price	300,000	300,000	300,000
upb	240,000	240,000	240,000
interest rate	8.50%	8.50%	8.50%
DTI before mod	50	40	55
new DTI	31	31	31
FC cost(%)	0.25	0.25	0.25
duration of FC	1yr	1yr	1yr
price decline after origination	30%	30%	30%
future price decline	10%	10%	10%
delinquency status	90+day	90+day	90+day
# of existing advances	6	6	6
market rate	5.0%	5.0%	5.0%
discount rate	7.5%	7.5%	7.5%
Redefault: traditional *	59.4%	59.4%	59.4%
Redefault: rate_mod *	40.9%	45.1%	28.4%
Redefault: principal mod *	27.5%	34.9%	15.9%
Redefault: rate and principal red *	37.8%	-	21.7%
Prepay (Principal mod)	8 yr	8 yr	8 yr
Prepay (rate mod)	15 yr	15 yr	15 yr
Previous pmt	1,845	1,845	1,845
New pmt	1,144	1,430	1,040
Term	30 yr	30 yr	30 yr

Note: * redefault rates are assumed to be the nine-month cumulative foreclosure rates estimated based on the mixed logit regression for a typical subprime loan (*mixed1* in Table 4).

Table 9 Net Present Value of Different Loan Mods

		Overall	Market1	Market2-4
DTI50toDTI31	Rate reduction	60.49%	54.45%	63.24%
	Principal forgiveness	59.58%	56.22%	61.07%
	Rate and principal red	60.59%	55.19%	63.03%
	Foreclosure	42.20%	42.20%	42.20%
DTI40 toDTI31	Rate reduction	67.44%	57.78%	71.89%
	Principal forgiveness	68.57%	61.62%	71.70%
	Rate and principal red	-	-	-
	Foreclosure	42.20%	42.20%	42.20%
DTI55 toDTI31	Rate reduction	60.36%	56.71%	61.98%
	Principal forgiveness	57.31%	55.76%	57.97%
	Rate and principal red	60.22%	57.59%	61.36%
	Foreclosure	42.20%	42.20%	42.20%
With subsidy * DTI50toDTI31	Rate reduction	62.07%	55.51%	65.06%
	Principal forgiveness	61.53%	57.79%	63.18%
	Rate and principal red	62.26%	56.37%	64.92%
	Foreclosure	42.20%	42.20%	42.20%

Note: * the house price decline insurance in the Obama plan is not considered here.