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Second chances: Subprime mortgage modification and re-default

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Second Chances: Subprime Mortgage Modification and Re-Default

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Ebiere Okah
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Staff Report no. 417
December 2009

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Second Chances: Subprime Mortgage Modification and Re-Default

Andrew Haughwout, Ebiere Okah, and Joseph Tracy

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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 of the modified mortgage re-defaulting 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 in which the borrower was seriously delinquent and the monthly payment was reduced as part of the modification. 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 opposed to lower interest rates.

Key words: mortgage modifications, subprime

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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. 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).[1] While the number of mortgage modifications steadily increased during 2008, the number of delinquencies and foreclosures also continued to rise. Many observers, including the 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 year.

Residential mortgages are complex financial instruments with many features: the principal balance, the interest rate and any adjustments for ARMs, and the maturity or

[1] See http://www.americansecuritization.com/uploadedFiles/ASFStreamlinedFrameworkQA121707.pdf for details.

duration of the contract. Any or all of these contract terms may 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 redefault, but that different kinds of modifications have diverse effects on outcomes. In particular, while HAMP 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 quite unusual, 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 mods" 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 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 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

redefault 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 many studies of the incentives of mortgage borrowers and their payment performance over many decades. Borrower payment behavior is affected by many 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 while maintaining other kinds of consumption.

Incentive to pay

Homes, like other assets, offer capital gains or losses to their owners. Borrowers with positive equity in their properties have an incentive to keep current on their mortgage, since delinquency and foreclosure will ultimately lead to a loss of the asset. In

fact, borrowers 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 may cause the borrower to lose her equity.[2]

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.

Both previous research and industry practice has shown that all three of these 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 – defined as the case in which the mortgage balance exceeds the current house value – 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 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;

[2] Homes sold at a foreclosure auction sell at a discount to those listed and sold by the borrower.

the classic example is of a negative equity homeowner who loses his job. 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 "ruthlessly" 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.

On the other hand, drawing from more recent experience, Haughwout *et al* (HPT, 2008) find that borrower equity, particularly as determined by falling house prices after 2006, dominates the explanation for high rates of early nonprime – encompassing subprime and near-prime – defaults, particularly among acknowledged investors. These results can be at least partially reconciled with FGW by recalling how the housing and mortgage markets have changed since the early 1990s, and in particular the rapid increase in the nonprime market share prior to 2007. The roughly 200 point reduction in credit scores associated with a mortgage default is presumably less costly to borrowers with lower credit ratings to begin with, and such borrowers dominate the subprime part of the HPT sample. Borrowers who do not live in the subject property do not lose the

consumption value of the house if they default; investors – whether declared or masquerading as owner-occupants – are heavily represented in HPT's near-prime (Alt-a) subsample. Finally, expectations of price increases that will "right" currently underwater mortgages are likely significantly diminished in such foreclosure hotspots as California and Nevada in comparison with New England in the 1990s.

These questions remain quite relevant, as policy makers seek to design modifications 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, enough modifications change the borrower's equity position that we are able to draw some inferences about 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 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 67 percent 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 our results should be restricted to the subset of securitized subprime loans (Keys 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 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% were reported by servicers. For modified loans, LP includes variables for the new

interest rate, balance, scheduled monthly payment, and other relevant data, including loan term, on the modification.[3]

Modification Selection

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 51,626 loan subset used in our analysis (see below); for comparison the table also shows the same characteristics for a 1% random sample of loans originated between 2004-2007. Of these loans, approximately 2% subsequently received a modification.

The table indicates that modifications were made to loans that look riskier ex ante -- they had lower borrower FICO scores, higher LTVs and higher DTIs at the origination of the mortgage. 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.

[3] Unfortunately, the term of the modified loan is present 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.

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 (HPT 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 ¼ of the modifications in our estimation sample.

In general, mortgage modifications are offered to borrowers evidencing some signs of distress. Nearly sixty percent of modified mortgages were experiencing some level of delinquency at the modification date, and an additional 14% 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 2005-2006 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".[4]

[4] 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 compared to an average of 88 for loans that were in some stage of delinquency 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.

