Second Chances:

Subprime Mortgage Modification and Re-Default

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Abstract

Mortgage modifications have become an important component of public interventions designed to reduce foreclosures. In this paper, we examine how the structure of a mortgage modification affects the likelihood that the modified mortgage re-defaults over the next year. Using data on subprime modifications that precede the government's Home Affordable Modification Program, we focus our attention on those modifications where the borrower was seriously delinquent and the monthly payment was reduced as part of the modification. The average re-default rate over the 12 months following the modification is 56 percent. The data indicate that the re-default rate declines with the magnitude of the reduction in the monthly payment, but also that the re-default rate declines relatively more when the payment reduction is achieved through principal forgiveness as compared to lower interest rates.

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The stunning rise in mortgage delinquencies and foreclosures that began in 2007 has led to significant research and policy activity designed to identify and rectify the sources of the crisis. Foreclosure is an expensive and time-consuming process, resulting in significant costs to both the borrower and investor/lender. Further, as foreclosed properties are left vacant or resold at reduced prices, there is a risk of downward pressure on other home prices, potentially increasing the number of homeowners at risk of foreclosure.[1] Thus, both private and public actors have sought interventions that would reduce foreclosures and help to stabilize the housing market.

While public incentives for prospective buyers to purchase a home and for current owners to refinance their mortgages are in place, an important thrust of these interventions, and the subject of this article, is modification of existing mortgages. As early as December 2007, the mortgage industry began promoting voluntary interest rate freeze modifications to securitized subprime adjustable rate mortgages (ARMs).[2] While the number of mortgage modifications steadily increased during 2008, the number of delinquencies and foreclosures also continued to rise. Many observers, including the newly-elected Obama Administration, argued for a more comprehensive approach to modifications. As a result, among the Administration's first acts was to create the Home Affordable Modification Program (HAMP), which is designed to modify millions of mortgages over the next few years. An important policy question is how effective these second chances given to borrowers will be in terms of preventing foreclosures.

Residential mortgages are complex financial instruments with many features: the principal balance, the interest rate and any adjustments for ARMs, and the maturity or duration of the contract may all be modified. To help facilitate an understanding of mortgage modification and its effects, this paper presents results of our analysis of securitized subprime mortgages that received modifications between December 2005 and March 2009. These modifications preceded the HAMP.

After reviewing relevant previous studies and describing our data, we turn to an analysis of the effectiveness of the modifications we observe. We find that delinquent borrowers whose mortgages receive some kind of modification have a strong tendency to re-default, but that different kinds of modifications have diverse effects on outcomes. In particular, while HAMP

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[1] See Schuetz *et al.*(2008) and Campbell *et al* (2009).
[2] See http://www.americansecuritization.com/uploadedFiles/ASFStreamlinedFrameworkQA121707.pdf for details.

focuses on reducing payment burdens, our results indicate the importance of borrower equity -- the relationship between the mortgage balance and the home value -- a factor that has been stressed in the previous literature on mortgage defaults. We conclude with a discussion of the implications of our results for modification policy.

Previous Literature on Mortgage Modifications

Modification of existing mortgages has historically been relatively rare, and mostly limited to allowing borrowers who receive a temporary income shock - like unemployment or illness – to be brought current, often with any missed payments being added to the balance on the loan. Because such “capitalization” modifications do not change the features of the mortgage, they have not received much attention from academic researchers. Yet in recent months as modifications have become more common and more diverse, attention from researchers and policy analysts has increased sharply. The perception that, in light of the costs of foreclosure, mortgage servicers have been surprisingly slow to offer borrowers modifications has led to a set of recent studies exploring the legal and economic issues involved in the decision to modify.

One particular focus in this work has been on agency problems attributable to the complex structure of mortgage ownership and servicing. The great majority of outstanding residential mortgage loans are securitized, meaning that the “owners” of the loan are numerous and ownership is diffused (Ashcraft and Schuermann, 2008). The day-to-day management of the loans is left to a servicer, who typically is in closest contact with the borrower and who collects a fee based on the size of the loan. This arrangement has led some to worry that servicers – who must decide whether to modify each mortgage – either lack the authority or have insufficient incentives to undertake costly modifications.

Cordell *et al* (2008), for example, argue that a lack of specific guidance from private mortgage-backed security (MBS) investors has led to a reluctance on the part of servicers to change loan terms, even when such changes might benefit both investors and borrowers. Similarly, Piskorski *et al* (2009) find that loans that end up in banks’ portfolios ultimately perform better than those held in securities, possibly because of an increased willingness by banks to offer modifications to loans of which they are the sole owners. Adelino *et al* (2009), however, point out that modification is only worthwhile if it induces borrowers who would otherwise default to continue paying. Servicers choosing whether to modify mortgages face the risk that they will waste resources either by modifying loans that will default later, in spite of the modification, or by modifying loans that would never have defaulted even without a modification. Given high rates of re-default on modified mortgages, and substantial rates of "self-cure" among delinquent borrowers who do not get a modification, Adelino *et al* (2009, pg. 7) conclude that the slow pace of modifications results from the fact that "lenders expect to recover more from foreclosure than from a modified loan".

This conclusion depends critically on post-modification mortgage performance, which is the subject of the current study. There have been numerous studies of the incentives of mortgage borrowers and their payment performance over many decades. Borrower payment behavior is affected by several factors, which can be classified into three broad categories:

Ability to pay

Mortgage borrowers pay for the consumption benefits of living in the home through monthly principal and interest payments. The Debt-to-Income (DTI) ratio, which measures the cost of the mortgage payment (including principal, interest, taxes and insurance) as a share of income, is a measure of the ability of a borrower to make his scheduled payments. When DTIs are very high, borrowers will have difficulty maintaining the cash flow required to make their mortgage payments in the face of any income or spending shocks.[3] Default by a borrower with a high DTI should depend on the borrower's current equity position in the house. A borrower with positive equity (that is, borrowers whose house is worth more than the balance on their mortgage) should rarely default, since refinancing the mortgage or selling the property are better options than foreclosure, which will cause an avoidable equity loss to the borrower.[4]

[3] The DTI as we have defined it is also referred to as the "front-end" ratio. Another important measure of the borrower's ability to pay is the "back-end" ratio that includes other revolving debt such as credit cards, auto loans and student loans in the numerator.

[4] Homes sold at a foreclosure auction sell at a discount to those listed and sold by the borrower. A default will also damage the borrower's credit rating and thereby increase the cost of credit to the borrower in the future.

Incentive to pay

Homes, like other assets, offer potential capital gains or losses to their owners. Borrowers who expect to have positive equity in their properties when they move in the future have an incentive to keep current on their mortgage, since delinquency and foreclosure will ultimately lead to a loss of the asset. A borrower's expected equity position depends on the current loan-to-value (LTV) on the property and expectations over future price appreciation. When the current LTV exceeds 100, that is the mortgage balance(s) exceed the value of the house, we say that the borrower is "underwater" or in "negative equity." As we show below, if a borrower expects to be underwater when a future move is contemplated, then the borrower may choose to default today even if the borrower can afford to make the required mortgage payments. This has been labeled as "strategic default" in the literature.

Willingness to pay

One feature of the borrower rather than the mortgage has been shown to be an important predictor of mortgage default. Lenders have long known that a borrower's credit score – a summary of the borrower's record of repayment on previous obligations – is a strong predictor of future performance.[5]

Both previous research and industry practice have shown that all three of these interrelated factors are predictors of the likelihood that borrowers will fall behind on their mortgages prior to any modification – a state that we will refer to as "initial default". Examples of this research include Gerardi *et al* (2008) on all mortgages; An *et al* (2007) on FHA mortgages and Pennington-Cross and Ho (2006) and Demyanyk and van Hemert (2008), on subprime mortgages.

A central tenet in both the theoretical and empirical literatures on borrower behavior is that negative equity is a necessary condition for borrower default. As noted above, a borrower with positive equity has options that are clearly superior to default, including refinance and sale

[5] The term "willingness to pay" is motivated by the fact that the borrower's credit score is predictive of default even controlling for the borrower's initial DTI and current LTV. However, the credit score can also be capturing heterogeneity across borrowers in income variability and default costs that can trigger payment problems.

of the house. There is little doubt that borrowers in negative equity whose ability to pay is very constrained will exhibit a high probability of default; the classic example is of a negative equity homeowner who experiences a job loss. The options available to such a borrower are very limited, since sale or refinance would require that the borrower come up with additional cash to satisfy the mortgage.

While negative equity is a necessary condition for default, a debate among economists concerns its sufficiency (Vandell, 1995). That is, do negative equity borrowers default, even if they have sufficient ability to pay their mortgages? Foote *et al* (FGW, 2008), using data from the Massachusetts' regional housing downturn in the late 1980s and early 1990s, estimate that only a small share of borrowers whose house values fell below their mortgage balances ended up in foreclosure. They argue that a combination of the benefits of living in the house, borrower costs of foreclosure (including sharply reduced access to credit in the future) and expectations that their negative equity position is temporary lead borrowers to continue paying on their mortgages.

These considerations can be illustrated in a simple two period model where for the moment we assume that the borrower faces no income or payment shocks and therefore has the ability to pay the mortgage.[6] Consider a homeowner who plans to move after two years. The borrower has a non-recourse loan with an end of year balance of L_t. The annual mortgage payment including property taxes and homeowner insurance is m_t. The annual rent on an equivalent house is r_t. The current house value is V_t. With probability p the homeowner expects the value of the house net of selling costs in two years to be V_{t+1}^{H}, where $V_{t+1}^{H} > L_{t+1}$. Otherwise, the homeowner expects the value of the house to be V_{t+1}^{L}, where $V_{t+1}^{L} < L_{t+1}$. In the event that the borrower defaults, it takes a fraction s of a year for the lender to take possession of the house. Finally, let C_i denote the costs to the borrower of a default and δ the borrower's discount factor. Default costs are distributed across borrowers according to the cumulative distribution function F(C_i).

