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Loan Modifications: What Works

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1. Introduction

From November 2007 through March 2012, over 2.5 million mortgages were modified in the United States (Office of the Comptroller of the Currency (OCC), 2012). Policymakers have heralded such modifications as a key to addressing the ongoing foreclosure crisis. Successful mortgage modifications can help borrowers by allowing them to stay current on their loans and thereby avoid foreclosure and the increase in future borrowing costs that a foreclosure entails. Modifications can help servicers, lenders and investors by preventing the high costs associated with foreclosures. Finally, modifications can help neighbors, neighborhoods and local governments avoid the costs that vacancies and foreclosures impose on neighboring properties. However, there is insufficient research about whether modifications are successful at helping borrowers stay current on their loans over the long run, and if so, what are the most important determinants of successful modifications. Those questions are crucial, because modifications that simply delay an eventual foreclosure, or prevent foreclosure at a cost higher than necessary, actually may add to the cost and length of the housing crisis, which is detrimental to lenders, investors, borrowers who make payments under the modification, future borrowers, and the neighborhoods in which the homes are located. The questions are central to several current debates, most notably arguments about the wisdom of principal write downs versus other kinds of modifications spurred by discussions by Edward DeMarco, Acting Director of the Federal Housing Finance Agency, about whether modifications involving loans guaranteed by the Government Sponsored Enterprises should include principal write downs (DeMarco, 2012).

Mortgage modifications can help a borrower remain current on her loans by lowering the monthly payment to an affordable level. Some proponents also suggest that by altering the terms of the loan, modifications may give an underwater borrower who would otherwise have been inclined to strategically default on her loan an incentive to continue paying the mortgage.

Servicers can employ a variety of methods to modify mortgages. These include: (1) reducing the principal balance by forgiving part of amount owed, (2) using principal forbearance, in which some portion of the principal becomes due as a balloon payment when the loan is paid off, rather than being amortized through monthly payments; (3) freezing or lowering the interest rate of the loan, and (4) extending the term of the loan. Any of the options may involve recapitalization of any arrearages into the principal balance. The options may be combined in any number of ways, so that, for example, a rate reduction can be paired with forbearance on some portion of the principal. Generally, a combination of these modification strategies will result in a lower monthly payment for the borrower, at least as long as the combination includes principal forgiveness or forbearance. A significant number of modifications however—especially the early modifications and those in which arrearages were capitalized into monthly payments—have employed these tools in such a way that the monthly payment actually increased.

In March 2009, the Obama administration introduced the Home Affordable Modification Program (HAMP), a streamlined structure for modifications that includes financial incentives for servicers to modify loans, as well as federal subsidies for the

modifications themselves.[1] Prior to HAMP, servicers offered a range of proprietary modifications using various tools, and servicers can continue to offer proprietary modifications (with no requirement that they follow the HAMP structure) for borrowers who do not qualify for HAMP.

Given HAMP's perceived importance, its effectiveness has been of great policy

[1] Supplemental Directive 09-01 specified the following incentives:

For Servicers: one-time payments of $1,000 for each completed HAMP modification (plus $500 each if the borrower was current under the original mortgage loan); where modifications reduce monthly payments by 6% or more, annual payments of the lesser of (a) $1,000 or (b) one-half of the reduction of the borrower's annualized mortgage payment, for up to three years as long as the loan is in good standing;

For Borrowers: where modifications reduce monthly payments by 6% or more, annual payments of the lesser of (a) $1,000 or (b) one-half of the reduction of the borrower's annualized mortgage payment, for up to five years as long as borrowers remain current to pay down the principal on the mortgage;

For Investors: in addition to the cost-sharing scheme that appears above, one-time payments of $1,500 for each completed HAMP modification with a borrower who was current under the original mortgage loan.

Our analysis follows permanent modifications granted through November, 2010. After our study period ended, the incentive structure was modified by Making Home Affordable Program, 2012a. Supplemental Directive 12-01.

interest since its inception. However, little research assesses whether either HAMP or proprietary modifications are successful in keeping borrowers in their homes, or compares their relative performance. More generally, we know too little about what features of a modification are associated with sustained home-ownership. Most importantly, despite the robust debate underway in Washington about whether modifications should include principal write downs, little research has explored the effects of write-downs versus principal deferrals on redefault probabilities. A better understanding of the circumstances under which various types of modifications are most likely to succeed is necessary to resolve that debate and to improve the performance of both HAMP and proprietary modifications in the years it will take to resolve the mortgage delinquencies still in the pipeline.

In this paper we use a unique dataset that combines data on loan, borrower, property, and neighborhood characteristics of modified prime and non-prime mortgages on properties in New York City to examine the determinants of successful modifications, with an emphasis on the impact HAMP has on the post-modification loan performance. The dataset includes both HAMP modifications and proprietary modifications.

Our analysis advances the literature in several ways: 1) by controlling for underlying borrower, property, and neighborhood characteristics not available in other modification datasets, we can ensure that we are isolating the effects of the modification itself; 2) our data focus on New York City, which is likely to be more representative of parts of the country other than the sand states, where the housing market is quite different; 3) our data allow us to distinguish between modifications that involve reductions in principal balances (presumably resulting from principal forgiveness that

exceeds any additions to principal from the capitalization of arrears), those that involve increases in principal (presumably from capitalization of arrearages that is not offset with principal forgiveness), and those that involve principal deferrals (which do not change the amount of principal due, but defer payment on some portion of that amount until the loan is paid off or the home is sold); and 4) by comparing HAMP and non-HAMP modifications, and controlling for the nature and magnitude of the terms of modifications, we can assess the relative efficiency of the design and implementation of the HAMP program relative to proprietary programs.

The paper is organized as follows: Section 2 provides background information on the HAMP program compared to proprietary modifications, and an overview of relevant literature; Section 3 presents the empirical model; Section 4 describes the data; and Section 5 discusses the results. The last section contains conclusions and policy implications.

2. Background and literature review

2.1. HAMP vs. proprietary modifications

Between the beginning of 2008 and the end of 2011, some 2,543,133 homeowners received a modification; of those, 565,751 were HAMP modifications (OCC, 2012). Proprietary modifications account for all the 755,278 modifications granted before the

third quarter of 2009, when the first permanent HAMP modifications were recorded,[2] and continue to account for the majority of modifications. Even in the first quarter of 2012, the most recent quarter for which data are available, there were 65,604 non-HAMP modifications granted, compared to 36,554 HAMP modifications, and 102,486 non-HAMP trial period plans granted, compared to 26,530 HAMP trial period plans (OCC, 2012).

Under the HAMP guidelines in effect during our study period (through November, 2010),[3] a borrower who was at least 60 days delinquent or in "imminent danger" of delinquency was eligible for a modification of the first lien if the mortgaged property was a single family home (one to four units) that was the borrower's primary residence and was not vacant or condemned. The mortgage must also have originated on or before January 1, 2009, require payments that did not exceed 31 percent of the borrower's gross monthly income (calculated using the borrower's front-end debt-to-income ratio[4]), and have an unpaid balance less than $729,750[5] (GAO, 2011a). If a

[2] The number of proprietary modifications is computed by authors based on the quarterly statistics in OCC and OTS 2009a, OCC and OTS 2009b, OCC and OTS 2009c, OCC and OTS 2009d, OCC and OTS 2010a, and OCC and OTS 2010b.

[3] Some of these requirements have since been changed (Making Home Affordable Program, 2012b; 2012c).

[4] The front-end-debt –to-income ratio is the percentage of a borrower's gross monthly income required to pay the borrower's monthly housing expenses, namely: mortgage principal, interest, taxes, insurance, and if applicable, condominium, co-operative, or

borrower is eligible for the HAMP modification, and has missed two payments, servicers must "proactively solicit" the borrower for HAMP, and provide her with written information about HAMP (Making Home Affordable Program, 2011).[6] Once the borrower submits the required application materials, participating servicers[7] must perform a Net Present Value (NPV) calculation, assessing whether expected cash flows from a loan modified according to the modification "waterfall" described below would exceed those from the same loan with no modification, using specified assumptions.[8]

If a borrower meets the eligibility requirements and the NPV test is positive, HAMP requires participating servicers to adjust the monthly mortgage payment on the first lien mortgage to 31 percent of a borrower's total monthly income according to the

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homeowners' association dues.

[5] Higher limits apply for two, three or four unit properties (Making Home Affordable Program, 2011).

[6] The proactive solicitation requirement was made clear in U.S. Department of Treasury, Supplemental Directive 10-02 (2010), effective in June 1, 2010.

[7] More than 100 servicers currently participate in HAMP; participation is mandatory for servicers of loans owned or guaranteed by Fannie Mae or Freddie Mac, but voluntary for servicers of non-GSE loans. See http://www.makinghomeaffordable.gov/get-assistance/contact-mortgage/Pages/default.aspx

[8] The NPV model is detailed in Making Home Affordable Program (2011); Holden et al. (2011) provides a helpful explanation of the model.

following "waterfall":[9] first by reducing the interest rate to as low as two percent, then, if necessary, extending the loan term to 40 years, and finally, if necessary, forbearing a portion of the principal[10] until the loan is paid off and waiving interest on the deferred amount.[11] Servicers may write-down the principal amount at any stage of the waterfall.[12] The modified monthly payment is fixed for five years as long as the loan is not paid off and the borrower remains in good standing. After five years, the borrower's interest rate may increase by 1 percent a year, up to the Freddie Mac rate for 30-year fixed rate loans as of the date of the modification agreement (GAO, 2011a).

The decision to grant or deny an application for a HAMP modification is

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[9] Before beginning the waterfall, servicers must capitalize accrued interest and certain expenses paid to third parties and add this amount to the principal balance.

[10] The servicer is not required to forbear more than 30 percent of the unpaid balance or more than the amount that would create a mark to market LTV of 100 percent (Making Home Affordable Program, 2011).

[11] The first loss—the difference between the existing mortgage payment and 38 percent of the borrower's monthly gross income—is absorbed by the mortgage holders and investors. For non-GSE loans, TARP funds are then available to match the cost of reducing the payments to 31 percent of the borrower's monthly gross income. For GSE loans, matching funds are available from Fannie Mae and Freddie Mac. U.S. Government Accountability Office, 2011a.