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 delinquent. This supports the Adelino *et al* (2009) argument that servicers do not want to modify loans if they believe the borrower is capable of rectifying the situation unassisted. 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%) of the loan modifications resulted in a reduced monthly payment, 19 percent produced a higher payment (Table 4). Capitalization mods - previously delinquent borrowers who are brought current while having arrearages added to the balance of the loan – are common in the data. Fully 64% of modifications resulted in higher balances (a reduction in the borrower's equity position), while balances were reduced in just 5% of modifications. Nonetheless, 70% of modifications resulted in a decrease in interest rates. This pattern suggests an intention among servicers to make the loans more affordable, while not losing any of the underlying principle.

For the re-default analysis below, we focus on modifications that improve mortgage affordability. We select first-lien subprime loans on owner-occupied properties which were moved to "current" status after the modification, and for which at least three months post modification payment history is available. We further restrict our estimation sample to loans that were 60 days delinquent or worse, excluding loans which had already entered REO status and which received a payment reduction. In this way, we focus our analysis on re-default of loans that received a significant modification.

Our reduced 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 a significant number of principal reductions in our estimation sample. For the 7% of borrowers 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 allow us to explore their effects 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 51,626 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.[5] 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 what laws govern the foreclosure process in the housing market where the property is located.

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 becoming 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

[5] We call this "re-default" since all of our modified mortgages were at least 60+ days delinquent prior to their modification.

the case where the borrower of the modified mortgage failed to make a single payment subsequent to the modification.[6]

The graph in the northwest corner of Figure 1 shows the overall KM survival plot for our modified data. 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 the larger reductions in their monthly payments. By six months following the modification, 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" include all the modified mortgages whose current LTVs are estimated to exceed 100. 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.

[6] 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 modified mortgage 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.

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 duration t given that the mortgage had not reached this level of delinquency by duration $t-1$. We model this hazard rate using a proportional hazard framework. The hazard rate for mortgage i at duration t is given by:

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

where $g(t)$ is a function of the time since the mortgage was modified, t. We assume that the baseline hazard rate, $\exp(g(t))$, can be well approximated by fitting $g(t)$ using a step-function where the steps are defined at a monthly frequency.[7] The key assumption in the

[7] Meyer (1990) was an early advocate of approximating the baseline hazard using a step-function.

proportional hazard specification is that the explanatory variables, X_{it}, shift the baseline hazard proportionally.[8]

Besides re-defaulting, a mortgage can exit our sample by being paid off. This would occur 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 re-default or prepay. 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 leaves the sample without re-defaulting.[9] To date, only 0.58 percent of our modified mortgages have pre-paid.

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 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 and $X_{it}\beta$. Given the de minimis pre-payment rate, we ignore pre-payments in calculating the re-default rate.[10] With this assumption, the re-default rate for a mortgage over a given amount of time T since modification is one minus the survivor function for the re-default hazard, $1 - S_i(T)$.

[8] For more discussion of duration data and hazard rates see Kalbfleisch and Prentice (2002).
[9] 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.
[10] 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.

For continuous explanatory variables we report the average derivative of $1 - S_i(T)$. For a given duration T, we include in the average derivative calculation all mortgages where we can collect values for the explanatory variables for T periods since the modification.[11] The full sample of mortgages is used in the estimation even if a mortgage cannot be included in the average derivative calculation. The change in the magnitude of the particular explanatory variable is assumed in the derivative calculation to apply during each of the T 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 to zero. For categorical variables we also compute the average difference of the survivor functions with a specific indicator set to one while the remaining are set to zero and then to where all of the associated indicators are set to zero.

Misspecifying the baseline hazard can lead to bias in the estimates of the hazard coefficients β. To check for this possibility, we first estimate the β coefficients using a Cox proportional hazard model where the function $g(t)$ is left unspecified. We can then compare these hazard estimates to those that are produced when we specify $g(t)$ as a step-function in time. If the step function is providing an adequate approximation of the underlying baseline hazard $g(t)$ then we should not see significant differences in the estimated hazard coefficient estimates.