Assume that the borrower will default at the beginning of the second period if the low house value outcome occurs.[7] In the event of a default, the borrower makes no mortgage payments for the fraction s of the year and then relinquishes the house to the lender and rents for the remainder of the year. The lender is unable to collect on the deficiency between the value of

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[6] See FWG (2008) for a related discussion.
[7] If the borrower does not default in this case, then the borrower will also not default in the earlier period.

the house and the remaining balance on the mortgage. To avoid a default due to the move at the end of the year, the borrower would have to make the mortgage payments, sell the house and pay the lender the difference between the balance on the mortgage and the proceeds from the sale. The condition for the borrower to default if the low house value outcome occurs is:

$$C_i + (1-s)r_{t+1} < m_{t+1} - (V_{t+1}^L - L_{t+1})$$

Now consider the decision by the borrower to default at the beginning of the current year. In the event of a default, the borrower incurs the default cost C_i and must move to a rental property after s of the first year passes when the lender takes possession of the house. If the borrower does not default at the beginning of the current year, the mortgage payments must be made during the year and then the borrower will decide to default or not at the beginning of the following year depending on the house value outcome that occurs. If the good house value outcome materializes, the borrower will not default and will sell the house at the end of the year and keep the capital gains. If the bad house value outcome materializes, the borrower will default as discussed above. The condition for the borrower not to default at the beginning of the current period is:

$$C_i + (1-s)r_t + \frac{r_{t+1}}{1+\delta} > m_t + \frac{1}{1+\delta}\left[p\left(m_{t+1} - (V_{t+1}^H - L_{t+1})\right) + (1-p)(C_i + (1-s)r_{t+1})\right]$$

Substituting for C_i using our default condition in the second period we get.

$$C_i + (1-s)r_t + \frac{r_{t+1}}{1+\delta}$$
$$> m_t + \frac{1}{1+\delta}\left[p\left(m_{t+1} - (V_{t+1}^H - L_{t+1})\right) + (1-p)\left(m_{t+1} - (V_{t+1}^L - L_{t+1})\right)\right]$$

Rearranging

$$C_i > sr_t + \mathrm{PV}(m - r) - \frac{[\bar{V}_{t+1} - L_{t+1}]}{1 + \delta} \; ,$$

Where $\mathrm{PV}(m - r)$ is the discounted value of the mortgage/rent differential and $\bar{V}_{t+1} - L_{t+1}$ is the borrower's expected equity position in the house. This equity position can also be rewritten as $[\overline{LTV}_{t+1} - 100] * L_{t+1}/100$.

The borrower in this simple example will choose not to strategically default in the first period if the borrower's costs of default exceed a threshold. An upper bound to the probability that the borrower strategically defaults is given by

$$F\left(sr_t + \mathrm{PV}(m - r) - \frac{[\overline{LTV}_{t+1} - 100] * L_{t+1}/100}{1 + \delta}\right)$$

The costs of default should be thought of broadly to include both the financial costs of a damaged credit file, the costs of moving and any stigma associated with a default. Investors who do not live in the house and therefore incur no cost of moving would on average have lower values of C_i and therefore higher probabilities of strategic default *cet par*. Similarly, if the stigma to default declines in a local housing market perhaps as a result of a significant rise in foreclosures, then this lowers C_i and raises the likelihood of strategic default. For those borrowers living in a state where mortgages have recourse, then this effectively raises their cost of default by the expected deficiency judgment and should reduce the incidence of strategic default.

The likelihood of strategic default will vary across borrowers not only because of differences in borrower default costs but also due to differences in the borrower thresholds for strategic default. The simple two-period model suggests that the threshold cost for strategic default depends on the length of the foreclosure process (s), the cost of the mortgage relative to the cost of renting, the borrower's expected future LTV and the size of the loan balance. As a borrower's expected future LTV increases above 100 pushing the borrower deeper into negative equity at the anticipated time of a move, the borrower is more likely to default today. As discussed in Foote *et al* (2008), the borrower's current LTV does not directly impact the decision to strategically default. Rather, the borrower's current LTV in conjunction with the borrower's expectations of house price appreciation combine to determine the borrower's expected LTV in the future which is a determinant of today's default decision. For borrowers in the hardest hit housing markets such as Arizona and Nevada, expectations may be that house prices will not any time soon cure the negative equity problems that were created in the housing price bust. This may be in contrast to expectations that existed in Massachusetts during the time period studied by FWG, 2008 and could reconcile their findings of a low rate of foreclosures among negative equity borrowers in Massachusetts in the 1990s.

To summarize, a borrower's current LTV will affect observed default rates for two reasons. First, if a borrower is currently in negative equity and experiences either an income shock or a payment shock that raises the borrower's DTI, the borrower may be unable to make the mortgage payments and will likely default. Second, holding constant a borrower's expected house price appreciation, as a borrower's current LTV increases this increases the borrowers expected future LTV, reducing the threshold for a strategic default.

The influence of borrower equity on payment behavior remains quite relevant, as policy makers seek to design modification programs that will stem the current wave of foreclosures. For the mortgage modifications we examine, as we shall see, monthly mortgage costs fall, usually through reductions in interest rates. Nonetheless, our modified mortgages exhibit enough variation in borrowers' equity positions that we are able to examine the relative importance of "incentive to pay" and "ability to pay" in post-modification performance. We begin our exploration with a description of the loan modifications in our data, then turn to a performance analysis and conclude with some implications of our results for current policy discussions.

Data Description

Our primary data source is FirstAmerican CoreLogic's (FACL) LoanPerformance ABS data set, which contains loan-level information on approximately 17.3 million subprime and alt-A securitized loans, 7 million of which were active as of June 2009. The data cover about 90 percent of the securitized subprime market and about two-thirds of the entire subprime market. Given that securitized subprime loans may differ systematically from those held in portfolios, particularly in ways that increase the likelihood of default, inferences drawn from our results should be restricted to the subset of securitized subprime loans (Keys *et al,* 2008).

LoanPerformance (LP) provides a detailed description of the features of each mortgage. LP records the origination loan amount, the initial interest rate, loan term, loan product type, index rate and margin to which an adjustable rate mortgage (ARM) would be linked, and reason for the loan (purchase or refinance). Data provided on the property securing the loan includes the property type and the location of the property. Since the LP data is geared toward describing the terms and progress of the loan, data on the borrower is limited to the risk profile variables at origination: debt-to-income (DTI), loan-to-value (LTV), level of documentation, and FICO score. LP also tracks the progress of the loan on a monthly basis giving information on the payment status of the loan, the current interest rate, the scheduled monthly payment, and the remaining balance on the loan.

In addition to monthly updates for all outstanding loans, LP maintains a separate data set of modified loans and provides additional information on which aspects of the original loan have been modified. LP defines a loan as modified if the servicer alerts them of the loan modification, or if they conclude, based on noticeable changes in aforementioned variables, that there has been a modification. The majority of modified loans in the LP modification data are marked as such due to a servicer notification. For example, only 8 percent of loans that received a modification to the principal were inferred by LP, the remaining 92 percent were reported by servicers. For modified loans, LP includes variables for the new interest rate, balance, scheduled monthly payment, and other relevant data on the modification.[8]

Modification Selection

[8] Unfortunately, the term of the modified loan is reported in less than 5 percent of cases, and solving for the post-modification remaining term of the loan using the new balance, interest rate, and monthly payment is unreliable. For example, a five-year freeze on interest rates for an adjustable-rate loan would change the monthly payment but not necessarily the term. Deducing the term based on the new monthly payment would produce erroneous results. Thus, we will restrict our analysis of the modifications to those changes that are explicitly provided in the data.

Unsurprisingly, there are significant differences between characteristics of the outstanding nonprime mortgages that received a modification and those that did not. Table 1 details the origination characteristics of the 330,724 modified nonprime loans and those of the 53,618 loan subset used in our analysis (see below); for comparison the table also shows the same characteristics for a 1 percent random sample of loans originated between 2004 and 2007. Of these loans, approximately 2 percent subsequently received a modification.

The table indicates that modifications were made to loans that look riskier ex ante -- they had lower borrower FICO scores and higher origination LTVs and DTIs. Adjustable rate mortgages are also disproportionately likely to receive a modification, as are those secured by a single family residence (as opposed to condominiums, multi-unit properties and planned unit developments). However, the data indicate that servicers are less likely to modify loans that were not fully documented at origination.

Loans originating in 2005 and 2006 received the lion's share of modifications. While 50 percent of the loans in LP were originated in 2005 and 2006, 78 percent of the loans selected for modification were from those vintages (Table 2). Recent research has shown that the loans of the 2005 and 2006 vintage fared notably worse than other vintages, defaulting much more quickly than loans originating earlier (Haughwout *et al* 2008). In addition to the temporal focus on particular vintages, modifications are geographically concentrated. Loans secured by property in California or Florida account for over a quarter of the modifications in our estimation sample.

In general, mortgage modifications are offered to borrowers evidencing some signs of distress. Nearly 60 percent of modified mortgages were experiencing some level of delinquency at the modification date, and an additional 14 percent were already in some stage of the foreclosure process (Table 3). Perhaps surprisingly, over a quarter of modified loans had a payment status of "current" before modification. Eighty-four percent of these current loans that were modified came from the 2005 and 2006 vintages. It is possible that servicers, aware of the high rates of default among these vintages, were willing to preemptively modify them due to a belief that they were at risk of "imminent default".[9]

[9] While there are statistically significant differences in the risk profiles among borrowers receiving modifications between those who were current and those who were in some stage of delinquency, the differences were slight. For example, the average combined LTV for loans that were current previous to modification was 89 as compared to an average of 88 for loans that were in some stage of delinquency

Types of modifications

As a result of the modification process, most of the delinquent loans had their payment status improved. The transition patterns in payment status from loans in the full dataset of modified mortgages indicate that a large majority of loans in all stages of delinquency, excluding real estate owned (REO), were redefined as “current” after modification. As the pre-modification status worsened, the percentage of loans that received an improved payment status at modification increased, peaking for loans that were 90 days or more delinquent. Additionally, given any incentive that might exist for servicers to leave borrowers as delinquent in order to collect late fees, that motive would diminish as the borrower’s delinquency status worsens and the likelihood of a default increases.