[12] Later directives allowed a servicer to vary the waterfall if the servicer wrote down the principal balance in specified ways (Making Home Affordable Program, 2012b; 2012c).

supposed to be made within 30 days of the servicer's receipt of the completed application, but counselors report that it actually takes four to seven months or more on average (GAO, 2011b). Under HAMP, borrowers must complete a 90-day trial modification period—making all of the modified payments in full and on time—to be eligible for conversion to a permanent modification. Again, however, counselors report a different reality—with 96 percent saying that trials typically run for more than three months, and 50 percent reporting that trials typically lasted 7 months or more. The delays appear to be improving, however, and at the end of March 2011, the share of all active trials that had been initiated at least 6 months earlier fell to about 19 percent (GAO, 2011b).

Prior to HAMP, servicers were offering a range of proprietary modifications using the same tools—interest rate reductions, term extensions, principal forbearance and (at least in theory) principal write downs (Quercia and Ding, 2009). After HAMP, servicers can offer modifications on terms other than those that HAMP requires only in three circumstances:[13] to borrowers who are not eligible for HAMP; borrowers for whom the NPV of a modification is not positive;[14] or borrowers who fail the HAMP trial period

[13] A servicer providing a HAMP modification is not precluded from offering terms more favorable than HAMP requires (Making Home Affordable Program, 2011). For example, the servicer can offer to reduce the interest rate even below 2 percent.

[14] Servicers have the option of offering a HAMP modification to eligible borrowers even when the NPV test is negative, but must have permission of any third party investor to do so (Making Home Affordable Program, 2011).

(Karikari, 2011). Indeed, HAMP guidelines require servicers to consider all potentially HAMP-eligible borrowers for other loss mitigation options, such as proprietary modifications, payment plans, and short sales, prior to a foreclosure sale (Making Home Affordable Program, 2011). The GAO estimates that approximately 18 percent of borrowers with canceled HAMP trial modifications received permanent proprietary modifications, and an additional 23 percent had pending permanent proprietary modifications (GAO, 2011a).

2.2. Literature review

The OCC (2012) has reported that 12 month redefault rates on loans modified in the last quarter of 2010 and the first quarter of 2011 (the last modifications for which 12 month redefault rates are available) were at 25 percent (with redefault defined as 60 or more days delinquent one year after the modification), although the 12 month redefault rates have varied from a high of 57 percent for loans modified in 2008 to a low of 25 percent for loans modified in 2010 and the first quarter of 2011. Other studies also have reported high redefault rates for the early modifications (40 to 50 percent in Adelino et al. (2009) and 56 percent in Haughwout et al. (2010)).[15] Further, the OCC reports that the 12 month redefault rate for modifications entered into in 2010 varies from 18 percent for portfolio and Freddie Mac loans to 41 percent for government guaranteed (FHA) loans

[15]Adelino et al. (2009) define redefault as a loan that is 60 or more days delinquent, in the foreclosure process, or REO within 6 months of the modification. Haughwout et al. (2010) define redefault as 90 or more days delinquent within a year of the modification.

(OCC, 2012).

To better understand those redefault rates and differences over time and among types of loans, several studies have examined correlations between the characteristics of borrowers, loans and different types of modifications and redefault rates. Amy Cutts and William A. Merrill (2008) examined Freddie Mac's portfolio of modified loans and found an association between the amount of arrearage capitalized into the loan modification and the modification's failure rate. Richard Brown, the Chief Economist for the Federal Deposit Insurance Corporation, analyzed the redefault rates of modifications extended under the IndyMac modification program and found that higher rates of redefault were correlated with longer times in delinquency at the time of the modification, ARM mortgages, low original FICO scores, and higher LTV at modification (Brown, 2010). He also found that lower redefault rates were associated with larger reductions in monthly payments (Brown, 2010). Cordell and his colleagues also found an association between redefault and whether the modification resulted in an increase, no change, or a decrease in monthly payments (Cordell et al., 2009).

Recently, Laurie Goodman and her colleagues used the CoreLogic Loan Performance Mortgage Backed Securities and Asset Backed Securities datasets (which cover the private label securities market) to assess the correlation between modification types and redefault rates. They found that lower redefault rates are more closely associated with principal write downs or forbearance (they could not distinguish between the two), than with interest rate adjustments or recapitalizations, larger monthly payment reductions, less time in delinquency prior to the modification, or higher FICO scores (Goodman et al., 2012). Similarly, Arthur Acoca and his colleagues used BlackBox data

(with coverage similar to CoreLogic's Loan Performance data) to examine the correlations between characteristics of the borrowers and modifications and the redefault rate (Acoca et al., 2012).

Other studies have used multivariate analysis to control for a limited number of potentially confounding factors and to evaluate the causal link between the characteristics studied and redefault rates. Quercia and Ding (2009) examined the relationship between redefault rates and different types of loan modifications based on a national sample of nonprime loans modified in 2008. They found modifications that lower mortgage payments by at least 5% lower the risk of redefault, while modifications that increase payments do not; modifications that involve principal reductions decrease the redefault risk even further than those involving just a rate reduction. Haughwout et al. (2010) also used data on subprime modifications that preceded HAMP, and found through a hazard analysis that the redefault rate declines with the magnitude of the reduction in the monthly payment, and declines further when the payment reduction is achieved through principal forgiveness rather than lower interest rates.

The GAO examined the characteristics of the borrowers who had received trial or permanent HAMP modifications through September 2010, and assessed which characteristics were associated with cancellation of the trial modifications. It found that trials were more likely to be cancelled when the borrower qualified for a trial modification on the basis of stated, rather than documented, income (a practice now forbidden under HAMP), the borrower was in the trial modification for less than four months, and the borrower was 60 to 90 days delinquent at the time of the modification. Those with high current mark-to-market loan to value ratios, those who had received

forgiveness of at least one percent of their principal balance, and those who had received larger monthly payment reductions were less likely to have their trials cancelled (GAO, 2011a). The GAO also found that redefault on permanent modifications for non-GSE loans was more likely for borrowers with longer periods of delinquency at the time they were evaluated for a trial modification, borrowers with lower credit scores, borrowers who had received lower payment reductions, and borrowers with lower levels of debt before modification (GAO, 2011a).

Karikari (2011) found that of the borrowers who entered a HAMP trial modification prior to June 2010, those who received reductions in monthly payments (of principal and interest) greater than 20 percent or reductions in loan balances (through principal forgiveness or deferral) were less likely to have their trials cancelled. Agarwal et al. (2011a) and Agarwal et al. (2010), using a sample of prime and nonprime loans from the OCC Mortgage Metrics file (the same database we use), follow loans through May, 2009 and find, through OLS and probit estimations for each of the various loan outcomes, that larger payment or interest rate reductions are associated with lower redefault rates, while the capitalization of missed payments and fees is associated with higher redefault rates. Portfolio loans, loans to owner-occupants, fixed rate mortgages and full-documentation loans are less likely to redefault. Redefault increases as FICO decreases, and as LTV and origination year increase. Agarwal et al. (2011b) use a difference in difference strategy to compare borrowers who qualify for HAMP modifications to those who did not because they were not owner-occupiers or because the mortgage size was over the limit, and found that HAMP modifications had a six month redefault rate that was about 34 percent lower than the redefault rate for proprietary

modifications.

The research to date is incomplete, however, for several reasons. First, many of the studies rely on older data from the beginning of the wave of modifications resulting from the current housing crisis and only follow the loan performance for short spans of time after modification. Therefore, they may be of limited generalizability to the current effectiveness of HAMP, an issue of great interest as policymakers decide whether to extend HAMP beyond its December 31, 2013 sunset date. Second, most of the research faces serious data limitations—most include a very limited set of controls and only cover nonprime loans. The GAO research, for example, laments the inaccuracies and inconsistencies in the HAMP data it used, and the significant gaps in the data about such borrower characteristics as race and ethnicity (GAO, 2011a). In addition, some of the data sets cannot distinguish between principal write downs and principal deferral. Third, studies with access to most detailed data on the types of loan modifications (e.g., Agarwal et al. 2011a and 2010) do not adequately isolate the effects of each type of modification, and none of the very few studies that evaluate the effectiveness of HAMP attempts to distinguish between the effects of program design and the effects of the magnitude and type of term changes on loan performance. Last but not least, because of data limitations or methodological choices, most studies do not use hazard models, even though such models are most appropriate to assess how various factors affect the probability that a borrower will stay current after a modification. Our very rich data set allows us to address these shortcomings in the existing research.

3. Empirical model

This paper provides an empirical analysis of the factors that determine the performance of modified loans. The outcome of interest is whether a modified mortgage redefaults, where redefault is defined as being at least 60 days past due (in other words, where the borrower has missed two payments). Specifically, our empirical strategy employs logit models in a hazard framework to explain how differences in the types of modifications along with loan, borrower, property, servicer and neighborhood characteristics, affect the likelihood of redefault.

The data are organized in event history format, with each observation representing one month in which a modified loan remains current, to allow for time-varying covariates.[16] A loan drops out of the sample after it redefaults.[17] With the data structured in event history format, the logit has the same likelihood function as a discrete time proportional hazards model (Allison, 1995). In the logit framework, the probability that the loan *i* redefaults at time *t*, conditional on the loan remaining current until then, (i.e., the hazard of redefault) is given by:

[16] A loan is considered current if there are no delays in payments or the payment is only 30 days past due.

[17] In principle, a loan could also drop out of the sample by being paid off. This would occur if the loan is refinanced or the house is sold, and would require a competing risk hazard model, where the competing risks would be redefault and paid-off. However, only about 100 modified loans in our data were paid off and we eliminated these loans because it was not feasible to estimate a competing risk model with so few observations for one of the outcomes.

$$P_{it} = \frac{e^{\beta X_{it}}}{1 + e^{\beta X_{it}}},$$

where X_{it} are the explanatory variables observed for loan *i* at time *t* (indexed by month in this paper), and β are the coefficients to be estimated. We include time since the modification process was completed among the covariates to allow the hazard to be time-dependent. To control for city-, state-, or nation-wide macroeconomic factors, we include quarterly fixed effects. To control for systematic changes in mortgage lending over time, we include origination year fixed effects. To control for unobserved heterogeneity and possible dependence among observations for the same loan, we use a cluster-robust variance estimator that allows for clustering by loan.