Our hazard coefficient estimates are given in Table 5. Specification (1) and (2) are derived from the Cox model where the baseline hazard is left unspecified, while

[11] We fill out the panel of explanatory variables for a full T months even if the mortgage re-defaults or prepays at an earlier month.

specification (3) approximates the underlying baseline hazard with a step-function. Specification (1) starts with a simple specification of the determinants of re-default. Specification (2) elaborates on this specification by adding additional information on local house price dynamics, the borrower's recent payment history, as well as overall subprime mortgage delinquency behavior in the local housing market. We report the estimated hazard coefficients rather than the exponentiated hazard coefficients. 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.

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. 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 a 13 percent reduction in the re-default hazard.

An alternative measure of the improvement in the affordability of the mortgage post modification is the percent change in the required monthly payment 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 in the specification, both are significant but the magnitude

of our original measure of the change in affordability is three times the magnitude of the alternative measure.

Unemployment is considered a traditional "trigger" for mortgage default.[12] We include a time-varying measure which is the local unemployment rate lagged six months less the average local unemployment rate.[13] Absent information on unemployment spells by the individual borrower, we use a local unemployment rate as a proxy. 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 from 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. In specification (1) the local unemployment rate has no effect on the re-default hazard. When we move to the expanded set of control variables in specification (2), the data suggest that each additional percentage point rise in this lagged local unemployment rate shifts up the re-default hazard by around 0.9 percent. Again, this estimated impact is both small and imprecisely measured.[14]

This weak effect associated with the unemployment rate may be a reflection of a selection process by servicers/lenders determining which mortgages are modified. That

[12] The other two triggers being serious health problems and divorce.
[13] We compute the average local unemployment rate based on data from 1990 Q1 to 2009 Q1.
[14] Subtracting out the average local unemployment rate doubled the estimated impact in specification (2). We also tried 3- and 9-month lags as well as the 3-, 6- and 9-month change in the local unemployment rate.

is, if servicers/lenders tend not to modify mortgages for borrowers who have lost their job, then this vitiates the local unemployment rate as a proxy variable for a job loss. This selection effect requires that the servicers/lenders are re-underwriting the loans versus offering simple modifications.[15] The case for selection being an issue is stronger when we interact our local unemployment rate measure with each of the negative equity indicators. The "double trigger" hypothesis would suggest that these interactions should be positive.[16] Adding the interactions raises the coefficient on the local unemployment rate to 0.018 and is significant at the 5 percent level. The interactions with the negative equity indicators are all *negative* with the coefficient on LTV between 110 and 114 being statistically significant. This is consistent with lenders screening out borrowers with significant negative equity and who are suffering a job loss from qualifying for a mortgage modification.[17]

The incentive to pay is captured in specification (1) through indicators for varying levels of current negative equity. These indicators are dynamic variables in that they can change over time following the modification date as house prices evolve in the local housing markets. Specification (2) adds several variables capturing different aspects of the dynamics of local housing prices. The data indicate that relative to borrowers with positive equity, the re-default risk is significantly higher for borrowers with negative

[15] In simple modifications, servicers/lenders mail out modification agreements that only require the borrower to sign and return. These might be used for borrowers who were already in the foreclosure process where there is insufficient time to complete the underwriting process in time to prevent a foreclosure.

[16] The double-trigger hypothesis is that default is likely to take place when a borrower faces both a negative equity situation as well as a loss of income, for example from an unemployment spell. For a discussion see Foote *et al* (2008).

[17] If lender selection is what is generating the weak unemployment effect, then we would expect the unemployment effect to become positive when we have observed the modified mortgages for long enough period of time that the unemployment event occurs following the modification.

equity, and is increasing with the degree of negative equity. In specification (1), borrowers with a current LTV in the range of 115 or higher have a 51 percent higher risk of re-defaulting in any given month. This increased risk diminishes as we move to lower levels of negative equity, but remains significantly higher than for borrowers with positive equity.

An important issue is whether the current LTV is capturing the pure effect of negative equity on borrower 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, we add the percent change in MSA house prices over the twelve months prior to the modification. If only the current LTV matters for re-default, then this house price change is already incorporated into the current LTV calculation and so should have no additional explanatory power. Turning to specification (2), the data suggest that declining house prices do not play an independent role on re-default. Including the additional variable capturing local house price dynamics lowers somewhat the estimated effects of negative equity on the re-default hazard.