Not all modifications result in a more affordable loan. While nearly two-thirds (65 percent) of the loan modifications resulted in a reduced monthly payment, 19 percent produced a higher payment (Table 4). Capitalization modifications - previously delinquent borrowers who are brought current while having arrearages added to the balance of the loan – are common in the data. Fully 64 percent of modifications resulted in higher balances (a reduction in the borrower’s equity position), while balances were meaningfully reduced in just 5 percent of modifications. Nonetheless, 70 percent of modifications resulted in a decrease in interest rates. This pattern suggests an intention among servicers to extend the number of payments that the borrower will likely make by improving the borrower’s cash-flow position, while retaining the option value that either house prices will increase and/or the borrower will sufficiently pay down the mortgage to the point where the borrower is back in positive equity.

For the re-default analysis below, we focus on those modifications that improve mortgage affordability. We select first-lien subprime loans on declared owner-occupied properties, which received a monthly payment reduction, were moved to “current” status after the modification, and for which at least three months of post modification payment history is available. We further

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previous to modification. However, 40 percent of loans with a pre-modification status of current had exiting balances that were larger than the original loan size. There are two ways this can happen: a previous modification or a negatively amortizing mortgage. Fourteen percent of those with an increase in balance were negatively amortizing, 38 percent were previously modified, 1 percent were both negatively amortizing and previously modified, and 50 percent were neither negatively amortizing nor modified. Thus, half of these loans have an unexplained increase in their balance.

restrict our estimation sample to loans that were 60 days or more delinquent at the modification date, excluding loans which had already entered REO status. In this way, we focus our analysis on re-default of loans that received a significant modification.

Our estimation sample is of a similar composition as the full set of modified mortgages (Table 1). In the second panel of Table 4, we report the features of the modifications made to loans in this estimation sample. Again, the data indicate a general emphasis on making loans more affordable without improving borrower equity. Ninety-seven percent of these modifications resulted in a reduction in interest rates. Among those receiving an interest rate reduction, rates were dropped by an average of three hundred basis points.

Nonetheless, we observe examples of principal reductions in our estimation sample. For the 7 percent of borrowers in the estimation sample who received a balance reduction, the balances were reduced by an average of 20 percent; those borrowers whose principal was not reduced saw their balances increase by an average 7 percent. Thus, while reductions in interest rates are a far more common way of making loans more affordable, changes in principal balances are common enough to motivate exploring the effects of principal write-down on the performance of these mortgages after they receive a modification, the task to which we now turn.

Empirical Specification and Results

How do modified mortgages perform? To answer this question, we focus on the 53,618 modified mortgages described in panel (b) of Table 4. The outcome of interest is whether a modified mortgage re-defaults. We define a re-default as the borrower becoming 90 days delinquent on the modified mortgage.[10] In particular, we are interested in evaluating how the structure of the modification affects the likelihood that the borrower re-defaults within a year following the modification. We select this definition of re-default over other choices such as foreclosure beginning or foreclosure ending since this re-default event is consistently measured across the mortgages in our sample regardless of who services the loan, what laws govern the foreclosure process in the housing market where the property is located, or when the mortgage was modified.

[10] We label this as a "re-default" since all of our modified mortgages were at least 60 days delinquent prior to their modification.

Before turning to a multivariate analysis of re-default, it is useful to look at descriptive features of the data relating to re-default. Figure 1 presents Kaplan-Meier (KM) survival plots over the year following the modification. The survival plots track, over time since the modification, the fraction of the modified mortgages that have "survived," in that they have not yet re-defaulted. The origin of these plots corresponds to the second month following the modification. That is, given our definition of re-default as a borrower being 90 days delinquent, the first month that a mortgage is "at risk" of re-defaulting is in the third month subsequent to the modification. This would correspond to the case where the borrower of the modified mortgage failed to make a single payment subsequent to the modification.[11]

The graph in the northwest corner of Figure 1 shows the overall KM survival plot for our modified mortgages. Starting in the 3rd month following the modification there is a steady transition of mortgages into re-default with the pace diminishing by the eighth month. The graph in the northeast corner splits the data by those mortgages that received more or less than the median reduction in the monthly payment (20 percent). The group labeled "large_reduction = 1" are the mortgages that received higher than the median reduction in their monthly payments. By six months following the modification (analysis time = 4), there is a noticeably higher survival rate for the mortgages that received the larger payment reductions. The graph in the southwest corner compares mortgages with positive and negative equity following the modification. The group labeled "neg_equity = 1" includes all the modified mortgages whose current LTVs are estimated to exceed 100.[12] Again, by the sixth month following the modification, those mortgages with positive equity have a noticeably higher survival rate. Finally, in the southeast corner we contrast the post modification performance for borrowers with very low origination FICO scores relative to other borrowers. The group labeled "low_fico = 1" corresponds to borrowers whose origination FICO score was less than 590. There appears to be little difference between the survival curves for the different ranges of origination FICO scores.

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[11] The specifics of the modification program will impact the origin of the KM survival plot. For example, under the new HAMP program, a mortgage must make the first three payments in a timely manner in order for the modification to be made permanent. A mortgage that receives a permanent modification under the HAMP program, then, is first at risk of re-default (using our 90 day delinquent definition) in the sixth month following the modification.

[12] For this graph, the current LTV is estimated using First American CoreLogic non-distressed MSA level repeat-sale house price indices.

The survival graphs in Figure 1 provide simple two-way comparisons of the influence of various determinants of re-default. To provide a more detailed analysis we now turn to a multivariate statistical analysis of the data. Our modification data contains mortgages that have experienced varying amounts of time since their modification. We use a hazard framework to analyze the data in order to account for censoring of mortgages that are still within their first year following their modification and have not yet re-defaulted, as well as to account for the effect of time-varying variables such as the current LTV on the likelihood of a re-default. We use a month as our unit of time in the hazard analysis since this choice matches with the monthly servicing records for payments made by the borrower.

The hazard rate for re-default at duration *t* since the modification is defined to be the probability that a modified mortgage first reaches 90 days delinquent at month *t* given that the mortgage had not prepaid or reached this level of delinquency by month $t-1$. We model this hazard rate using a proportional hazard framework. The hazard rate for mortgage *i* at month *t* is given by:

$$h_i(t|X_{it}) = \exp(g(t))\exp(X_{it}\beta),$$

where $g(t)$ is a function of the time since the mortgage was modified. We approximate the baseline hazard rate, $g(t)$, using a step-function where the steps are defined at a monthly frequency.[13] The key assumption in the proportional hazard specification is that the explanatory variables, X_{it}, shift the baseline hazard proportionally.[14]

Besides re-defaulting, a mortgage can exit our sample by prepaying, which occurs if the mortgage is refinanced or the house is sold. This creates a competing risk framework where in each month a modified mortgage is at risk to exit the sample through a re-default or a prepayment. In our data, we observe the first exit time. For mortgages that exit by prepaying, we include the mortgage in our re-default hazard up to the month that it prepays. The mortgage then

[13] Meyer (1990) was an early advocate of approximating the baseline hazard using a step-function. We verify that our hazard estimates match those from a Cox hazard model where the baseline hazard is left unspecified.
[14] For more discussion of duration data and hazard rates see Kalbfleisch and Prentice (2002).

leaves the sample without re-defaulting.[15] To date, only 0.58 percent of our modified mortgages have pre-paid during the first year following modification.

The survivor function indicates the probability that the modified mortgage has not re-defaulted by a specified duration. For our hazard function the survivor function at time T since modification is given by;

$$S_i(T) = \exp\left(-\sum_{t=1}^{T} \exp\left(Z_{it}\gamma\right)\right),$$

where $Z_{it}\gamma$ contains both the step-function in time from the baseline hazard and $X_{it}\beta$. Given the de minimis pre-payment rate, we ignore pre-payments in calculating the re-default rate.[16] With this assumption, the re-default rate for a mortgage over a given number of months T since modification is one minus the survivor function for the re-default hazard, $1 - S_i(T)$.

The key set of results is the impact that individual variables have on the predicted probability that a mortgage re-defaults over the 12 months following the modification. For continuous explanatory variables we report the average derivative of $1 - S_i(12)$. We include in the average derivative calculation all mortgages where we can collect values for the explanatory variables for 12 months since the modification.[17] The full sample of mortgages is used in the re-default hazard estimation even if a mortgage cannot be included in the average derivative calculation. The change in the magnitude of the particular explanatory variable in the derivative calculation is assumed to apply during each of the 12 months following the modification. For indicator and categorical explanatory variables, we compute the average difference of the survivor functions where we set the indicator variable to one and then set it to zero. For categorical variables we also compute the average difference of the survivor functions with a specific categorical variable set to one while the remaining categorical variables are set to zero

[15] In this case, the time to re-default is censored in that we only know that it is longer than the time observed between when the mortgage was modified and when it pre-paid.
[16] If there were more prepayments following modification, we would separately estimate the prepayment hazard. We would then generalize the survivor function to reflect the combined effects of the two hazards.
[17] We fill out the panel of explanatory variables for a full 12 months even if the mortgage re-defaults or prepays at an earlier month.

from the value of the survivor functions to where all of the associated categorical variables are set to zero.

Our re-default hazard coefficient estimates are given in Table 5.[18] Each specification uses a different set of MSA house price indices to update the current LTVs. Specification (1) uses the First American CoreLogic (FACL) overall MSA indices, while specification (2) uses the FACL non-distressed MSA indices (discussed later). We include explanatory variables that attempt to capture the three factors that should affect re-default behavior: ability to pay, incentive to pay and willingness to pay.[19] Descriptive statistics are provided in Appendix Tables A1 and A2.