The logit coefficient estimates are used to calculate the effects of the explanatory variables on the conditional probability of redefault, in the form of odds ratios. To gain a better understanding of the effects of various types of modifications on loan performance—an issue of heightened policy interest in the current economic environment—we estimate four regression specifications that differ by the modification features that they include. While all specifications include a HAMP indicator, the first (M1) does not include any other modification features; the second (M2) adds the change in monthly mortgage payment; the third (M3) replaces the change in monthly mortgage payment with changes in individual loan terms including the change in loan balance, the change in interest rate, and a term extension indicator; and the last (M4) includes both the change in monthly mortgage payment and the changes in individual loan terms.

Thus, the first regression captures a more inclusive effect of HAMP on loan performance, but does not distinguish between effects that may be due to differences in program design and those that may be due to differences in the magnitude of payment

reductions and individual term changes between HAMP and non-HAMP modifications. Differences in program design may include, for example, HAMP-specific features, such as the specificity and order of the waterfall and the incentive payment to borrowers who remain current on their payments after the modification for specified periods.[18] While HAMP-specific eligibility criteria in place during our study period, such as requirements that the borrower be an owner-occupant and that the current unpaid loan balances be within conforming loan limits, also could be considered program design differences, our regressions include specific controls for such features.[19] Other distinctive features of

[18] Another program design feature of HAMP, the requirement of a trial period prior to the borrower being granted a permanent modification, has been adopted by many servicers for their proprietary modification programs since the enactment of HAMP in 2009, and thus it is less likely to be responsible for any differences in redefault rates between HAMP and non-HAMP modifications in our data.

[19] Specifically, we include a dummy variable that is equal to 1 for owner-occupied properties and 0 otherwise, and the current unpaid loan balance in log terms. In preliminary work we also included additional indicators of HAMP eligibility such as property structure (1-4 family vs. multi-family) and a dummy variable equal to 1 if loan balance at modification time was below the HAMP limit; however, these variables had very low statistical significance, likely due to the lack of variation of our sample across these dimensions (e.g., 99% of the observations corresponded to 1-4 family properties and 98% of the observations had a loan balance below the HAMP limit), and thus were excluded from the final regressions. In addition, we experimented with a single indicator

HAMP (such as the eligibility criterion that qualifies only borrowers who had a front-end DTI of more than 31% before modification, and the requirements that this front-end DTI be reduced to 31% and that the resulting loan must pass an NPV test) tend to result in a larger reduction in monthly payment for those borrowers who receive a HAMP modification. In comparison, proprietary modifications may be granted to borrowers with original front-end ratios below 31%, but whose payment problems are due to excessive back-end debt, and may also often result in a front-end ratio greater than 31% in order to pass NPV.

The second, third, and fourth regressions help distinguish between the program design effects and those related instead to the magnitude of payment reductions and individual term changes. The last regression also tests whether changes in individual loan terms have an impact on loan performance beyond any effects that would occur through payment changes.

In additional specifications, we explore variation in the effects over time and test whether the effects of modification features such as payment change, balance change, rate change, and term extension vary with the borrower's credit score (FICO) and loan to value (LTV) levels. Temporal variations in any performance differential between HAMP and non-HAMP modifications may occur as a result of changes in the structure of

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that captured the joint HAMP eligibility under the loan limit, owner occupancy, and property structure criteria. This indicator also had very low significance level and its inclusion left the results virtually unchanged. Results from these alternative specifications are available upon request from the authors.

proprietary loan modifications (perhaps in part due to the advent of HAMP itself) as well as to changes in HAMP rules (e.g., those in Supplemental Directive 10-01 from June 2010 including new rules regarding documentation requirements and amendments to policies and procedures related to borrower outreach and communication).

To explore these temporal dynamics, we supplement model M1 with two variables that capture the pre- and post-HAMP enactment time trends: a post-HAMP enactment dummy variable, and an interaction between the HAMP indicator and the post-HAMP enactment time trend.[20] The time trend and post-HAMP dummy variables describe the comparative loan performance of older and newer vintages of proprietary modifications, allowing for a direct comparison of the performance of the pre-HAMP and post-HAMP proprietary modifications. The HAMP indicator and its interaction with the post-HAMP trend capture temporal variations in the differential performance of HAMP modifications versus proprietary modifications granted in the post-HAMP period.

[20] The post-HAMP enactment period is assumed to start in September 2009 when the first permanent HAMP modifications were granted, according to our Mortgage Metrics data extract for New York City. Thus, the post-HAMP time trend is equal to 0 if the modification was completed prior to September 2009, is equal to 1 if the modification was completed in September 2009, is equal to 2 if the modification was completed in October 2009, etc. The pre-HAMP time trend is equal to 0 if the modification was completed in August 2009 or later, is equal to -1 if the modification was completed in July 2009, is equal to -2 if the modification was completed in June 2009, etc.

To test whether the effects of modification features vary with the FICO and LTV levels, we extend models M2 through M4 to include interactions between the relevant modification changes and indicators for the lowest FICO category (FICO less than 560) and for underwater borrowers (LTV greater than 100 percent), respectively.

4. Data description

To investigate the determinants of the performance of modified loans, we analyze performance between January 2008 and November 2010 for all first lien mortgages in the OCC Mortgage Metrics database that were originated in New York City from 2004 to 2008, still active as of January 1, 2008, and received a permanent mortgage modification between January 2008 and September 2010. OCC Mortgage Metrics provides loan-level data on loan characteristics and performance, including detailed information about loan modifications, for residential mortgages serviced by selected national banks and federal savings associations. The database contains prime and subprime loans serviced by 9 large mortgage servicers covering 63 percent of all mortgages outstanding in the United States (OCC, 2011).[21] Nationally, the loans in the OCC Mortgage Metrics dataset represent a large share of the overall mortgage industry, but they do not represent a statistically

[21] The number of servicers in the OCC Mortgage Metrics has varied over time since the onset of the data collection in 2007, primarily due to mergers and acquisitions among the initial servicers that provided the data. As of 2011, the servicers in the OCC Mortgage Metrics include 8 national banks and one thrift with the largest mortgage-servicing portfolios among national banks and thrifts (OCC, 2011).

random sample of all mortgage loans. Only the largest servicers are included in the OCC Mortgage Metrics, and a large majority of the included servicers are national banks. The characteristics of these loans may differ from the overall population of mortgages in the United States. For example, subprime mortgages are underrepresented and conforming loans sold to the GSEs are overrepresented in the OCC Mortgage Metrics data (OCC, 2008).

An observation in the data set is a loan in a given month. Although we look at all loans originated between 2004 and 2008, monthly performance history for those loans is only available from January 2008 through November 2010. If a loan was originated in 2004 and went through foreclosure proceedings in 2007, therefore, it is not included in our data set. Although OCC Mortgage Metrics provides detailed information on borrower characteristics, loan terms, payment history and modifications, it contains no information on borrower race or gender and provides little information about property or neighborhood characteristics. We therefore supplement the loan level data with information from multiple sources.

To match loan level information from the OCC Mortgage Metrics database to other sources, we relied on mortgage deeds contained within the New York City Department of Finance's Automated City Register Information System (ACRIS). Using a hierarchical matching algorithm, we were able to match 65 percent of the loans in the OCC Mortgage Metrics database back to the deeds records, giving us the exact location

of the mortgaged property.[22] This 65 percent sample is not significantly different from the

[22] Our procedure for matching OCC Mortgage Metrics to ACRIS is similar to the method used by Chan et al. (2012) to match LoanPerformance to ACRIS. Our data from ACRIS do not include Staten Island and thus we had to drop this borough from our analysis. We merged OCC Mortgage Metrics loans to ACRIS mortgage deeds using three common fields: origination or deed date, loan amount and zip code, using six stages of hierarchical matching. At the end of each stage, loans and deeds that uniquely matched each other were set aside and considered matched, while all other loans and deeds enter the next stage. Stage 1 matched loans and deeds on the raw values of date, loan amount and zip code. Stage 2 matched the remaining loans and deeds on the raw values of date and zip code, and the loan amount rounded to $1,000. Stage 3 matched on the raw values of date and zip code, and the loan amount rounded to $10,000. Stage 4 matched on the raw values of zip code and loan amount, and allowed dates to differ by up to 60 days. Stage 5 matched on the raw value of zip code, loan amount rounded to $1,000, and allowed dates to differ by up to 60 days. Stage 6 matched on the raw value of zip code, loan amount rounded to $10,000, and allowed dates to differ by up to 60 days. We believe it is valid to introduce a 60-day window because in ACRIS, there may be administrative lags in the recording of the deeds data. The chance of false positive matching is low because we are matching loans to the full universe of deed records, and only considering unique matches. The relatively low match rate of 65 percent is due to the fact that we were unable to match loans made on coop units in the OCC Mortgage Metrics data to ACRIS deeds because coop mortgages are recorded differently in ACRIS and do not list a loan amount.

full universe in terms of the loan and borrower characteristics we use in the analyses below.

After we had a unique parcel identifier matched to each loan record, we were able to match on many other sources. First, we attach some additional borrower characteristics, including race and ethnicity, from Home Mortgage Disclosure Act (HMDA) data.[23] Second, we merge information on whether the borrower received

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During our study period, 28 percent of residential property sales in the four boroughs studied were coops. Further, our match rate was lowest (44 percent) in Manhattan where 48 percent of sales during the study period were of coop units. This evidence suggests that had we been able to exclude coop loans from our original OCC Mortgage Metrics dataset prior to matching to ACRIS, our final match rate would have been much higher (around 90 percent).