The decision by a borrower to re-default may 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 as well as the underlying variability of house prices in the local housing market. In specification (2), 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, this year predates the sharp run-up in house prices and serves as a useful

benchmark. Where the current index is still above the year 2000 index value, borrowers may perceive little near-term scope for house price appreciation. We proxy for the underlying variability of individual house prices in the local housing market using the variance of 2-year house price changes for the MSA based on the OFHEO/FHFA repeat-sale estimation. For a given degree of current negative equity, the higher the variability of house price changes the greater the option value of delaying a re-default. Given the current equity position of the borrower, the data indicate that for every 10 percent that current area house prices exceed their year 2000 level, the re-default risk increases by 3 percent. Measurement error in capturing individual borrower house price expectations would be expected to bias down our estimate of this effect. Increasing the variability of local house prices by an additional percentage point is associated with a negligible decline in the re-default risk.

The willingness to pay is captured using the origination FICO score. We include three indicators for FICO scores below 620, as well as an indicator for a missing FICO score. Despite the fact that we do not have an updated FICO score for the borrower as of the modification date, in specification (1) the data indicate that borrowers with an origination FICO below 560 have a re-default hazard that is 12.6 percent higher than borrowers with an origination FICO that was above 620. Similarly, borrowers with an origination FICO between 560 and 589 have a re-default hazard that is 11.2 percent higher. Modified mortgages that went through a full underwriting and documentation when originated have a 15 to 20 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 longer period are likely to be better risks.[18] 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 7.7 percent lower.

In specification (2) we add two additional controls that may relate to the borrower's willingness to pay. Since we lack a current FICO score for the borrower, we add a measure of the borrower's payment history over the twelve months prior to the modification as a proxy for the current FICO score. We use a summary of this payment history which is the percent of the time that the borrower was current. While we restrict our sample to modifications were the borrower was 60 plus days delinquent as of the modification date, there is variation in the 12 month payment histories across borrowers. The data indicate that controlling for the origination FICO score, each additional month that the borrower was current in the prior year reduces the re-default hazard by 5 percent. Not surprising, controlling for the borrower's recent payment history also reduces the magnitude of the effects associated with the original FICO score.

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

[18] The average age of our mortgages at the modification date is 38 months.

problems or are in a negative equity situation. Fear of what will happen to a borrower if he/she defaults may be mitigated from conversations from friends or neighbors who have already gone through the process. To check for this in the data, we include the percent of subprime mortgages in the MSA that currently are 90 days or more delinquent. The data indicate that a 10 percentage point increase in the area delinquency rate raises the re-default risk by 8.2 percentage points.[19]

Specification (3) provides the hazard coefficient estimates where we approximate the baseline hazard using a step-function in months since the modification. Comparing the estimates in specification (3) to specification (2), confirms that we have not misspecified the baseline hazard. Estimating the baseline is necessary for us to calculate the impacts of the various explanatory variables on the probability that a modified mortgage re-defaults over a specified time period since the modification.

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 7,894 mortgages that meet this data requirement. The average predicted re-default rate is 57 percent.

Reducing the monthly required payment on the mortgage by 10 percent lowers the predicted 12-month re-default probability by 4.4 percentage points (or 8 percent of the

[19] It is possible that this variable is not capturing a decline in stigma effects but rather is proxying for problems in the local housing market that are not fully captured by our other control variables.

average). Comparing a modified mortgage with positive equity to one with a current LTV between 100 and 104 for each month following the modification, the predicted re-default rate increases by 7.6 percentage points (or 13 percent of the average). The re-default risk continues to increase with the extent of the borrower's negative equtiy. For a borrower with a current LTV of 115 or higher, the re-default rate over the first year is 15.5 percentage points higher (or 27 percent of the average).