Start first with variables affecting the borrower's ability to pay. A key factor in a mortgage modification is the extent to which the required monthly mortgage payment is reduced as a result of the modification. A limitation of our data is that we do not observe the new DTI level following the modification. What we can control for is the percent reduction in the required monthly mortgage payment on the 1st-lien mortgage. Because 26 percent of the modified mortgages have 2nd-liens, the same percentage change in the payment on the 1st-lien can represent a different percentage change in the overall payment. To correct for this, we estimate the percent change in the total monthly payment as follows:

$$\%\Delta P = \left(\frac{B_1}{B_T}\right) * \%\Delta P_1 \ ,$$

where $\%\Delta P$ is the percent change in the total monthly payment, $\%\Delta P_1$ is the percent change in the monthly payment on the 1st-lien and B_1 / B_T is the ratio of the 1st-lien balance at origination to the total balance at origination. The same percent reduction, though, can be associated with differing post modification DTIs. With that qualification in mind, the data indicate that a 10 percent reduction in the required monthly mortgage payment is associated with around a 13 percent reduction in the re-default hazard.

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[18] The hazard estimates match those produced by a Cox proportional hazard where the baseline hazard is left unspecified.

[19] We also checked for unobserved heterogeneity at the loan level. In each specification, the data did not support the hypothesis that a non-degenerate distribution of unobserved heterogeneity needed to be controlled for.

An alternative measure of the improvement in the affordability of the mortgage post modification is the percent change in the required monthly payment on the 1st-lien mortgage relative to the initial payment. This is particularly of interest for the adjustable rate mortgages which may have experienced one or more rate resets since origination. The impact of this measure of the improved affordability is statistically significant, but half the magnitude than our first measure. In addition, when we add this second affordability measure together with the first measure, only the first affordability measure is positive and significant.

Unemployment is considered a traditional "trigger" for mortgage default.[20] We include a time-varying measure which is the local unemployment rate lagged six months less the average local unemployment rate.[21] The ideal variable to include in the re-default hazard specification is a time-varying indicator variable for whether the borrower is currently unemployed. Absent information on individual borrower unemployment spells, we use a local unemployment rate as a proxy variable. In addition, we use a six month lag to account for the possibility that a combination of household savings and/or unemployment benefits would allow a household to continue to make mortgage payments for several months following the onset of an unemployment spell, and that it takes three months of missed payments to trigger our definition of a re-default. We focus on the difference between the lagged local unemployment rate and its average to account for persistent differences in unemployment rates across different geographic areas. These persistent differences in local unemployment rates do not appear to be related to default behavior.

The local unemployment rate has a low correlation with the unemployment experience for an individual borrower.[22] In addition to the problem of a low correlation between the MSA unemployment rate and the individual borrower's unemployment experience, the correlation can be further weakened by the decision by the lender/servicer to modify the mortgage or not. If a borrower experiences an unemployment spell and contacts the lender/servicer about a

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[20] The other two triggers are divorce and serious health problems.

[21] We compute the average local unemployment rate based on data from 1990 Q1 to 2009 Q1.

[22] To illustrate, we simulated 20,000 individual monthly employment histories from April 1990 to April 2010 using 3-month moving averages of the BLS transition rates between the employment, unemployment and out of the labor force states. In each month, we computed the aggregate unemployment rate. The correlation between the aggregate unemployment rate and the individual unemployment indicator is highest in 2008 at 0.019 and lowest in 2007 at 0.006.

modification, the lender is unlikely to be willing to modify the mortgage for that borrower.[23] We allow for this screening of borrowers for mortgage modifications by zeroing out our lagged unemployment variable until it points to a period subsequent to the mortgage modification.

In both specifications the local unemployment rate has a positive and significant effect on the re-default hazard. The data indicate in specification (2) that for each percentage point increase in the local unemployment rate the default hazard increases by less than 5 percent. The small size of this effect reflects the likely attenuation bias due to by the low correlation between the local unemployment rate and the unknown indicator variable for an unemployment spell by the borrower. If we do not zero out the unemployment variable when it references a time period prior to the modification date, the estimated coefficient on the unemployment rate declines by 35 percent.[24]

We also checked for the "double-trigger" hypothesis that suggests that a combination of negative equity and losing a job generates defaults.[25] We interacted our unemployment variable with the LTV indicators in specification (2). The coefficients on these interaction variables were positive for the borrowers with estimated negative equity in excess of 10 percent, and the interaction was significant for borrowers with estimated negative equity in excess of 20 percent. The interactions indicated that each percentage point rise in the local unemployment rate increased the default hazard by 30 percent for a borrower estimated to have negative equity in excess of 20 percent.[26]

The incentive to pay is captured through a set of variables suggested by the two period model presented earlier. To control for the borrower's current equity position, we include indicators for varying levels of current negative equity. The LTV indicators are dynamic variables in that they can change over time following the modification date as house prices evolve in the local housing markets. The two specifications differ in terms of the house price indices used to calculate the current LTV. In both cases, the purchase price or appraised value is updated using the relevant price index for the MSA where the property is located. Specification

[23] This is assuming that there is new underwriting involved in the modification process in which case the unemployment by the borrower would be identified.
[24] We also tried 3- and 9-month lags as well as the 3-, 6- and 9-month change in the local unemployment rate.
[25] See Gerardi *et al* (2007).
[26] The hazard coefficient on the 120 or higher indicator LTV declines from 1.06 to 0.90 when we include the interaction between the local unemployment rate variable and the high LTV indicators.

(1) is based on the First American CoreLogic (FACL) MSA overall price indices, whereas specification (2) is based on the FACL MSA non-distressed price indices. The two sets of price indices use the same statistical methodology but differ in that repeat-sales that involve a “distress sale” are excluded from the non-distressed index estimation.[27]

To get a sense for the relative behavior of the two different price indices, Figure 2 shows the cumulative house price changes since January 2000 for the FACL national overall and non-distressed house price indices. In addition, Figure 2 shows the share of repeat-sales transactions in each month that were distress sales. In the pre-crisis period through 2005 when the distress sales share was consistently below 5 percent, the two house price indices track each other closely. In late 2007 and into 2008 as the share of distress sales rises, the overall price index falls below the non-distress index. Appendix Table A1 shows the distribution of our LTV indicators using each set of house price indices. The FACL overall house price indices predict that 46.1 percent of the monthly observations are associated with negative equity borrowers. In contrast, the FACL non-distressed indices that exclude distress sales predict that only 25.4 percent of the monthly observations are associated with negative equity borrowers. Including the distress sales in constructing the price indices also generate more extreme cases of negative equity with 22.2 percent of the monthly observations having a predicted LTV of 120 or higher. The non-distressed price indices predict that only 0.4 percent of the monthly observations are for borrowers with a predicted LTV of 120 or higher.

The log likelihood values indicate that the non-distressed prices indices produce the better overall statistical fit. Comparing the coefficients on the LTV indicators across the two specifications, both show that the default hazard is increasing in the degree of negative equity by the borrower. The magnitude of this effect, however, is attenuated when using the overall as compared to the non-distressed indices. One interpretation of these findings is that borrowers base their default decision on their perceived equity position assuming that they were to sell the house themselves. Auction sales, then, may generate “noise” in the house price returns which leads to the attenuation of the LTV effects based on the overall indices. The data from specification (2) suggest that the default hazard doubles for borrowers who have negative equity of 15 percent or more as compared to a borrower with at least 10 percent positive equity.

[27] FACL treats foreclosures and short-sales as distress sales.

An important issue is whether the current LTV is capturing the pure effect of negative equity on borrower default behavior, or whether it is also acting as a proxy for more general adverse aspects associated with living in an area with declining house prices that may affect a borrower's decision to default. To check for this, in results not reported in Table 5 we add to our baseline specification the percent change in MSA house prices over the prior twelve months. If the LTV indicators are biased upwards due to any left-out local economic variables that are correlated with declining house prices, then including this dynamic house price variable should reduce the coefficients on the LTV indicators. The 12-month house price change variable is statistically significant and indicates that each percentage point decline in house prices raises the default hazard by 1.8 percent. However, the coefficients on the LTV indicators are not affected by including this house price change variable. Rather, the coefficients on the variables capturing local conditions become smaller in magnitude. This supports the interpretation that the LTV indicators are reflecting the effect of the borrower's equity position and not left-out local economic conditions that are correlated with house prices.

As illustrated in our simple two period model, the decision by a borrower to re-default should depend not just on whether the borrower is currently facing a negative equity situation, but also on the prospect that future house price appreciation might bring the borrower back into positive equity prior to a decision to move. This is a function of the expected path of local house prices. We proxy for the borrower's expected path of local house prices by the difference between the current MSA house price index and the value of the index in year 2000. For most MSAs, year 2000 predates the sharp run-up in house prices and serves as a useful benchmark. This variable is constructed using the same house price indices as are used to update the borrower's LTV. Where the current index is still above the year 2000 index value, borrowers may perceive little near-term scope for house price appreciation. Given the current equity position of the borrower, in specification (2) the data indicate that for every 10 percent that current area house prices exceed their year 2000 level, the re-default risk increases by 1.7 percent.[28] Measurement error in capturing individual borrower house price expectations would be expected to bias down our estimate of this effect.[29]

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[28] In specification (1), this variable has a small negative but statistically significant effect.
[29] House price expectations are difficult to observe. An alternative to our approach would be to use futures contracts for the S&P Case-Shiller index. However, prices for these contracts are not available for most cities, and are thinly traded when they are available.

Given a borrower's expected LTV, the two period model indicated that the decision to default should depend on the size of the mortgage and the expected time the borrower can stay in the house after defaulting on the mortgage. Experian-Wyman (2009) use credit data to proxy for strategic default by identifying borrowers who default on their mortgage without going delinquent on any of their unsecured debt. They find that borrowers with higher origination balances are more likely to strategically default. Our data indicates that each additional $10,000 of current balances increases the re-default hazard by 1.1 percent.