[23] We merged HMDA records to ACRIS deeds based on date, loan amount and census tract, using the same six stage hierarchical matching technique as for the OCC Mortgage Metrics-ACRIS match. We then paired each of the OCC Mortgage Metrics records with HMDA records based on the unique deed identification number from ACRIS. In the end, we were able to match 73 percent of the OCC Mortgage Metrics-ACRIS matched loans (or 48 percent of all OCC Mortgage Metrics loans) to the HMDA records. While other researchers have matched loan level data (such as OCC Mortgage Metrics) directly to HMDA by using the zip code as a common geographic identifier, our matching strategy is likely more reliable as it uses a more precise common geographical identifier (census tract).

foreclosure prevention counseling or other assistance[24] from any of the non-profit organizations coordinated by the Center for New York City Neighborhoods (CNYCN).[25] Third, we merge in repeat sales house price indices the Furman Center for Real Estate and Urban Policy compiles to track appreciation in 56 different community districts of

[24] HAMP requirements stipulate that borrowers obtain counseling if the monthly payments on their total debt are more than 55 percent of their gross monthly income. But borrowers may seek counseling voluntarily to help them navigate the modification process. Counselors report that borrowers most commonly seek help because their servicer claims to have lost documents necessary for the modification application, they have been in a trial for more than the required 90 day period, they believe they were wrongly denied a HAMP modification, or they have had difficulty contacting their servicer. GAO, 2011b.

[25] CNYCN is a non-profit organization, funded by grants from government, foundations, and financial institutions, to coordinate foreclosure counseling, education, and legal services from a variety of non-profit providers throughout New York City to homeowners and tenants at risk of losing their home to foreclosure. CNYCN directs borrowers who call 311 or CNYCN directly about problems with their mortgages to local foreclosure counseling or legal services. Each of the partner organizations then reports back to CNYCN on which borrowers received foreclosure prevention counseling or legal services. One of the co-authors serves on the Board of Directors for CNYCN.

New York City.[26] Fourth, we link information on the demographic characteristics of census tracts using the 2000 Census. Finally, we add the rate of mortgage foreclosure notices (*lis pendens*) at the census tract level.[27]

When available, we matched data at the observation level to show information about the specific property being studied. When observation level data was not available (e.g., educational attainment) or was not appropriate (e.g., 6 month prior neighborhood *lis pendens* rate), we used neighborhood level data instead. We define neighborhood as a census tract, the smallest geographic level available, whenever possible. However, for several variables—specifically, the unemployment rate and the rate of house price appreciation—census tract data was not available, so we had to use community district level data.[28] To illustrate the relative size of each jurisdiction, Figure 1 shows census tract boundaries, community district boundaries and *lis pendens* filed in the four boroughs of

[26] See Been et al. (2012) for a description. We transform quarterly indices into monthly series by linear interpolation.

[27] The *lis pendens* are from Furman Center's calculations based on data from Public Data Corporation. The rate is computed as the number of *lis pendens* per 1000 housing units recorded over the 6-month period preceding the month of loan performance.

[28] Community districts are political units unique to New York City. Each of the 59 community districts has a Community Board that makes non-binding recommendations about applications for zoning changes and other land use proposals, and recommends budget priorities.

New York City in 2009, during our study period.[29]

Our data is limited to New York City, because it not feasible to match data on modifications back to deeds records and other local data that provide important controls in our model on a national scale. Differences among the states in foreclosure processes, the timing of the housing boom and bust, unemployment patterns, the availability of foreclosure counseling services, and other important variables may cause the prevalence, timing and nature of modifications, and borrowers' performance under a modification to differ somewhat across jurisdictions. Any national study would be likely to miss important variables on local conditions, and any local study will reflect idiosyncratic features of the local market. But our design compares the performance of HAMP modifications to the performance of proprietary modifications, and it is less likely that those differences will be affected by any idiosyncratic features of New York's market, because so many of the servicers are national in focus, and the HAMP requirements and design are uniform across jurisdictions.

Further, Figure 2, which shows the distribution of MSA-level house price appreciation rates between mid-2007 and mid-2009, suggests that the national housing market is bimodal, with the modes around -27 percent and +2 percent, respectively.[30] Much of the left side of the distribution, with depreciation rates larger than 13 percent, is

[29] For readability purposes, we do not show zip code boundaries in this map. We note however that the typical zip code size, both in terms of area and population, is larger than the typical census tract size but smaller than the typical community district size.

[30] The data for Figure 2 is based on the FHFA repeat-sales house price index.

represented by MSAs in the four states which were hardest hit by the foreclosure crisis—California, Florida, Arizona and Nevada.[31] By comparison, the depreciation rate for the NY-NJ MSA (9.38 percent) is much more representative of the rest of the market, which makes up the right side of the distribution. HAMP was targeted to a large group of distressed borrowers, but studies that use the nationwide data may not capture the typical effect of HAMP on loan performance because their results may be driven by the four outlier states.[32] Our focus on the New York City, which is more in line with the rest of the market, enables us to estimate the typical HAMP effect more accurately.

4.1. Descriptive statistics

Table 1 presents descriptive statistics for the dataset used in the estimation, organized in six panels: A – delinquency rates; B – modification features; C – loan characteristics; D – borrower and property characteristics; E – neighborhood characteristics; and F – servicer characteristics. Panel A shows that nearly 30 percent of the modified loans in our data became seriously delinquent following modification. A

[31] For example, these four states account for almost 80 percent of the MSAs with depreciation rates greater than 13 percent, and for all the MSAs with depreciation rates greater than 27 percent.

[32] 47.4 percent of HAMP modifications and 31.8 percent of non-HAMP modifications were made to borrowers in Florida, California, Arizona and Nevada in the second half of 2010, the only portion of our study period for which these statistics are available (OCC and OTS, 2010c; 2010d).

more informative description of the performance of modified loans is provided by the Kaplan-Meyer survival graph in Figure 3A. The survival graph plots, with respect to time since modification, the fraction of the modified loans that have "survived,"— that is, not yet redefaulted.[33] Given our definition of redefault as the payment becoming 60 days past due, a loan is first "at risk" in the second month after modification, and the origin of the survival plot in Figure 3A corresponds to the first month following modification. Starting in the second month after modification, there is a steady transition of loans into serious delinquency with the pace diminishing after the 15th month following modification. The survival rate one year after modification is just below 60 percent. Figure 3B shows sharp differences in survival rates between the loans that received HAMP modifications and those that received proprietary modifications. For example, the survival rate of HAMP loans one year after modification is over 30 percentage points higher than the survival rate of non-HAMP loans.

Panel B of Table 1 presents descriptive statistics for the types of the modifications in our sample. One third of the loans received HAMP modifications. The modification process resulted in payment reductions for most—but not all—loans. While over 81 percent of the modifications resulted in payment reductions, almost 7 percent resulted in payment increases and nearly 4 percent produced no payment change. On average, the mortgage payment was reduced by 28 percent. A majority of the modifications resulted in higher balances, while only about 10 percent resulted in lower balances and almost 15

[33] By measuring the survival rate, we avoid the measurement errors that Goodman et al. (2012) argue afflict many reports of redefault rate.

percent produced no balance change. On average, the balance was increased by 2.6 percent. The prevalence of balance increases is not surprising given that capitalization—the addition of arrearages to the loan balance—is a frequent component of the modifications in our data, whereas principal write-down is very rarely used.[34] Principal was deferred in about 17 percent of the modifications, and, on average, the deferral postponed payment on almost 22 percent of the balance. Over 75 percent of the modifications resulted in a decrease in interest rates, and the rate reductions were substantial—2.8 percentage points, on average. Although approximately 45 percent of the modifications included term extensions, the actual size of the term change was largely missing in our data, so we could not use this information in our analysis. Overall, these patterns suggest that servicers aim to make the loans more affordable while minimizing losses in the underlying principal.

Panel C presents descriptive statistics for the characteristics of the loans in our dataset. Our dataset covers a range of loan products. Of the 6,541 modified loans in our dataset: there is a fairly even split between prime and non-prime loans;[35] 57 percent have fixed interest rates (the remainder are adjustable rate mortgages); 14 percent were interest

[34] Almost 90 percent of the modifications involved capitalization whereas only about 2 percent were flagged as involving principal write-downs and another 17 percent seemed to involve principal deferrals. Deferrals would have no effect on the amount of principal due, because they just postpone the payment due on that amount.

[35] Loans are categorized as prime or non-prime based on the credit grades defined by the servicers.

only at origination and 79 percent are conventional mortgages. Our sample also includes a mix of loans that were privately securitized, bought by the GSEs and held in portfolio. This robust mix of loan products, uses and investors allows us to give a more complete analysis than the existing literature because our conclusions are not limited to only one loan type or group of loans.

The relative interest rate after modification for FRMs is calculated as the interest rate minus the Freddie Mac average interest rate for prime 30-year fixed rate mortgages during the first month after the modification was completed. For ARMs, it is the interest rate minus the six-month London Interbank Offered Rate (LIBOR) during the first month after the modification. In our sample, nearly 30 percent of the fixed rate loans have relative interest rates between 1 and 2 percentage points over the market index and over 50 percent of the adjustable rate loans have relative interest rates larger than 4 percentage points at origination.

The performance of the modified loans was poor prior the modification. The average loan was seriously delinquent in 37 to 45 percent (depending on origination year) of the months from the pre-modification period covered by Mortgage Metrics (i.e., starting from the beginning of 2008). Additionally, 78 percent of the loans were seriously delinquent at the time of modification and 17 percent of the loans had a *lis pendens* (notice of foreclosure) filed before being modified.

Because certain characteristics of the loans change over time, we construct loan-months for every month during our study period in which a loan was active, for a total of 42,380 loan-months. The last six descriptive statistics in Panel B are measured across all loan-months in our sample. Only a small proportion of the loan-months for ARMs (14

percent) involved a rate that had been reset before the month being studied.[36] The average current LTV for all of the loan-months in our sample was 107.7 percent.[37]

As Panel D shows, over 90 percent of the borrowers in our sample report that they are owner-occupiers.[38] We constructed borrower-months for those borrower level variables that change over time. The current FICO score[39] has a mean of 597 across all borrower-months, and over 60 percent of borrower-months have FICO scores of 620 or less. On average, FICO scores of the borrowers in our sample declined by 88 points from origination to the month in which the loan was modified. Only 3.5 percent of the borrowers received foreclosure counseling before being granted the loan modification.