If the current house price index is 10 percent above its year 2000 house value, this raises the predicted 12-month re-default rate by an additional percentage point. As discussed above, the variability of house prices as measured by the 2-year OFHEO/FHFA MSA house price variance has no significant impact on the one year re-default probability. Each additional month that a borrower is current in his/her payments over the year prior to the modification is associated with a 1.7 percentage point lower predicted re-default rate. Borrowers who went through a full underwriting and documentation of their original mortgage are 5.2 percent less likely to re-default over the subsequent year.[20] Modified mortgages that are seasoned by an additional six months have a 2.7 percentage point lower predicted 12-month re-default rate. Finally, raising the average 90-day delinquency rate in the MSA by 10 percentage points increases the one year re-default probability by 2.8 percentage points.

Design of mortgage modification programs

[20] 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.

We can use these estimates from Table 6 to discuss the implications of 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).[21]

Consider the example described in Table 7. A house is purchased 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 8.44 percent. Annual taxes and insurance on the house are 1.2 percent of the purchase price. The borrower has an annual income of $52,097, or $4,341 per month. The initial DTI on the mortgage is 0.4. Subsequent to the purchase, area house prices decline by 18 percent, to $169,945. The borrower's current LTV is 118.

The lender approaches the borrower to modify the mortgage. The target DTI on the modified mortgage is 0.31. The lender agrees to reduce the interest rate on the mortgage to 5.6 percent bringing down the required monthly payment to $1,148.[22] This modification generates a 25 percent decline in the monthly payment burden. As a result,

[21] 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.

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

this borrower would be expected to have a re-default rate over the first year post modification that is 11 percentage points lower than would be the case without this improvement in the affordability of the mortgage.

Now assume that the lender decided instead to modify the mortgage by first writing down the principle to get the current LTV to 90, and then reducing the interest rate if necessary to hit the desired monthly payment of $1,148. We use a target LTV of 90 since this is the average current LTV among the modified mortgages in our data conditional on the borrower having positive equity.[23] Our negative equity estimates reported in Table 6 indicate the change in the re-default risk for borrowers with negative equity in the interval indicated relative to the average of the "left-out" set of borrowers who have positive equity. To realize the full impact of the LTV effect, we need to write-down the principal not to an LTV of 100, but to the average LTV among the positive equity mortgages.

To reduce the LTV to 90, the lender writes down the principal balance on the mortgage to $152,951. To reach the desired DTI of 0.31, the lender also reduces the interest rate on the mortgage to 8.24 percent. Under this modified mortgage the borrower would be expected to have a re-default rate over the first year post modification that is 15.5 percentage points lower due to the principal write-down, and an additional 11 percentage points lower due to the 26 percent reduction in the monthly payments. The total impact of this modification would be to lower the first year re-default risk by 26.5 percentage points – more than double the impact from the interest only strategy.

[23] This is also the target LTV under the Hope for Homeowners (H4H) plan.

Whether a lender would prefer the second over the first modification strategy requires a more complete cash-flow analysis in order to compare the net present values under each approach. However, this simple example illustrates the potential role for principal write-down to mitigate the high recidivism experienced with modified mortgages. If re-default is likely to generate a foreclosure and distressed sale of the property, then there may be a public policy argument to provide incentives to lenders to use principal write-down in their modification strategies in order to reduce the negative externalities from these distress sales.[24]

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 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 57% 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 redefault, as are those

[24] Lenders will account for any price discounts likely to occur from a distressed sale in their NPV calculation. However, they are unlikely to incorporate any of the externalities arising from increased distressed sales unless they hold a large inventory of REO property in that local housing market. Government policy can use incentive to make the lenders effectively incorporate these externalities into their NPV calculations.

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 simultaneously enhance the borrower's ability and *willingness* to pay the debt, by writing down principal in order to restore the borrower's equity position. We estimate that restoring the borrower's incentive to pay in this way can double the reduction in re-default rates achieved by payment reductions alone.

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 1.4 percentage points.[25] 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 borrower receives the subsidy only if he or she does not move. Take the example discussed earlier in Table 7. Compare the interest rate modification

[25] 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.

illustrated in "Modification 1" to an alternative 100% LTV loan, at the borrower's existing interest rate, on an identically priced house. Compared to this mortgage, modification 1 creates an annual subsidy of over $3,000. The results in Ferreira *et al* (2010) imply that this will lead to on average a reduction in the household two-year mobility rate of over 4.4 percentage points – more than a forty percent reduction in the overall rate. In contrast, reducing the monthly payment through reducing the principal on the mortgage does not create an in-place subsidy and would not lead to a lock-in effect.