We proxy for the time that a borrower can expect to remain in the house "rent-free" following a default by looking at the number of months in a string of unbroken delinquency between a borrower going 30-days delinquent until the mortgage passes through foreclosure and is classified as real-estate-owned (REO) or paid off. We calculate these durations using both foreclosures on subprime and prime mortgages between 2008 and 2009. We control for the median duration by state.[30] While the two-period model assumed that the borrower was risk neutral, in practice borrowers may be concerned about the variability of the time until they would be required to leave the house. To account for this, we control for the 5th percentile of the duration times until REO. This should proxy for a duration that the household is reasonable sure they can stay in the home rent-free conditional on a default. The data indicate that each additional three months of delay in the foreclosure process increases the risk of re-default by 1.8 percent.

Holding constant the benefits associated with a strategic default, a borrower is more likely to default the lower the costs associated with a default. A growing concern is that the "stigma" to a borrower from a default may be reduced in areas experiencing a severe shock to the local housing market. If several houses along a street are in foreclosure, then neighbors may not be surprised to hear about another neighbor defaulting on their mortgage, and may ascribe the decision to general problems in the housing market rather than any specific issues with their neighbor. In addition, neighbors who have defaulted themselves or who know someone who has defaulted may urge their friends to do the same if they are facing either payment problems or are in a negative equity situation. Uncertainty of what will happen to a borrower if he/she defaults may be reduced from conversations from friends or neighbors who have already gone through

[30] To check our duration calculations, we regressed the state average durations on an indicator for whether the state is a judicial foreclosure state. The coefficient on the judicial foreclosure indicator was positive and significant with a coefficient of 3.4 months.

the process.[31] To check for this in the data, we include the number of distressed sales per 10,000 households in the MSA.[32] We use this variable to capture the stigma effect since distress sales are visible in a local housing market, and distress sales are the result of default decisions that took place with varying time lags across different local housing markets and time periods.[33] In specification (2), the data indicate that an additional 5 distress sales per 10,000 households raises the re-default risk by 6.7 percent. Finally, for borrowers in states where mortgage loans have recourse the re-default hazard is 5.3 percent lower.[34]

The willingness to pay is captured using the origination FICO score and the number of months that the borrower was current over the 12 months prior to the modification. We include the recent payment history on the mortgage as a proxy for an updated FICO score. The data indicate that each additional month that the borrower was current in the year prior to the modification, the default hazard declines by 4.3 percent. Controlling for the recent payment history, we also check to see if the origination FICO score is still predictive of re-default. We include three indicators for origination FICO scores below 620, as well as an indicator for a missing FICO score. Despite the fact that the FICO score for the borrower is out-of-date as of the modification date, in specification (2) controlling for the recent payment history the data indicate that borrowers with an origination FICO below 590 have a re-default hazard that is around 10 percent higher than for borrowers with an origination FICO that was above 620. Borrowers with a missing FICO score have a default hazard that is 40 percent higher. Modified mortgages that when originated went through a full underwriting and documentation have a 17 percent lower risk of re-default in each month. We also include the age of the mortgage as of the modification date. Holding constant the origination FICO and the fact that all of our modified mortgages were 60 plus days delinquent at the modification, borrowers who have carried the mortgage for a

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[31] Guiso *et al* (2009) use hypothetical survey data to establish that strategic default will likely increase with the extent of a borrower's negative equity and whether the borrower knows someone who is a strategic defaulter. A recent survey (Fannie Mae 2010) finds that borrowers who know someone who has experienced a foreclosure are more than twice as likely to seriously consider default as those who do not.

[32] We calculate a 3-month moving average of the number of distress sales. The number of distress sales each month is provided with the FACL MSA house price indices.

[33] That is, the distress sale measure does not entail putting an aggregate version of the outcome variable as an explanatory variable.

[34] We follow Ghent and Kudlyak (2009) in coding mortgage loans as being non-recourse in Alaska, Arizona, California, Iowa, Minnesota, Montana, Nor Carolina (purchase mortgages), North Dakota, Oregon, Washington and Wisconsin.

longer period are likely to be better risks.[35] The data indicate that for each additional 6 months in the age of the mortgage at the modification date, the hazard rate for re-default is 9 percent lower.

Table 6 presents estimates of the impact of our control variables on the predicted probability that a modified mortgage re-defaults over the twelve months following the modification. We restrict our calculation to the subset of modified mortgages where we have at least twelve months of data on the explanatory variables following the modification date. For each of these mortgages we compute the predicted survivor function evaluated at twelve months. We have 8,185 mortgages that meet this data requirement. The average predicted re-default rate is 56 percent. Since the predicted re-default rate is a non-linear function, we report the average marginal effects and their associated standard errors.

Reducing the monthly required payment on the mortgage by 10 percent lowers the predicted 12-month re-default probability by 4.5 percentage points (or 8 percent of the average). Comparing a modified mortgage with a current LTV between 100 and 104 for each month following the modification to a mortgage with at least 10 percent positive equity, the predicted re-default rate increases by 4.6 percentage points. The re-default risk continues to increase with the extent of the borrower's negative equity. For a borrower with a current LTV of 115 or higher, the re-default rate over the first year is 33 percentage points higher (or 59 percent of the average).

Turn now to the set of variables suggested by the simple two period model. Holding constant the current LTV, if the MSA house price index is 10 percent above its year 2000 level, then this raises the predicted 12-month re-default rate by an additional 0.6 percentage points. Each additional $10,000 in the mortgage balance at the time of the modification increases the 12-month re-default rate by 0.4 percentage points. All else the same, a borrower with a $100,000 higher mortgage balance as compared to a similar borrower has a 4 percentage point higher likelihood of falling back into serious delinquency over the year post modification. Each additional month that a borrower can expect to live rent-free in the house increases the 12-month re-default rate by 0.6 percentage points. Controlling for other factors, borrowers located in a recourse state have a 1.8 percentage point lower 12-month re-default rate. Finally, an additional 5 distress sales per 10,000 households increases the one year re-default probability by 2.2 percentage points.

[35] The average age of our mortgages at the modification date is 40 months.

Holding constant the borrower's FICO score at origination, each additional month that a borrower is current in his/her payments over the year prior to the modification is associated with a 1.5 percentage point lower predicted 12-month re-default rate. Borrowers who went through a full underwriting and documentation of their original mortgage are 5.8 percent less likely to re-default over the subsequent year.[36] Finally, modified mortgages that are seasoned by an additional six months have a 3 percentage point lower predicted 12-month re-default rate.

Design of mortgage modification programs

We can use these estimates from Table 6 to evaluate different design approaches to mortgage modification plans. The key distinction is whether the program relies on reduction in interest rates/lengthening of term alone to reduce the required monthly payment, or if principal write-down is also used to reduce the required monthly payment. The important insight from Table 6 is that principal write-down reduces re-default risk both directly – through reducing or eliminating the negative equity of the borrower – and, also indirectly by reducing the required monthly payment (holding the interest rate constant) and by reducing the balance of the mortgage.[37]

Consider the example described in Table 7. A house is purchased in June 2006 for $207,250. The borrower makes a downpayment of 3.5 percent and finances the balance with a subprime mortgage of $200,000. The interest rate on the mortgage is 9.17 percent. Annual taxes and insurance on the house are 1.2 percent of the purchase price. The borrower has an annual income of $55,231, or $4,602 per month. The initial DTI on the mortgage is 0.4. Over the next two years, area house prices decline by 18 percent bringing the current value of the house to $169,945. The borrower's current LTV is 118.

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[36] Querica *et al* (2009) report that fully documented mortgages are 3 percent less likely to re-default over the next 6 – 9 months (see Table 6). Their samples include Alt-a mortgages and modifications where the monthly payment increases.

[37] Recall that the interpretation of the marginal effect of the negative equity LTV indicators is the change in the re-default risk from a modified mortgage moving from positive equity to the implied negative equity LTV interval for each month following the modification -- *holding all other variables constant*. One of these "other" variables is the percent reduction in the required monthly payment, so the LTV effect is in addition to the payment reduction effect.

In June 2008 after the borrower is 60 days delinquent, the lender approaches the borrower to modify the mortgage.[38] The target DTI on the modified mortgage is 0.31. The lender agrees to reduce the interest rate on the mortgage to 6.29 percent bringing down the required monthly payment to $1,241.[39] This modification generates a 24 percent decline in the monthly payment burden. As a result, this borrower would be expected to have a re-default rate over the first year post modification that is 10.8 percentage points lower than would be the case without this improvement in the affordability of the mortgage.

Now instead assume that the lender decided to modify the mortgage by first writing down the principal to the current market value of the house, and then reducing the interest rate by the amount necessary to hit the desired monthly payment of $1,241. The direct impact of this principal write-down on the 12-month re-default rate is given by the difference in the LTV marginal effects for the LTV indicators for the 115-119 range and the 100-104 range.

To reduce the LTV to 100, the lender writes down the principal balance on the mortgage to $169,945. To reach the desired DTI of 0.31, the lender also reduces the interest rate on the mortgage to 7.95 percent. Under this modified mortgage the borrower would be expected to have a re-default rate over the first year post modification that is 28 percentage points lower due to the lower LTV, 10.8 percentage points lower due to the 24 percent reduction in the monthly payments, and 1.2 percent due to the reduction in the mortgage balance. The total impact of this modification would be to lower the first year re-default risk by 40 percentage points – nearly four times the impact from the interest rate only strategy.

Evaluating the relative economic value of the two modification strategies requires a more complete cash-flow analysis in order to compare the net present values under each approach. We carry out such an analysis using a model of cash flows shown in Figure 3. For simplicity, we assume that the mortgage is only at risk of a foreclosure in the first year following the modification. In the case of a modified mortgage, we assume that the probability associated with a foreclosure is the re-default rate predicted from the model.[40] If the mortgage goes into foreclosure, we assume that the proceeds from an auction sale amount to a 27 percent discount to

[38] Taking into account the debt amortization in addition to the two missed payments, the balance on the mortgage has increased to $200,752.