Some of the characteristics of the neighborhoods in which the properties in our sample are located (shown in Panel E) are different from the neighborhood characteristics of the four boroughs of New York City included in our analysis. Specifically, the properties in our sample are: (1) more likely to be located in neighborhoods with high concentrations of non-Hispanic blacks; (2) less likely to be located in neighborhoods with

[36] Those rate resets do not include those due to a modification.

[37] LTV is based on the first lien only. We do not have data on outstanding balances, delinquencies or other outcomes for junior liens.

[38] To be eligible for a HAMP modification, the borrower is required to be an owner-occupier, but some proprietary modifications are extended to non-owner-occupiers.

[39] The current FICO score is based on periodically updated information provided by the servicers. The score is typically updated quarterly however the frequency of updates may vary across servicers and even for the same servicer.

high concentrations of Hispanics; and (3) more likely to be in neighborhoods with median incomes between $40,000 and $60,000 and less likely to be in neighborhoods with median incomes less than $40,000 or more than $60,000.

Panel E also reveals some interesting neighborhood shifts from the time of modification to the loan month studied. In particular, in the neighborhoods in which the loans in our sample are located, house prices decreased by an average of 6 percent between the month the modification process was completed and the loan month being studied.

Our model also includes servicer fixed effects. Panel F shows the range of FICO scores and LTV ratios at the time of loan origination for the modified loans in our sample across the 9 servicers that serviced them. Average FICO scores range from 644 to 695. LTVs range from .731 to .794.

One of the main goals of our study is to evaluate the impact of HAMP, among other modification features, on the post-modification loan performance. That might raise concerns that any estimated differences in redefault rates between loans modified through HAMP and loans that received non-HAMP modifications may be due to unobserved differences in the riskiness of the borrowers and loans that received different types of modifications rather than because of features of the modifications.[40] However, because

[40] While loans that received a modification might not be fully representative of all the loans that are eligible to receive a modification, it is beyond the scope of this study to account for potential biases due to selection into the sample of modified loans. The goal of our study is to evaluate loan performance *conditional on the loan being modified*; we

part of the HAMP effect we try to measure is likely due to the program design itself, it is only unobserved differences *unrelated* to differences in program design that should be of concern. To alleviate such concerns, our models include a comprehensive set of borrower, loan, and neighborhood characteristics, as detailed above. Additionally, we note that the vast majority of the loans in our sample satisfy the basic HAMP eligibility criteria with respect to loan limit, owner-occupancy, and property structure.[41]

Nonetheless, it is reassuring to note that differences in many observed characteristics between the HAMP and non-HAMP loan samples do not indicate that one set of loans is clearly "better" than the other. As Table 2 shows, while HAMP is associated with significantly more advantageous changes in loan terms,[42] the loan, borrower, and neighborhood characteristics of the two loan samples are, in general, fairly similar. For example, the average FICO score and LTV, at both the time of origination and the time of modification, are very similar. The two pools of loans also appear to have had similar performance prior to modification, as measured by the percentage of months in which the loans were seriously delinquent before modification[43] and by whether there

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hope in future work to gain access to data about the characteristics and performance of unsuccessful applicants for modifications, as well as borrowers who might have qualified for modifications but did not apply.

[41] See above for specific requirements.

[42] The significantly larger payment reduction for HAMP is not surprising given the DTI-related requirements of HAMP described above.

were any *lis pendens* filed before modification. Loan products differ somewhat along several dimensions, however these differences do not consistently suggest that one set of loans would be expected to perform better over time. For example, 56 percent of the non-HAMP loans are subprime whereas only 45 percent of the HAMP loans are subprime. On the other hand the share of FRMs is larger in the non-HAMP sample (60 percent) than in the HAMP sample (50 percent). Similarly, the relative interest rate at origination for FRMs is lower whereas that for ARMs is higher in the HAMP set. Moreover, and more importantly perhaps, the proportions of loans with very risky characteristics such as interest only and low or no documentation are very similar in the two samples. Differences in debt-to-income ratios and unpaid loan balance just before the modification are consistent with the different selection criteria of the two sets of modification programs, with the HAMP loans exhibiting significantly larger debt-to-income ratios and somewhat lower outstanding balances. Finally, the only differences between neighborhood characteristics for the two sets of loans are unemployment rate at modification and house price appreciation between origination and modification, with the HAMP loans faring somewhat worse along both dimensions.[44]

5. Results

[44] However, neighborhood differences, in general, should be of little concern with respect to endogeneity biases in the HAMP effect estimate given that neighborhood conditions turn out to have little influence on post-modification loan performance, as shown below.

Table 3 presents, in the first four columns, odds ratio estimates—i.e., the impacts explanatory variables have on the conditional odds of redefault at a given point in time (conditional on the loan being current until that time)—for the four logit regressions described in Section 3. The table also shows, in the "Std. OR" columns, the standardized odds ratios for selected variables to enhance comparability of the effects.[45] Below, we review in detail the results for these regressions.

5.1. Effects of variables on the conditional odds of redefault

5.1.1. Modification features

The first set of rows in Table 3 show the impacts modification features have on loan performance. These effects are, in general, highly statistically significant and economically important. In all specifications, HAMP is associated with sizable reductions in the odds of redefault. The overall HAMP effect from the first regression is a 49 percent reduction in the odds of redefault. Controlling for changes in mortgage terms dampens that effect somewhat, which is to be expected, because HAMP is associated with more advantageous changes in loan terms (as Table 2 shows). Nonetheless, the improvement in loan performance remains significant (a 29 to 35 percent reduction in the redefault odds,

[45] The standardized odds ratios are obtained by standardizing the explanatory variables to have mean 0 and standard deviation 1. They can be interpreted as the effect of a one standard deviation change in the explanatory variable on the conditional odds of redefault. We only show standardized odds ratios for selected continuous variables because their interpretation is problematic for dummy variables.

depending on the specification), even after controlling for these changes. Thus, the design of the modification program may play a significant role in how the loan fares after modification, even when other features of the modification remain equal.

Modifications that result in larger monthly payment reductions make the loan less likely to redefault; a 1 percentage point increase in the payment reduction is associated with a 1.6 percent decline in the odds of redefault, as shown in model M2. Looking at the effects of the individual term changes in model M3, a larger balance decrease (or a smaller balance increase) makes redefault less likely; if the balance reduction grows by 1 percentage point, the odds of redefault decrease by 1.3 percent. Surprisingly, the amount of principal deferred has no statistically significant effect on the likelihood of redefault. The larger the interest rate reduction, the smaller the odds of redefault; a 1 percentage point increase in the rate reduction is associated with a 10 percent decline in the redefault odds. The effect of the interest rate reduction is larger than that of the balance reduction, as shown by the standardized odds ratios. Specifically, a one standard deviation increase in the rate reduction reduces the odds of redefault by about 19 percent, whereas a similar increase in the balance reduction reduces the odds of redefault by 10 percent. If the modification includes a term extension, the odds of redefault are 16.5 percent lower than if a term extension is not granted.

Interestingly, some of the effects of interest rate and balance reductions still remain, while the effect of a term extension disappears, after controlling for the size of the payment reduction (see model M4). Increases of 1 percentage point in the percent of balance reduction and the rate reduction are associated with statistically significant declines of 1 percent and 4.7 percent, respectively, in the redefault odds, over and above

the effect of the monthly payment reductions they generate. The remaining effects of the interest rate and balance reductions are very similar in magnitude, as indicated by the standardized odds ratios. While the persistence of the balance change effect is not very surprising given that this modification also reduces the principal burden (in addition to reducing the monthly payment), the reason the effect of a rate change persists is less clear and deserves further investigation. What is crucial, however, is that both the amount of the monthly payment reduction and whether that reduction is achieved through a write down of the principal or a reduction in the interest rate have statistically and economically significant effects on the probability of redefault.

5.1.2. Loan characteristics

Loans that the servicer define as non-prime at origination were more likely to redefault than prime loans. Conventional mortgages with private mortgage insurance (PMI) were less likely to redefault than government and conventional mortgages without PMI, although the differences diminish after controlling for the payment reduction from modification. While previous research (Been et al., 2011) found that securitized loans guaranteed by the GSEs were more likely than all other loans to be modified, we find that the modified GSE loans are more likely to redefault than all other loans.

We next focus on the pricing of loans after modification. Both for FRMs and ARMs, loans with interest rates after modification that are much higher than the market index (more than 3 points higher for FRMs and more than 4 points higher for ARMs) are significantly more likely to become seriously delinquent after modification. Consistent with other research (Chan et al., 2010), these effects could be picking up some borrower

risk that is not reflected in the specific risk controls we include in our model, if we interpret the loan pricing terms to reflect *ex ante* risk pricing by lenders.

We find that the loan performance post modification is affected by the performance prior to modification as measured by the percent of the months from the pre-modification period that the loan was seriously delinquent. Specifically, if that measure of pre-modification performance increases by 1 percentage point, the odds of redefault after modification increase by 0.6 to 1.8 percent, depending on year of origination and regression specification.

Similarly, early intervention matters. Most of our models indicate that modifying loan terms while the borrower is still current or is 60 or fewer days past due makes redefault less likely compared to modifications that are granted while the borrower is 90 or more days past due.

The post modification loan performance does not differ significantly by current LTV levels, but the higher the dollar value of the current outstanding balance, the higher the likelihood of redefault. A 10 percent increase in loan balance is associated with a 1.4 percent increase in the odds of redefault. This effect suggests that the loan limit associated with HAMP is a desirable feature.

The impact of time elapsed since modification is associated with an increased likelihood of delinquency. The impact of time elapsed since modification can be thought of as baseline odds. All other variables are interpreted as proportional shifts up or down from the baseline odds.