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. 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.

References

Adelino, Manuel, Kirstopher S. Gerardi, and Paul Willen. "Why Don't Lenders Renegotiate More Home Mortgages? Redefault, Self-cure, and Securitization." Working Paper 2009-17. Federal Reserve Bank of Atlanta, August, 2009.

An, Xudong, Raphael W. Bostic, Deng Yongheng, and Stuart A. Gabriel. "GSE Loan Purchases, the FHA, and Housing Outcomes in Targeted, Low-Income Neighborhoods." In *Brookings-Wharton Papers on Urban Affairs*, edited by Gary Burtless and Janet Rothenberg Pack, 205-240. Washington DC, Brookings Institution Press, 2007.

Ashcraft, Adam and Til Schuermann. "Understanding the Securitization of Subprime Mortgage Credit," Federal Reserve Bank of New York *Staff Report* 318, March 2008.

Cordell, Larry, Karen Dynan, Andreas Lehnart, Nellie Liang, and Eileen Mauskopf. "The Incentives of Mortgage Servicers: Myths & Realities." Working Paper 2008-46. Federal Reserve, 2008.

Demyanyk, Yuliya, and Otto Van Hemert. "Understanding the Subprime Mortgage Crisis." Working Paper. New York University, Stern School of Business, February, 2008.

Ferreira, Fernando, Joseph Gyourko and Joseph Tracy. "Housing Busts and Household Mobility." *Journal of Urban Economics* (forthcoming) 2010.

Foote, Christopher L., Kristopher Gerardi, and Paul S. Willen. "Negative Equity and Foreclosure: Theory and Evidence." *Journal of Urban Economics* 64, no. 2 (2008): 234-245.

Keys, Benjamin, Tanmoy Mukherjee, Amit Seru, and Vikrant Vig. "Did Securitization Lead to Lax Screening? Evidence From Subprime Loans 2001-2006." *EFA 2008 Athens Meetings Paper*. Available at SSRN: http://ssrn.com/abstract=1093137 (2008)

Gerardi, Kristopher, Adam Hale Shapiro, and Paul S. Willen. "Subprime Outcomes: Risky Mortgages, Homeownership Experiences, and Foreclosures." Working Paper 07-15. Federal Reserve Bank of Boston, 2007.

Haughwout, Andrew, Richard Peach, and Joseph Tracy. "Juvenile Delinquent Mortgages: Bad Credit or Bad Economy." *Journal of Urban Economics* 64, no. 2 (2008): 246-257.

Kalbfleisch, Jack D., and Ross L. Prentice. *The Statistical Analysis of Failure Time Data*. Wiley, 2002.

Meyer, Bruce D. "Unemployment Insurance and Unemployment Spells." *Econometrica* 58 (July 1990): 757-782.

Piskorski, Tomasz, Amit Seru, and Vikrant Vig. "Securitization and Distressed Loan Renegotiation: Evidence From the Subprime Mortgage Crisis." Research Paper No. 09-02. Chicago Booth School of Business, August, 2009.

Quercia, Roberto G., Lei Ding, and Janneke Ratchitte. "Loan Modifications and Redefault Risk: An Examination of Short-term Impact." Working Paper. The University of North Carolina at Chapel Hill, Center for Community Capital, March, 2009.

Vandell, Kerry D. "How Ruthless Is Mortgage Default? A Review and Synthesis of the Evidence." *Journal of Housing Research* 6, no. 2 (1995): 245-264.