[39] In both modifications described in Table 7, we assume that the mortgage term is extended to 360 months from the modification date.

[40] If the lender does not modify the mortgage, we predict the re-default rate by setting the percent reduction in the monthly payment to zero and using the model estimates from specification (2) of Table 5.

the current market value of the house.[41] From the second year onwards, if the borrower moves we assume that the house is sold through a short-sale if the balance on the mortgage still exceeds the value of the house.[42] We assume that over the first ten years following the modification the borrower has a probability of moving that reflects whether the borrower is in negative equity and any financial incentive from a subsidized mortgage interest rate. If the borrower does not move over this ten year period, we assume that the borrower remains in the house and pays off the balance of the mortgage. We assume that nominal house prices remain unchanged for two years following the modification and then rise at a 3 percent nominal rate per year. Finally, we assume that each year that a borrower remains in negative equity results in an additional 2 percent depreciation of the house value. We discount the expected cash flows using the 3-month LIBOR rate.

The last line of Table 7 provides the estimated net present value calculations. We will call these "economic" NPV calculations to distinguish them from "accounting" NPV calculations that we will discuss below. The interest rate and term modification (Modification 1) produces an economic NPV that slightly exceeds that from no modification. The economic NPV estimate for Modification 1 indicates an expected loss at the modification date of 31 percent of the remaining balance of the mortgage. In contrast, if the targeted reduction in the monthly payment is achieved by writing down the principal to the current market value of the house and then reducing the interest rate on the mortgage (Modification 2), the economic NPV increases by 32 percent or by over $44,000. In this case, the expected value of the mortgage relative to the pre-write down mortgage balance implies a loss of only 9 percent.

Holding fixed the post-modification monthly payment, whether an interest rate and term modification or a principal write-down modification generates a higher economic NPV depends on the relative difference in the re-default rates between the two modifications as well as the current LTV of the mortgage. We can examine this within the context of our example in Table 7 by fixing the re-default rate from the principal write-down modification and varying the relative increase in the re-default rate from an interest rate modification that generates the same monthly payment. The upper curve in Figure 4 shows the combination of differential re-default rates and current LTVs that generate the same economic NPV for the modified mortgage. As the degree of

[41] See Campbell et al (2009).
[42] In the case of the household moving and selling the house, we assume that the household remains current up to the short-sale which takes place in December.

negative equity – and thus the principal write-down required to restore borrower equity - increases for a mortgage, the relative difference in re-default rates must be greater in order for the principal write-down modification strategy to produce the same economic NPV.

Whether a lender would prefer one modification strategy over another may depend not just on the relative economic NPV, but also on any differences in the accounting treatment for the modification and the impact this has on the lender's current net income.[43] If a lender modifies a mortgage, then the lender must treat the mortgage as a Troubled Debt Restructuring (TDR).[44] For an interest rate/term modification, accounting rules dictate that the lender would calculate the accounting NPV of the modified mortgage using the contract interest rate on the earlier mortgage as the discount factor.[45] The lender would then create a loan loss reserve equal to the current balance on the existing mortgage plus any arrears less the accounting NPV on the modified loan.[46] This loan loss reserve (or adjustment to the reserve) reduces the lender's current net income by an equal amount. However, if in the future economic conditions improve relative to what was expected, then the lender may reduce the loan loss reserve to reflect the improved accounting NPV for the mortgages in TDR. This situation would create a future gain to the lender's net income.

For a principal write-down modification, the lender would again calculate the accounting NPV on the modified loan using the contract interest rate as the discount factor. The amount of the principal write-down is treated as an immediate charge off, and a loan loss reserve is created equal to the difference between the written down balance and the accounting NPV on the modified mortgage. Both the amount of the charge off and the increase in the loan loss reserve reduce the lender's current net income by an equal amount. However, if economic conditions improve relative to what was expected, only the loan loss reserve can be adjusted – the charge-off from the principal write-down cannot be revised.

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[43] For details, see Accounting Standards Codification (ASC) ASC 450-20 – Loan Impairments (FASB Statement No. 5) and ASC 310-40 Receivables (FASB Statements No. 15 and 114).
[44] To be considered a TDR, the modification must be a concession that the lender would not otherwise make and which is due to the borrower's financial difficulties. The difference between the economic and accounting NPV reflects the choice of discount rate.
[45] Recall that we used the lender's cost of funding (3-month LIBOR) and not the mortgage interest rate as the discount factor when we did the earlier NPV calculations.
[46] If a loan loss reserve has already been established, then the lender would adjust the existing reserve to match this amount. There are also practical expedients which can be used by the lender in lieu of the accounting NPV calculation. These alternative measures of impairment are based on the loan's market value or the fair value of collateral if the loan is collateral dependent.

The lower curve in Figure 4 shows the combinations of relative re-default differences between the two modification strategies and current LTVs on the mortgage that generate the same reduction to the lender's current net income. The two curves divide the graph into three regions. In the northwest region the principal write-down modification strategy dominates both in terms of producing the higher economic NPV and a lower reduction to current net income. In the southeast region the interest rate/term modification strategy dominates. For mortgages that exist in the region between the two curves, the lender faces a tradeoff between economic NPV and implications for net income when selecting which modification strategy to pursue.[47]

To illustrate, consider a mortgage with a current LTV of 125 and assume that the interest rate modification strategy has a higher re-default rate of 6 percentage points (point A in Figure 4). The interest rate modification produces a higher economic NPV by $10,625. However, the initial write-down to income is $1,854 higher for the interest rate modification. Finally, of the total income write-down of $90,512 associated with the principal reduction modification, $39,609 (43.8% of the total) represents a charge-off that cannot be reversed. The relative size of the economic gain as compared to the current income write-down in conjunction with the added option value is likely to make lenders prefer the interest rate modification. However, consider keeping the LTV at 125 but moving from point A up to point B. At point B, the economic NPV is the same between the two modification strategies. The interest rate modification strategy requires a higher initial overall reduction in current income of $5,800, while the principal reduction modification strategy requires a charge-off of $39,600. Here it is much less clear that a lender would be willing to incur the larger initial income write-down in return for the option value of reducing the loan loss reserve in the future by some fraction of the charge-off.

Mortgage modifications and household mobility

Another distinction between modifications that reduce the monthly payment by cutting the interest rate as compared to reducing the principal is the likely impact on household mobility. Ferreira *et al* (2010) using over two decades of data from the *American Housing Survey* estimate that each $1,000 in subsidized interest to a borrower reduces the two-year mobility rate by 1.2

[47] Other considerations are that loan loss reserves (subject to a limit) count towards the lender's Tier II capital. If a lender reports a loss in a period where principal write-downs are creating charge-offs, then the lender receives deferred tax credits.

percentage points.[48] In addition, they find that negative equity lowers a borrower's 2-year mobility rate by 4 percentage points. They report an average 2-year mobility rate for homeowners of 11 percent over their sample period.

These results indicate that the design of modification programs can have an impact on household mobility. Modifying the interest rate to a below market rate creates an in-place subsidy to the borrower leading to a "lock-in" effect. That is, the borrowers receive the subsidy only if they do not move. Take the example in Table 7. A borrower who receives the interest rate modification in this example (Modification 1) receives an annual interest rate subsidy of approximately $5,600.[49] The results in Ferreira *et al* (2010) imply that this will lead to on average a reduction in the household 2-year mobility rate of over 6.8 percentage points. In addition, the borrower remains in negative equity which further reduces the 2-year mobility rate by 4 percentage points bringing the total mobility reduction to 10.8 percentage points. In effect, borrowers participating in this type of modification program will be "locked into" their current residences during the duration of the program. In contrast, a borrower receiving the balance and rate modification in this example (Modification 2) is restored to positive equity and receives an annual interest rate subsidy of only around $1,900. This modification program would lower the 2-year household mobility rate by 2.3 percentage points. These differing mobility rate effects can in aggregate impact the extent of frictional unemployment rates in local labor markets.

Conclusion

As subsidized mortgage modifications become an increasingly prominent feature of national housing policy, it is important for policy makers to understand how to leverage these expenditures to produce the maximal reduction in foreclosures. In our study of subprime mortgages, we found that pre-HAMP mortgage modifications were focused on mortgages that looked especially risky. These mortgages had lower borrower credit scores, higher origination

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[48] The source of interest rate subsidy in their analysis was from a borrower having a fixed-rate mortgage in an environment of rising mortgage interest rates.

[49] We assume that the market interest rate for the borrower at the modification date is 9.07% which is the average 30-year FRM interest rate in June 2008 of 6.32% plus a spread of 2.75%. This spread which we assume is fixed over time is the calculated as the difference between the average 30-year FRM interest rate in the month the mortgage was originated and the interest rate on the original mortgage.

LTVs and borrower DTIs, and were much more likely to be adjustable rate mortgages than those mortgages that did not receive a second chance.

Our analysis of those modifications in which payments were meaningfully reduced indicates that re-default rates – around 56% in the first year – are distressingly high. Yet the magnitude and form of modifications make a difference. Mortgages that receive larger payment reductions are significantly less likely to re-default, as are those that are modified in such a way as to restore the borrower's equity position. Of course, these kinds of modifications are not mutually exclusive, since reductions in mortgage balances offer both increased equity and reduced payments.

Our findings have potentially important implications for the design of modification programs going forward. The Administration's HAMP program is focused on increasing borrowers' ability to make their monthly payments, as measured by the DTI. Under HAMP, reductions in payments are primarily achieved by subsidizing lenders to reduce interest rates and extend mortgage term. While such interventions can reduce re-default rates, an alternative scheme would achieve the desired DTI by first writing down principal to the current market value of the property and then reducing the interest rate as necessary. We estimate that restoring the borrower's incentive to pay in this way nearly quadruples the reduction in re-default rates achieved by payment reductions through interest rate modifications and term extensions alone.