Finally, we find differences in the performance of loans modified by different servicers.[46] We do not have enough servicer-specific information, however, to further explore the reasons for these differences. Future research incorporating detailed servicer characteristics may be warranted to better understand these differences.

5.1.3. Borrower characteristics.[47]

FICO score is the only borrower characteristic that matters for performance of the modification. Specifically, borrowers with higher current FICO scores were less likely to redefault, and the differences in loan performance across the various credit score brackets are large. For example, a borrower in the highest bracket (FICO≥720) has almost 83 percent lower odds of redefaulting, and one in the middle bracket (650≤FICO<680) has almost 60 percent lower odds of redefaulting, relative to a borrower in the lowest bracket

[46] Our findings are consistent with Moody's reports that redefault rates differ by servicer (Brock, 2012; Bay, 2011).

[47] The OCC Mortgage Metrics also includes front-end and back-end debt-to-income ratios used by servicers to decide the loss mitigation outcome. While these factors are unlikely to affect the post-modification loan performance (because they are adjusted significantly as a result of the modification), the non-housing debt ratio (i.e., the difference between the back-end and front-end ratios) may affect that performance. However, this variable is missing for over half of the observations in our sample, and in preliminary work we found it to have very low statistical significance (p-values around 0.90) and little influence on the other results. Therefore, we chose not to include it in the final specifications.

(FICO<560). The lack of a significant effect on the owner-occupancy variable suggests that the recent relaxation of HAMP's original exclusive focus on owner-occupants may be warranted from an efficiency perspective.[48] The insignificance of the foreclosure counseling variable suggests that counseling is resulting in modifications that are no more or less successful than average, even though prior work shows that counseling increases the likelihood that a borrower will receive a modification (Been et al., 2011; for a survey of the older literature, see Collins and O'Rourke, 2011). The borrower's race or ethnicity is not significantly correlated with the odds of redefault.

5.1.4. Neighborhood characteristics

Table 3 also explores whether demographic or housing market characteristics of the neighborhood affect the post-modification loan performance. Interestingly, we find little evidence of any neighborhood effects. The lack of any significant effect of house price depreciation or *lis pendens* rate is puzzling, because Chan et al. (2012) show that those factors are important for default, and one would expect them to affect redefault in a similar manner. Our result might be an indicator that once a family has received a modification, they are not being influenced by the neighborhood property values because the payment reduction is good enough to allow them to live in the house at the equivalent of market rents (so that it does not matter if the house value falls).

5.2. Do HAMP effects vary over time?

[48] Supplemental Directive 12-02 relaxed the owner occupied requirement in various circumstances, as of June 1, 2012 (Making Home Affordable Program, 2012b).

The results in Table 4 offer insights about the temporal dynamics of the comparative performance of HAMP and non-HAMP modifications.[49] The odds ratios for the pre- and post-HAMP time trend variables are statistically significant, smaller than 1, and very similar in magnitude[50], whereas the odds ratio for the post-HAMP indicator is not statistically significant. These results indicate that newer proprietary modifications are associated with lower conditional odds of redefault, and this improvement appears unrelated to the advent of HAMP. Further, we find that HAMP modifications result in a nearly 60 percent decrease in the odds of redefault relative to the proprietary modifications from the post-HAMP period (as indicated by the odds ratio for the HAMP indicator). The newer HAMP modifications result in performance improvements relative to older ones similar to those in the non-HAMP sector, which leaves the HAMP versus non-HAMP differential relatively constant over time.[51] Moreover, the differential remains relatively constant even when controlling for the features of the modifications, which have certainly become more generous to borrowers for both HAMP and proprietary modifications over time.

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[49] Table 4 only shows the results regarding modification features. The effects of the loan, borrower and neighborhood characteristics in these models are very similar to the effects in the baseline models, and thus they are not shown here; however, they are available upon request from the authors.

[50] In addition, the difference in odds ratios is not statistically significant.

[51] As indicated by the statistically insignificant odds ratio for the Post-HAMP Time Trend X HAMP interaction term.

5.3. Do effects of modification features vary with FICO and LTV?

In alternative specifications, shown in Table 5, we took steps to test whether the effects of modification features such as payment change, balance change, principal deferral, rate change, and term extension vary with the FICO and LTV levels.[52] We find that the balance change effects discussed in the previous section only occur for the borrowers with negative equity. This suggests that principal write-downs may be more effective in preventing redefault if targeted to underwater borrowers. We also find that a reduction in interest rate may be less effective in improving loan performance for the borrowers with the lowest credit scores than for the more creditworthy borrowers, controlling for changes in monthly payment. Finally, we find no evidence that the effects of payment changes, principal deferrals, and term extensions on the loan's post modification performance vary with FICO and LTV.

5.4. Robustness checks

As noted above, one concern that readers might have about our findings is that the results may be driven by selection into HAMP (as opposed to proprietary modification programs) based on unobserved characteristics. While the two different groups do not

[52] Table 5 only shows the results regarding modification features. The effects of the loan, borrower and neighborhood characteristics in these models are very similar to the effects in the baseline models, and thus they are not shown here; however, they are available upon request from the authors.

look substantially different in critical ways, as we discuss above, biases could result from borrower self-selection, if for example, the borrowers who manage to survive the gauntlet of the application process and trial period required by HAMP have perseverance, organizational ability or other unobserved personal characteristics different from those borrowers who are not eligible for, or who do not obtain, HAMP modifications, and those characteristics affect the loan performance. Or selection may occur by servicers, if as some have alleged, servicers try to steer certain borrowers into their proprietary modification programs based on unobserved characteristics that also affect loan performance.[53]

There is considerable selection involved between HAMP versus proprietary modifications: despite the fact that a servicer is supposed to provide a proprietary modification only when the borrower isn't eligible for a HAMP modification, the latest data available show that there are many more proprietary modifications than HAMP modifications. By January 2011, about 2.5 million homeowners had applied for a modification under HAMP, and of those, about 60 percent, or about 1.5 million, had qualified for and begun a "trial period plan." About 740,000 of those had their temporary

[53] HAMP requires participating servicers to consider the borrower first for a HAMP modification, and to use proprietary modifications only for those borrowers ineligible for HAMP modifications (Making Home Affordable, 2011). Nevertheless, servicers might employ certain tactics (in deciding who is in danger of "imminent default," or in "losing" documentation, for example) to render ineligible borrowers who might otherwise be eligible for HAMP (Karikari, 2011; Treasury, 2010).

modifications canceled for various reasons, another 145,000 were still in a temporary modification, and the remaining 600,000 had their temporary modifications converted to permanent modifications (although about 60,000 of those were subsequently cancelled) (GAO 2011a). Similar data about the applications rejected and the success of trial periods for proprietary modifications are not available. Between the first quarter of 2008 through the first quarter of 2012, a total of 602,305 HAMP permanent modifications had been granted, while 2,015,324 non-HAMP permanent modifications had been granted[54]. Karikari (2011) reports that "data from eight of the largest servicers suggest that about 45% of the homeowners whose HAMP trial modifications were canceled were considered for proprietary modification," although it is not clear how many of those actually received a proprietary modification. The different potential selection effects could cut in opposite directions and even offset each other, of course, but in any event could confound our findings.

To further address the concern about selection effects, we perform two robustness checks. First, we re-estimate our models using a random effects estimator that controls for any unobserved, time-invariant differences across loans.[55] Tables 6A and 7A show

[54] The number of proprietary modifications is computed by authors based on the quarterly statistics in OCC and OTS 2009a, OCC and OTS 2009b, OCC and OTS 2009c and OCC 2012,

[55] The random effects model produces consistent coefficient estimates if the individual effects are uncorrelated with the other regressors. However, we could not test the validity of this assumption using the usual Hausman test because we could not estimate the fixed

selected results from this alternative estimation for the baseline models and the models with temporal variation of HAMP effects, respectively.[56] For comparison purposes, these results are shown side-by-side with the estimates from Table 3 and Table 4, respectively. The HAMP effects estimated from the random effects models are very similar to those from Tables 3 and 4.[57]

Second, we perform a bivariate probit estimation, which is widely used when both the outcome variable and the endogenous variable (the HAMP indicator) are binary choice variables (Greene, 1998; Neal, 1997).[58] The bivariate probit model includes the redefault equation, which has the same explanatory variables as the logit regressions in

---

effects model required by that test. The fixed effects estimator cannot be computed with our data because some regressors are time-invariant and because for part of the loans (i.e., those that remain current throughout the observed post-modification period) the outcome is time invariant.

[56] Detailed results for the baseline models with random effects are shown in Appendix Table A. Detailed results for the random effects models with temporal variation of HAMP effects are not shown in the paper because the effects of the loan, borrower and neighborhood characteristics in these models are very similar to the effects in the baseline models; however, they are available upon request from the authors.

[57] The effects of modification terms and all other controls are also very robust to the random effects specification.

[58] Bivariate logit estimation is not available in commonly used statistical packages such as STATA or SAS.

Tables 3 and 4, and the selection equation, which has the HAMP indicator as the dependent variable. The identification of the selection equation—which is critical for estimating the effect of HAMP in the redefault equation—is achieved by using variables known prior to the granting of the modification that should not directly affect the post-modification performance. Such variable include front-end debt-to-income ratios just before modification, unpaid loan balance at the time of modification, FICO and LTV at loan origination, relative interest rate at origination, house price appreciation over the period between loan origination and modification, and unemployment rate at modification.[59] Appendix Table B shows the detailed specifications of the two equations of the bivariate probit model.[60] Tables 6B and 7B show selected results from the bivariate

[59] Note, however, that we could not include an indicator for the period following HAMP enactment among the explanatory variables because there are no HAMP modifications in the pre-HAMP enactment period and this would create zero cell sizes that would prevent convergence in the maximum likelihood estimation. Note also that to make the bivariate probit estimation feasible, the selection equation is estimated on the same loan-month-level sample as the redefault equation, although all the variables in the selection equation are time invariant.