Table 1: Origination characteristics of loans by modification status

Variables	Not Modified*	Modified	Estimation Sample
Count	118,355	330,724	51,626
FICO	658	617	597
Loan-to-value	85	88	88
Debt-to-income	39	41	42
Documentation: full doc	50	59	66
Low doc	48	39	34
Percent purchase	48	45	41
Percent: SFR	71	77	80
CONDO	8	5	4
Two-to-four unit	6	5	4
PUD	14	12	11
Percent FRM	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

Table 3: Distribution 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

Table 4: Nature of Modifications

	(a) All modifications (330,724 observations)		
Variable	Reduction	No Change	Increase
Monthly payment	65	16	19
Balance	36	5	64
Excluding small balance reductions	5	30	64
Interest rate	70	28	2

	(b) Estimation Sample (51,626 observations)		
	Reduction	No Change	Increase
Monthly payment	100	-	-
Balance	9	0	90
Excluding small balance reductions	7	3	90
Interest rate	97	3	0

Table 5. Proportional hazard estimates of re-default

	Cox proportional hazard		Step-function proportional hazard
Variable	(1)	(2)	(3)
Reduction in monthly payment (10%)	–0.135**	–0.128**	–0.128**
	(0.006)	(0.006)	(0.006)
Local unemployment rate lagged 6-months less average local rate	0.002	0.009	0.009
	(0.006)	(0.007)	(0.007)
Current LTV:			
100 – 104	0.237**	0.218**	0.218**
	(0.029)	(0.029)	(0.029)
105 – 109	0.277**	0.235**	0.234**
	(0.034)	(0.034)	(0.034)
110 – 114	0.387**	0.330**	0.330**
	(0.038)	(0.038)	(0.038)
115+	0.508**	0.444**	0.444**
	(0.021)	(0.025)	(0.025)
House price change in 12-months prior to modification (10%)		0.027	0.027
		(0.018)	(0.018)
House price index relative to 2000 average (10%)		0.030**	0.030**
		(0.003)	(0.003)
2-year variance in house price changes (1%)		–0.005	–0.004
		(0.037)	(0.037)
FICO at origination:			
< 560	0.126**	0.040*	0.040*
	(0.022)	(0.022)	(0.022)
560 – 589	0.112**	0.061**	0.061**
	(0.022)	(0.022)	(0.022)
590 – 619	0.052**	0.019	0.019
	(0.021)	(0.021)	(0.021)
Missing	0.216*	0.209*	0.209*
	(0.117)	(0.117)	(0.117)
Months current in year prior to modification		–0.050**	–0.050**
		(0.003)	(0.003)
Full documentation at origination	–0.201**	–0.152**	–0.152**
	(0.016)	(0.017)	(0.017)
Age of mortgage (6 months)	–0.077**	–0.078**	–0.078**
	(0.004)	(0.004)	(0.004)
90+ delinquency rate in MSA (10%)		0.082**	0.082**
		(0.011)	(0.011)

Notes: Subprime mortgage modifications from LoanPerformance data. Hazard coefficients with standard errors given in parentheses. Total at risk months 217,847. Fixed rate mortgage indicator as well as four property type indicators included. Reference property is a single family residence with an adjustable mortgage with positive equity and an origination FICO score of 620 or higher.

** significant at the 5 percent level

* significant at the 10 percent level

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

Variable	Change in re-default rate
Reduction in monthly payment (10%)	–0.044**
	(0.002)
Local unemployment rate lagged 6-months less average local rate	0.003
	(0.003)
Current LTV:	
100 – 104	0.076**
	(0.010)
105 – 109	0.082**
	(0.012)
110 – 114	0.115**
	(0.013)
115+	0.155**
	(0.009)
House price change in 12-months prior to modification (10%)	0.009
	(0.006)
House price index relative to 2000 average (10%)	0.010**
	(0.001)
2-year variance in house price changes (1%)	–0.002
	(0.013)
FICO at origination:	
< 560	0.014
	(0.008)
560 – 589	0.021**
	(0.008)
590 – 619	0.007
	(0.007)
missing	0.073*
	(0.041)
Months current in year prior to modification	–0.017**
	(0.001)
Full documentation at origination	–0.052**
	(0.006)
Age of mortgage (6 months)	–0.027**
	(0.001)
90+ delinquency rate in MSA (10%)	0.028**
	(0.004)