A question that we do not answer here is what determines which mortgages get a modification. While we can tell that borrowers (and mortgages) that receive a modification are different from those that do not, we do not model how a mortgage gets into our "modified" sample. If, as Adelino *et al* (2009) argue, servicers target their modifications to borrowers whom they expect to default without help, and avoid those who are likely to re-default, then our sample may not be reflective of the performance of modifications that are offered to borrowers regardless of their prospects. Such blanket modifications, which HAMP is intended to offer, could perform better or worse than our sample. Examining the servicer's decision to modify would help shed light on this important issue.

Since our data are limited to subprime mortgages, it is also of interest to examine whether our findings would hold for other segments of the mortgage market. In recent months, delinquencies on prime mortgages have risen sharply, and since these are a large share of outstanding mortgage debt, it is important to understand how modifications of these mortgages affect re-defaults, and whether the offer of a second chance will pay dividends to society.

While our exercise is thus limited, our results confirm the finding from previous research that borrower equity is a critical determinant of loan performance, and strongly suggest that loan modification programs will likely be more effective in limiting foreclosures and avoiding "lock-in" if they are attentive to borrower incentives to pay.

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Table 1: Origination characteristics of loans by modification status

Variables	Not Modified*	Modified: Full Sample	Modified: Estimation Sample
Count	118,355	330,724	53,618
FICO	658	617	597
Loan-to-value	85	88	83
Debt-to-income	39	41	31
Documentation (%):			
Full Doc	50	59	66
Low doc	48	39	34
Loan Purpose (%):			
Purchase	48	45	41
Property Type (%):			
Single family residence	71	77	80
CONDO	8	5	4
Two-to-four unit	6	5	4
PUD	14	12	10
Loan Type (%):			
Fixed rate mortgage	32	18	11

*From a 1% sample of mortgages originated during 2004-2007. There were 2,697 modified loans and 118,355 non-modified loans in this sample.

Table 2: Distribution of modified loans by vintage

Year of Origination	Percent
2000	0
2001	1
2002	1
2003	3
2004	9
2005	34
2006	44
2007	8

Note: Based on full sample of modified mortgages.

Table 3: Distribution of modified loans by pre-modification status

Variable	Percent
Current	26
30 days delinquent	10
60 days delinquent	10
90+ days delinquent	39
Foreclosure	14
Real estate Owned	0
Status Unknown	0

Note: Based on full sample of modified mortgages.

Table 4: Nature of Modifications

	(a) All modifications (330,724 observations)		
Variable	Reduction	No Change	Increase
Monthly payment	64.9	15.9	19.2
Balance	30.6	5.0	64.4
Excluding small balance reductions	5.5	30.1	64.4
Interest rate	70.4	27.5	2.1

	(b) Estimation Sample (53,618 observations)		
	Reduction	No Change	Increase
Monthly payment	100	0	0
Balance	9.2	0.4	90.4
Excluding small balance reductions	6.8	2.8	90.4
Interest rate	96.7	3.1	0.2

Table 5. Proportional hazard estimates of re-default

Variable	Overall (1)	Non-distressed (2)
Reduction in monthly payment (10%)	–0.132**	–0.130**
	(0.006)	(0.006)
Local unemployment rate lagged 6-months less average local rate	0.024**	0.052**
	(0.007)	(0.007)
Current LTV:		
90 – 94	0.018	0.014
	(0.031)	(0.026)
95 – 100	0.016	0.067**
	(0.032)	(0.026)
100 – 104	0.072**	0.135**
	(0.028)	(0.022)
105 – 109	0.192**	0.396**
	(0.032)	(0.031)
110 – 114	0.191**	0.714**
	(0.037)	(0.048)
115 – 119	0.195**	1.036**
	(0.040)	(0.075)
120+	0.323**	1.062**
	(0.024)	(0.110)
House price index relative to 2000 average (10%)	–0.007**	0.017**
	(0.003)	(0.004)
Balance at modification ($10,000)	0.012**	0.011**
	(0.001)	(0.001)
Duration to REO[1] – (1 month)	0.020**	0.018**
	(0.008)	(0.008)
Distressed sales per 10,000 households (5 sales)	0.007	0.067**
	(0.008)	(0.007)
Recourse state	–0.040**	–0.053**
	(0.020)	(0.020)
FICO at origination:		
< 560	0.070**	0.107**
	(0.022)	(0.023)
560 – 589	0.069**	0.091**
	(0.022)	(0.022)
590 – 619	0.021	0.030
	(0.021)	(0.021)
Missing	0.359**	0.408**
	(0.111)	(0.111)
Months current in year prior to modification	–0.051**	–0.043**
	(0.003)	(0.003)
Full documentation at origination	–0.167**	–0.170**
	(0.016)	(0.016)
Age of mortgage (6 months)	–0.081**	–0.090**
	(0.004)	(0.004)

Log likelihood	–42,429.0	–42,274.3

Notes: Subprime mortgage modifications from LoanPerformance data. Hazard coefficients with standard errors given in parentheses. The baseline hazard is estimated using a step-function with steps at each month. Total at risk months 226,891. Fixed rate mortgage indicator as well as four property type indicators included. Reference property is a single family residence with an adjustable mortgage with current LTV below 90 and an origination FICO score of 620 or higher.
** significant at the 5 percent level, * significant at the 10 percent level
[1] Measured as the 5^{th} percentile of the state distribution of delay durations where the duration is measures as the number of months between the initial delinquency and REO for an unbroken string of delinquencies.

Table 6. Probability of re-default over 12 months since modification

Variable	Change in re-default rate
Reduction in monthly payment (10%)	–0.045**
	(0.002)
Local unemployment rate lagged 6-months less average local rate	0.014**
	(0.002)
Current LTV:	
90 – 94	0.005
	(0.106)
95 – 99	0.023**
	(0.003)
100 – 104	0.046**
	(0.003)
105 – 109	0.136**
	(0.003)
110 – 114	0.239**
	(0.003)
115 – 119	0.327**
	(0.003)
120+	0.333**
	(0.003)
House price index relative to 2000 average (10%)	0.006**
	(0.001)
Balance at modification ($10,000)	0.004**
	(0.000)
Duration to REO – (1 month)	0.006**
	(0.003)
Distressed sales per 10,000 households (5 sales)	0.022**
	(0.002)
Recourse state	–0.018**
	(0.007)
FICO at origination:	
< 560	0.037**
	(0.008)
560 – 589	0.031**
	(0.008)
590 – 619	0.010
	(0.007)
Missing	0.140**
	(0.038)
Months current in year prior to modification	–0.015**
	(0.001)
Full documentation at origination	–0.058**
	(0.006)
Age of mortgage (6 months)	–0.030**
	(0.001)

Notes: Average derivatives (continuous variables) and differences (indicator variables) of one minus the predicted survivor function evaluated at 12 months from specification (2) of Table 5 with standard errors given in parentheses. Averages are taken over 8,185 mortgages. The average predicted re-default rate is 56 percent. Reference property is a single family residence with an adjustable mortgage with

positive equity and an origination FICO of 620 or higher.
** significant at the 5 percent level, * significant at the 10 percent level

Table 7: Modification Programs and Their Effects

	Original	Modification 1 Interest rate	Modification 2 Balance and rate
House value	$ 207,250	$ 169,945	$ 169,945
Mortgage balance	$ 200,000	$ 200,752	$ 169,945
LTV	96.5	118.1	100.0
Interest rate	9.17%	6.29%	7.95%
Monthly Income	$ 4,602	$ 4,602	$ 4,602
Tax & Insurance	$ 207	$ 207	$ 207
Principal & interest	$ 1,634	$ 1,241	$ 1,241
PITI	$ 1,841	$ 1,449	$ 1,449
DTI	0.40	0.31	0.31
% decline in payment	---	–24%	–24%
Δ Prob of re-default*	---	–10.8%	–40.1%
Δ 2-year mobility rate		–10.8%	–2.3%
Net present value	$ 137,703	$ 138,705	$ 183,291

Note: *Change in probability of re-default within 12 months

Table A1. Distribution of current LTV as of modification date

Current LTV at modification date	FACL Overall	FACL Non-distressed
90 – 94	7.1	10.3
95 – 99	7.1	9.8
100 – 104	9.1	16.4
105 – 109	6.3	5.8
110 – 114	4.7	2.0
115 – 119	3.8	0.8
120+	22.2	0.4
Negative equity	46.1	25.4