[60] We only show detailed bivariate probit results for the baseline models because the coefficients of the loan, borrower and neighborhood characteristics in the models with temporal variation in HAMP effects are very similar to those in the baseline models. Detailed results for the models with temporal variation of HAMP effects are available upon request from the authors.

probit estimation for the baseline models and the models with temporal variation of HAMP effects, respectively. For comparison purposes, these results are shown side-by-side with estimates from simple probit models. The rho parameter, which measures the correlation between the error terms of the redefault and selection equations and, thus, is a de facto test for the exogeneity of the HAMP indicator, is not statistically significant. This result suggests that the HAMP indicator can be treated as exogenous in the redefault equation. Second, the two sets of estimates are very similar for the baseline models, and reasonably close for the models that allow for temporal variation of HAMP effects—a finding which further reinforces the exogeneity of the HAMP variable.[61,62]

These alternative econometric techniques confirm once more that it is unlikely that self-selection biases drive our estimates of the HAMP effects.

6. Conclusion and policy implications

Our results demonstrate that borrowers who receive HAMP modifications have been considerably more successful in staying current than those receiving non-HAMP modifications. HAMP modifications have resulted, on average, in modifications with terms substantially more favorable to the borrower than other modifications, and not

[61] Although the bivariate probit estimates of the HAMP coefficient in models M2b and M4b are not statistically significant at conventional levels, they are statistically significant at the 12 percent and the 19 percent level, respectively.

[62] The effects of modification terms and all other controls are also very robust to the bivariate probit specification.

surprisingly, when mortgages are made more affordable to the borrower, the borrower performs better. But our results also show that successful modifications are not simply a matter of bringing the cost of the mortgage down to an affordable level. Overall, getting a HAMP modification improves the conditional odds that the borrower will not redefault by about 49 percent, but more than half of that effect remains after controlling for the terms of the modification, which suggests that the design or implementation of the HAMP program is promoting more successful modifications than the design or implementation of the proprietary modification programs. Proprietary modification programs accordingly would be well advised to experiment with adopting features of HAMP's design or implementation in addition to HAMP's more generous modification terms.

This research is unable to isolate precisely which HAMP features are reducing the likelihood of redefault. One possibility is that proprietary modifications are misguided in offering greater flexibility. Servicers claim that their proprietary modifications have "fewer documentation requirements," "fewer eligibility requirements," more flexibility around the DTI threshold, and "more flexible terms" (GAO, 2011a). These more flexible criteria may result in inefficient modifications. Servicers and policymakers should be cautious about adopting overly strict eligibility requirements or other processes that may marginally improve success but deny modifications that would be cost-effective. Of course, they must also strive to avoid relaxing rules that ensure efficient modifications.

It could also be that the standardized specificity and order of the waterfall protocol, or other specific features of the modification process itself help explain the

relative success of HAMP modifications. Again, experimentation and further analysis of the success of modifications under programs with different features is required.

Our findings also hold lessons for the debates over principal write downs versus principal deferral. Principal write downs have a relatively small but statistically significant effect on the probability of redefault, over and above the effect that they have through the reduction in monthly payment. Principal deferrals have no effect on the probability of redefault. Although few modifications are resulting in principal reductions, our analysis shows that increasing the balance reduction by 1 percentage point reduces the conditional odds of redefault by 1 percent, in addition to the reduction in the probability of redefault attributable to the monthly reduction that would follow from a principal write down. The total effect, then, of increasing the balance reduction by 1 percentage point (and decreasing the monthly payment accordingly) is 1.3 percent. For the average borrower in our sample with an outstanding balance of $400,739, each reduction of $4,007 (which would lower the monthy payment by $20.37, assuming the average post-modification rate of 3.86% and term of 26 years**)** accordingly would lower the conditional odds of redefault by 1.3 percent. The additional effects of the principal balance reduction are limited to borrowers who are in negative equity. Of course, the benefit of a balance reduction must be weighed against the effect the reduction would have on the net present value of the modified loan, to evaluate the resulting return to the investor, and against any effect principal write downs would have on the probability that borrowers would default in order to obtain a principal write down. The effects a balance reduction and a rate reduction have over and above the effect of the monthly payment

reductions they produce are similar in importance, and both are stronger than the effect of a term extension (which is statistically insignificant).

Our analysis also can inform the net present value models that HAMP and proprietary modifications use. First, servicers should recalibrate their assessments of when modifications are likely to result in a higher return than foreclosure or denial of the modification, given the findings that relatively small changes in modification terms can have a small but statistically significant effect on the probability of redefault. For the average borrower in our sample, for example, whose monthly payment is $2,562 and who receives a $723 monthly payment reduction, an additional 1 percentage point payment reduction of $26 would lower the borrower's conditional odds of redefault by 1.6 percent.

Second, the HAMP NPV model, which includes current loan to value as a predictor of redefault (DeMarco, 2012), may need to be adjusted. We do not find that current LTV affects the probability of redefault, when all other factors are held constant, except in that the effect principal write-downs have on probability of redefault is limited to borrowers who are in negative equity.

Our analysis of the temporal dynamics of the performance of HAMP and non-HAMP modifications reveals some encouraging trends. While the performance differential between the HAMP and non-HAMP modifications seems relatively steady across modification vintages, the more recent vintages—both in the HAMP and the non-HAMP sector—are associated with improved loan performance relative to the earlier ones.

Our results also suggest the borrowers with whom servicers and counselors should be especially careful to review the costs and benefits of a modification over the

long run; low credit score borrowers with high balance subprime loans that are guaranteed by the GSEs, originated at rates substantially higher than market, and who have many months of delinquency have particular difficulties carrying even modified loans. Our results also suggest that for borrowers with the lowest credit scores, interest rate reductions may be less effective than for other borrowers.

Interestingly, the determinants of which borrowers get modifications identified in Been et al. (2011)—subprime, high LTV, ARM, low FICO borrowers in less rapidly depreciating neighborhoods—do not turn out to be the determinants of which modifications succeed. The factors that are associated with a greater propensity to modify loans may reflect the servicer's attempt to prevent strategic default, or may reveal the servicer's belief that those homes will command so little on the market that they are not worth going through the foreclosure process to obtain. More attention to the factors that predict the success of modified loans in the decision making process that determines who gets modifications, however, may help increase the efficiency of loan default resolutions.

While many observers are seriously disappointed with the failure of the HAMP program to modify more of the millions of mortgages in default, our results reveal that those modifications that have been made under the HAMP program have performed well, relative to other modifications. The real test of the success of modification programs, however, is whether the modifications helped borrowers achieve better outcomes than they would have achieved without the modification, at a reasonable cost. Little public information is available about what happens to borrowers who applied for, but were denied modifications, or who were denied permanent modifications after a trial period.

To allow full assessment of the efficiency of modifications, information about which borrowers applied for modifications must be made available to researchers.

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Table

Table 1. Descriptive Statistics

A. Outcomes of Modified Loans

Outcome	% of all loans
Remains Current	70.7
Becomes 60+Days Delinquent	29.3

B. Modification Features

Variable	Mean	% of Loans with:[1] Reduction	Increase	No Change
HAMP	0.330			
Monthly Mortgage Payment Change (pre − post mod, as % of pre mod)	28.215	81.3	6.7	3.8
(missing payment change indicator)	0.083			
Principal Balance Change (pre − post mod, as % of pre mod)	-2.623	9.6	71.8	14.8
(missing balance change indicator)	0.038			
Amount Principal Deferred (as % of pre mod balance)	3.066	NA	NA	82.9
(missing amount principal deferred indicator)	0.034			
Interest Rate Change (pre − post mod, in percentage points)	2.807	75.1	2.8	11.2
(missing rate change indicator)	0.109			
Term Extension (Yes=1; No=0)	0.449	NA	NA	NA
(missing term extension indicator)	0.026			
Number of Loans	6,541			

C. Loan Characteristics

Variable		Mean
Credit Class		
	Prime	0.449
	Non-Prime	0.526
	(missing credit class indicator)	0.025
Product Description		
	FRM	0.568
	ARM 2/28	0.020
	ARM 3/27	0.015
	ARM (other)	0.261
	Other	0.135
Interest Only at Origination		0.142
	(missing interest only indicator)	0.009
Full Documentation		0.409
	(missing full documentation indicator)	0.001
Product Group		
	Government (FHA, VA)	0.079
	Conventional with PMI	0.115
	Conventional	0.789
	Other	0.017
Relative Interest Rate after Modification (FRMs):[3]		
	<0	0.210
	0-1	0.157
	1-2	0.295
	2-3	0.197

	>3	0.111
	(missing interest rate indicator)	0.030
Relative Interest Rate after Modification (ARMs):[2]		
	<0	0.345
	0-2	0.036
	2-4	0.077
	>4	0.517
	(missing interest rate indicator)	0.024
Investor Type in the Month of Modification		
	Private Investor	0.364
	GSE	0.418
	Held in Portfolio	0.187
	(missing investor type indicator)	0.030
% Months the Loan was 60+ DPD before Modification X Origination Year[5]		
	X 2004	45.352
	X 2005	39.107
	X 2006	39.929
	X 2007	39.956
	X 2008	36.912
Delinquency Status in the Month prior to Modification		
	90+DPD in the month prior to modification	0.716
	60DPD in the month prior to modification	0.062
	30DPD in the month prior to modification	0.055
	Current in the month prior to modification	0.161
	(missing delinquency status indicator)	0.005
Lis Pendens Filed before Modification		0.171
Has a Junior Lien on the Property		0.287
Number of Months Post-Adjustment (ARMs):[2]		
	before 1st adjust or no adjust	0.863
	0-3	0.016
	4-6	0.015
	>6	0.106
Current LTV[4]	Mean	1.077
	<80%	0.173
	80-100%	0.229
	100-120%	0.270
	>120%	0.319
	(missing LTV indicator)	0.010
log (Current Unpaid Balance)		12.855
Loan Age (months)		44.227
Time since Modification (months)		6.685
Number of Loans		6,541
Number of Loan-Months		42,380

D. Borrower and Property Characteristics

Variable		Mean
Owner Occupier		0.913
Borrower Race/Ethnicity		
	Non-Hispanic Black	0.281