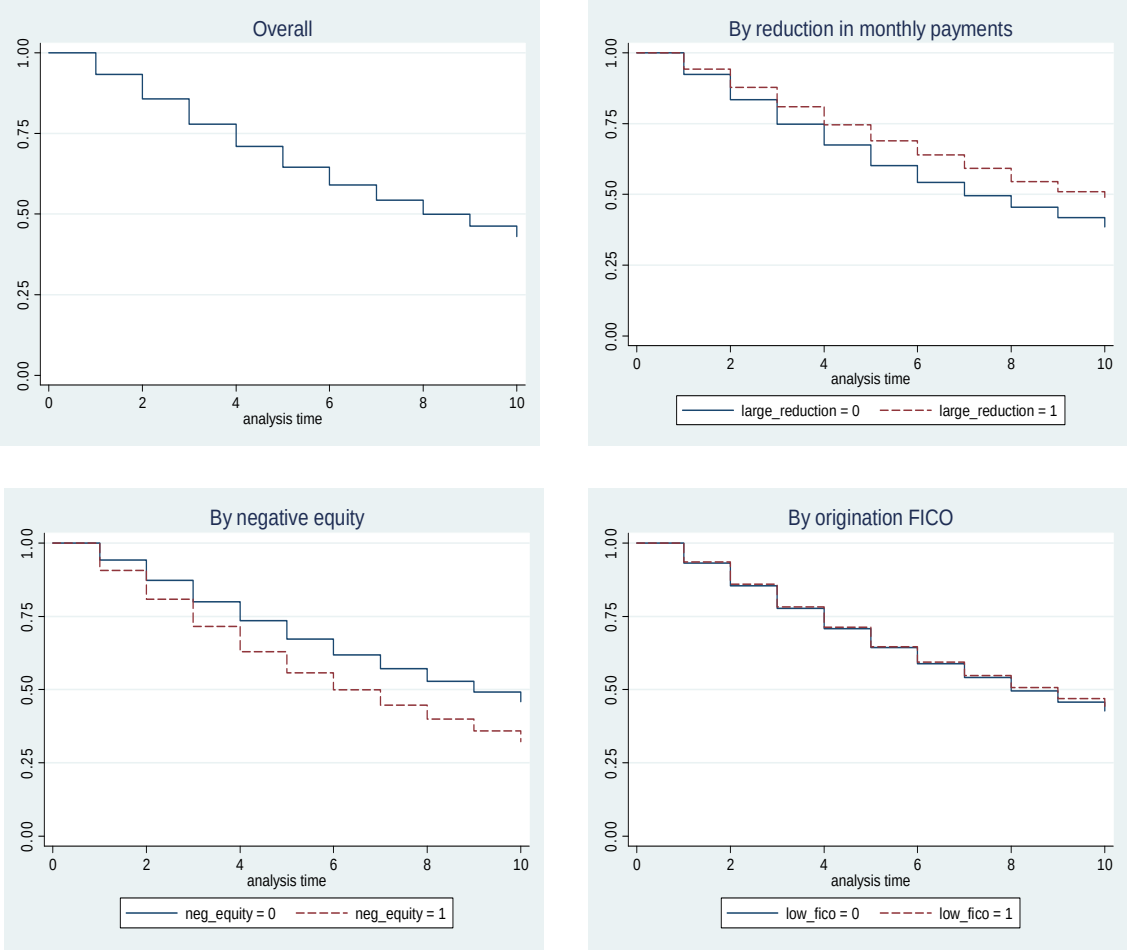
Notes: Average derivatives (continuous variables) and differences (indicator variables) of one minus the predicted survivor function evaluated at 12 months from specification (3) of Table 5 with standard errors given in parentheses. Averages are taken over 7,894 mortgages. The average predicted re-default rate is 57 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	$ 200,000	$ 152,951
LTV	96.5	117.7	90.0
Interest rate	8.44%	5.60%	8.24%
Income	$ 4,341	$ 4,341	$ 4,341
Tax & Insurance	$ 207	$ 207	$ 207
Principal & interest	$ 1,529	$ 1,148	$ 1,148
PITI	$ 1,737	$ 1,355	$ 1,355
DTI	0.40	0.31	0.31
% decline in payment	---	-25%	-25%
ΔPr(Re-default)*	---	-11.0%	-26.5%

*Change in probability of re-default within 12 months

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.