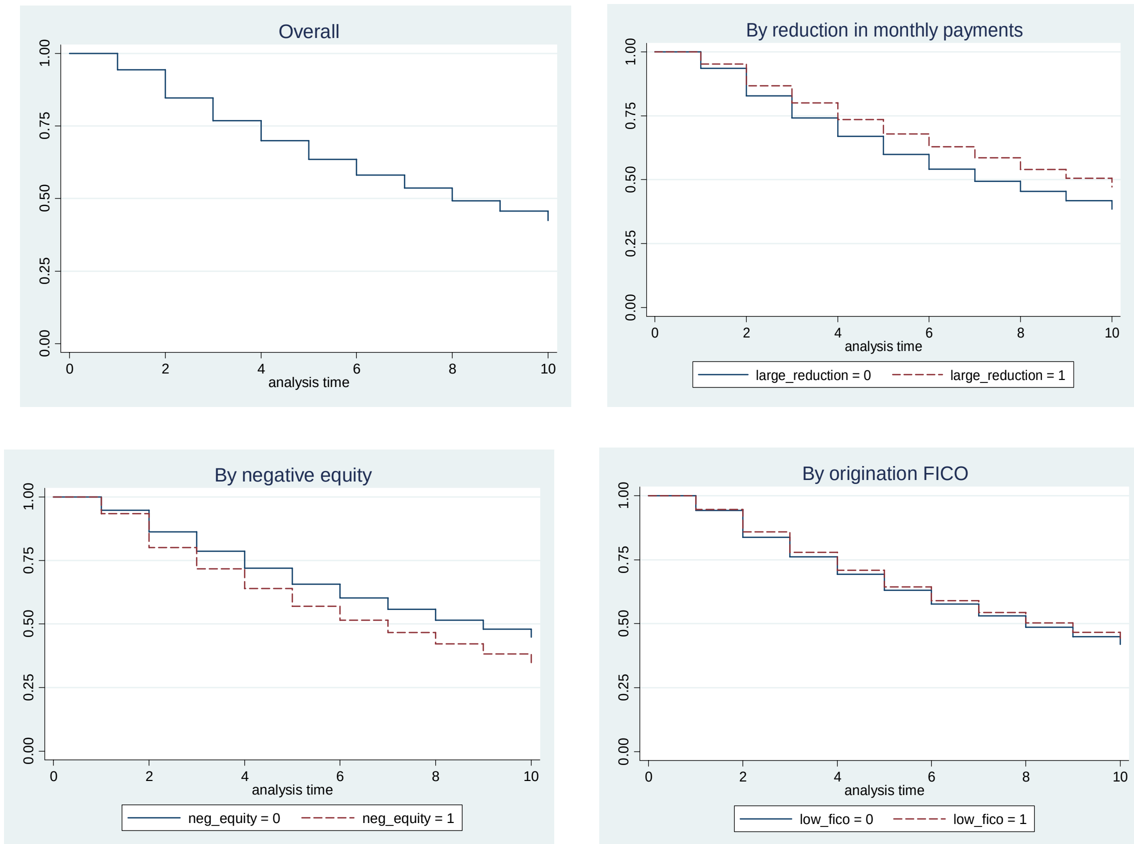
Note: Sample size 53,618

Table A2. Summary Statistics

	Static (number of obs = 53,618)			
Variable	Mean	Std Dev	Min	Max
Reduction in monthly payment	21.3	13.1	0	91.6
FICO at origination:				
<560	0.23	0.42	0	1
560 – 589	0.20	0.40	0	1
590 – 619	0.25	0.43	0	1
Missing	0.05	0.07	0	1
Months current in year prior to modification	2.7	3.0	0	11
Mortgage balance at modification ($10,000)	21.4	13.7	0.3	164.3
Duration to REO	7.1	1.0	6	9
Recourse state	0.76	0.43	0	1

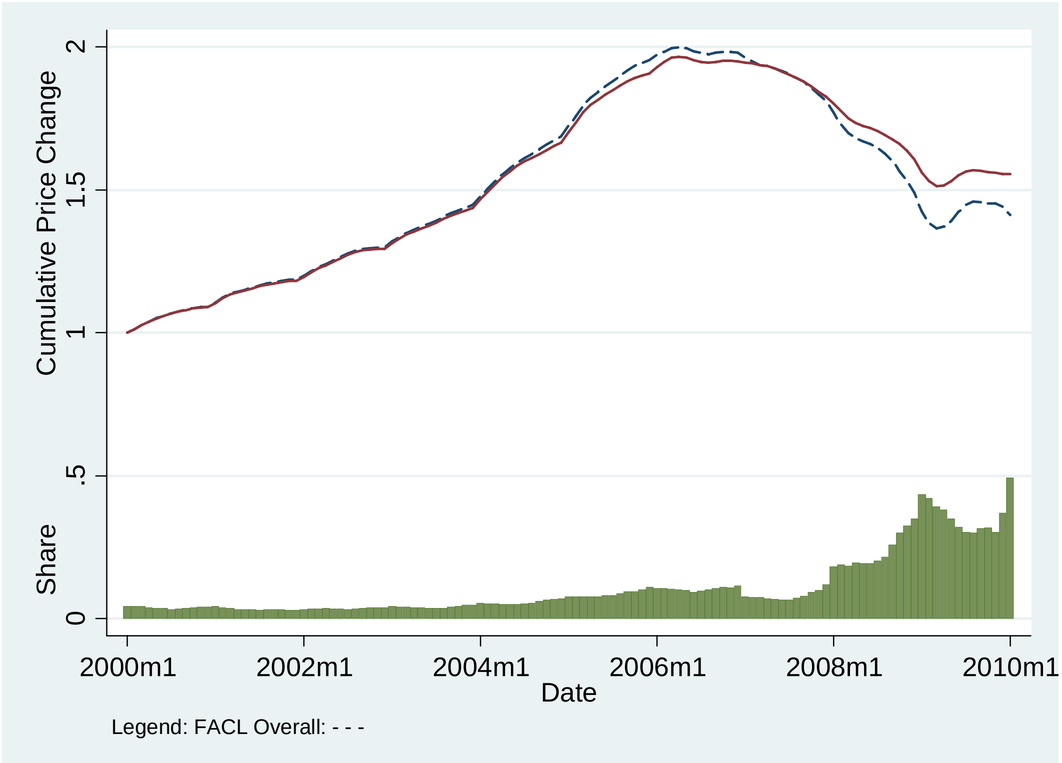
	Dynamic (number of obs = 226,891)			
Variable	Mean	Std Dev	Min	Max
Months since modification	5.8	2.9	3.0	32.0
Local unemployment rate lagged 6-months less average local rate	0.2	1.1	-13.2	8.9
House price change in last 12-months :				
FACL – overall	-9.7	10.0	-41.0	14.8
FACL – nondistressed	-10.7	7.9	-43.2	14.3
House price index relative to 2000 average:				
FACL – overall	22.1	24.6	-28.7	160.0
FACL – nondistressed	42.8	25.2	-17.7	161.8
Age of mortgage (months)	40.0	15.2	11.0	278.0
Distressed sales per 10,000 households	4.3	5.7	0	34.1

Figure 1. Kaplan-Meier Survival Graphs -- 12 months post-modification



Notes: Failure is defined as the modified mortgage reaching 90 days delinquent. Analysis time begins at the 3rd month following the modification.

Figure 2. FACL Overall and Non-Distressed House Price Changes and Distress Sales Share



Source: FirstAmerican CoreLogic.

Figure 3. NPV Cash Flow Diagram

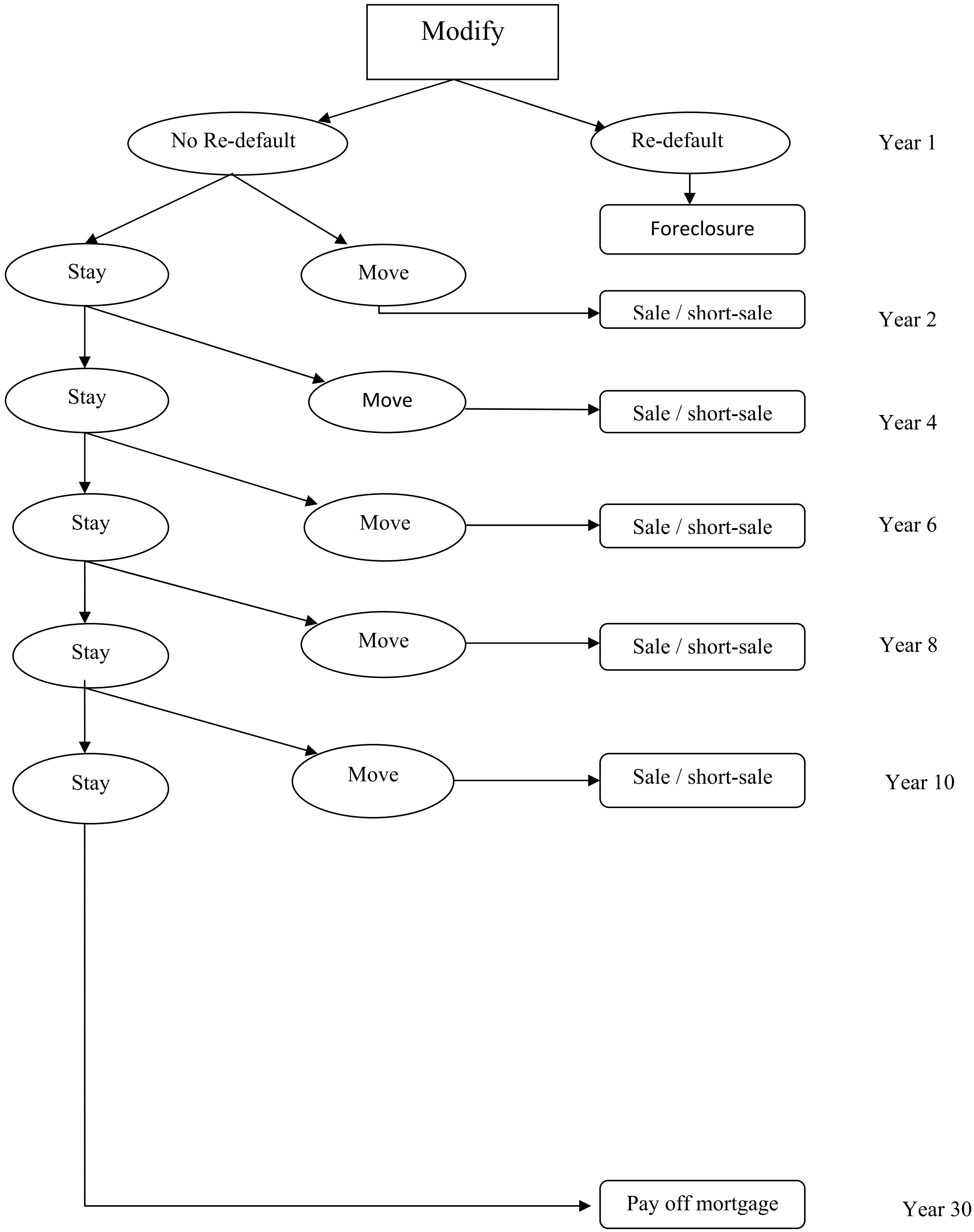


Figure 4. Comparison of Economic and Accounting Treatment of Modified Loan