	Non-Hispanic Asian	0.085
	Non-Hispanic Other	0.012
	Non-Hispanic White	0.152
	Hispanic	0.147
	(missing race/ethnicity indicator)	0.323
Received Foreclosure Counseling before Modification		0.035
FICO Score Decline between Origination and Modification[4]		87.760
	(missing FICO score decline indicator)	0.067
Current FICO Score[4]	Mean	597.009
	<560	0.364
	560-620	0.248
	620-650	0.112
	650-680	0.082
	680-720	0.085
	>=720	0.087
	(missing FICO score indicator)	0.022
Number of Loans		6,541
Number of Loan-Months		42,380

E. Neighborhood Characteristics

		Estimation Sample	NYC (4 boroughs)
Variable		Mean	Mean
Neighborhood Racial Composition			
% Non-Hispanic Black			
	<20%	0.377	0.584
	20-40%	0.092	0.117
	40-60%	0.083	0.085
	60-80%	0.143	0.089
	>80%	0.305	0.125
% Hispanic			
	<20%	0.631	0.551
	20-40%	0.201	0.203
	>40%	0.168	0.246
% Non-Hispanic Asian			
	<20%	0.884	0.840
	20-40%	0.102	0.124
	>40%	0.014	0.036
Other Neighborhood Characteristics			
% Foreign Born			
	<20%	0.132	0.181
	20-40%	0.459	0.414
	40-60%	0.339	0.307
	>60%	0.069	0.098
Median Household Income (1999)			
	<$20,000	0.049	0.121
	$20,000-40,000	0.360	0.435
	$40,000-60,000	0.495	0.312
	>$60,000	0.096	0.132
Origination Year			

	2004	0.077
	2005	0.173
	2006	0.324
	2007	0.308
	2008	0.118
Borough		
	Manhattan	0.018
	Bronx	0.153
	Brooklyn	0.287
	Queens	0.542
Quarter of Loan Performance		
	2008 - 1	0.001
	2008 - 2	0.009
	2008 - 3	0.011
	2008 - 4	0.018
	2009 - 1	0.024
	2009 - 2	0.043
	2009 - 3	0.065
	2009 - 4	0.080
	2010 - 1	0.102
	2010 - 2	0.171
	2010 - 3	0.262
	2010 - 4	0.214
Unemployment Rate (%)		10.079
Recent Foreclosure Rate		
	<1%	0.266
	1-2%	0.315
	2-3%	0.242
	>3%	0.177
HP Appreciation (%)		-5.854
Number of Loans		6,541
Number of Loan-Months		42,380

F. Servicer Characteristics: Mean FICO and LTV at Origination[4]

Servicer	FICO	LTV
1	643.7	0.794
2	651.4	0.775
3	662.4	0.753
4	695.2	0.774
5	667.4	0.782
6	649.8	0.731
7	685.2	0.754
8	675.3	0.770
9	652.1	0.770

Notes

Statistics based on the loan-month-level sample are represented with gray shading. The other statistics are based on the loan-level sample.

1) The percentages in the rows of this panel do not add up to 100 due to the exclusion of missing values; the share of loans with missing

values for the given feature is indicated by the mean of the corresponding missing value indicator in the Mean column. For Amount Principal Deferred, the No Change column reports the percent of loans which did not have principal deferred.

2) The means are computed using only the ARMs.

3) The means are computed using only the FRMs.

4) The mean is computed using only non-missing values.

5) The mean is computed using only the loans originated in the relevant year.

Table 2. Characteristics of HAMP and Non-HAMP Loans

Variable		HAMP Mean	Non-HAMP Mean
Modification Features			
Monthly Mortgage Payment Change (pre ─ post mod, as % of pre mod)		42.587	20.177
Principal Balance Change (pre ─ post mod, as % of pre mod)		0.520	-4.262
Amount Principal Deferred (as % of pre mod balance)		8.225	0.437
Interest Rate Change (pre ─ post mod, in percentage points)		4.171	2.023
Term Extension (Yes=1; No=0)		0.558	0.395
Loan Characteristics			
Credit Class[1]			
	Prime	0.543	0.402
	Non-Prime	0.446	0.558
Product Description			
	FRM	0.500	0.604
	ARM 2/28	0.004	0.028
	ARM 3/27	0.003	0.023
	ARM (other)	0.318	0.229
	Other	0.174	0.116
Interest Only at Origination		0.119	0.133
Full Documentation		0.435	0.392
Relative Interest Rate at Origination (%) (FRMs):[2]		-0.022	0.159
Relative Interest Rate at Origination (%) (ARMs):[3]		1.738	1.558
% Months the Loan was 60+ DPD before Modification X Origination Year[4]			
	X 2004	39.669	46.790
	X 2005	44.695	37.495
	X 2006	42.375	38.915
	X 2007	40.159	39.803
	X 2008	35.168	38.124
Delinquency Status in the Month prior to Modification[1]			
	90+DPD in the month prior to modification	0.784	0.683
	60DPD in the month prior to modification	0.060	0.063
	30DPD in the month prior to modification	0.023	0.071
	Current in the month prior to modification	0.132	0.175
Lis Pendens Filed before Modification		0.160	0.176
Has a Junior Lien on the Property at the Time of Modification		0.294	0.285
LTV at Origination		0.766	0.769
LTV at the Time of Modification		1.075	1.029
Unpaid Balance at the Time of Modification		389962	421538
Borrower Characteristics			

FICO Score at Origination		678.598	657.938
FICO Score at the Time of Modification		576.217	577.481
Debt-to-Income Front-End Ratio before Modification[5]		54.364	46.307
Debt-to-Income Back-End Ratio before Modification[5]		89.865	70.029
Neighborhood Characteristics			
Median Household Income (1999)			
	<$20,000	0.035	0.057
	$20,000-40,000	0.341	0.369
	$40,000-60,000	0.524	0.481
	>$60,000	0.100	0.093
Borough			
	Manhattan	0.005	0.025
	Bronx	0.137	0.160
	Brooklyn	0.260	0.300
	Queens	0.598	0.514
Unemployment Rate at the Time of Modification (%)		10.574	9.239
Recent Foreclosure Rate before Modification (%)		1.917	1.906
House Price Appreciation between Origination and Modification (%)		-28.645	-19.965
Number of Loans		2156	4385

Notes

Means are computed using only non-missing values.

1) Shares do not add up to 1 because of the exclusion of share of loans with missing information.

2) The means are computed using only the FRMs.

3) The means are computed using only the ARMs.

4) The mean is computed using only the loans originated in the relevant year.

5) Computed at the time the borrower information was collected by the servicer, to decide on the loss mitigation outcome; the information collection can occur up to six months prior to the date the modification becomes effective, and this time interval varies across modification programs and servicers.

Table 3. Baseline Models

Variable	Effects on hazard of re-default (odds ratios) M1	M2	M3	M4	Effects on probability of re-default over 12 months since modification (%) (selected variables) M1	M2	M3	M4
Modification Features								
HAMP	0.514***	0.653***	0.692***	0.712***	-13.90 ***	-8.95 ***	-7.86 ***	-7.18 ***
Monthly Mortgage Payment Change (pre− post mod, as % of pre mod)		0.984***		0.987***		-0.04 ***		-0.03 ***
(missing payment change indicator)		1.113		1.027				
Principal Balance Change (pre− post mod, as % of pre mod)			0.987**	0.990*			-0.03 ***	-0.03 *
(missing balance change indicator)			1.324**	1.292*				
Amount Principal Deferred (as % of pre mod balance)			0.990	0.998				
(missing amount principal deferred indicator)			2.332**	2.506**				
Interest Rate Change (pre− post mod, in percentage points)			0.902***	0.953**			-0.28 ***	-0.12 **
(missing rate change indicator)			0.834**	0.908				
Term Extension (Yes=1, No=0)			0.835**	0.922			-4.10 ***	
(missing term extension indicator)			0.447*	0.426*				
Loan Characteristics								
Credit Class Non-Prime	1.181**	1.186**	1.167**	1.177**	3.73 **	3.72 **	3.39 **	3.53 **
(missing credit class indicator)	3.030***	3.120***	3.023***	3.051***				
Product Description [REF: FRM]								
ARM 2/28	0.975	1.032	1.029	1.041				
ARM 3/27	0.816	0.847	0.864	0.860				
ARM (other)	0.781*	0.884	0.870	0.900				
Other	0.870	0.901	0.923	0.916				
Interest Only at Origination	0.920	0.959	0.966	0.990				
(missing interest only indicator)	0.697	0.691	0.584*	0.642				
Full Documentation	1.097	1.094	1.091	1.093				
(missing full documentation indicator)	1.914	1.799	1.853	1.783				
Product Group [REF: Conventional]								
Government (FHA, VA)	1.335**	1.307**	1.319**	1.310**	7.34 **	6.53 **	6.62 **	6.57 *
Conventional with PMI	0.789***	0.850*	0.819**	0.853*	-5.09 ***	-3.45 *	-4.45 **	-3.35 *
Other	1.157	1.144	1.175	1.160				
Relative Interest Rate after Modification (FRMs) [REF: <0]								
0-1	1.391***	1.127	1.211*	1.114	7.51 ***		4.20 *	
1-2	1.402***	1.130	1.208	1.102	7.72 ***			
2-3	1.389***	1.144	1.236*	1.121	7.49 ***		4.68 *	

	>3	1.652***	1.568***	1.566***	1.538***	12.08	***	10.89	***	10.70	***	10.34	***
	(missing interest rate indicator)	0.767**	0.778*	0.809	0.804*								
Relative Interest Rate after Modification (ARMs) [REF: <0]													
	0-2	0.786	0.716	0.728	0.719								
	2-4	1.447**	1.181	1.281	1.177	8.00	**						
	>4	1.822***	1.569***	1.597***	1.527***	14.03	***	10.54	***	10.84	***	9.84	***
	(missing interest rate indicator)	0.732	0.797	0.750	0.803								
Number of Months Post-Adjustment (ARMs) [REF: <0]													
	0-3	0.931	0.918	0.940	0.918								
	4-6	1.191	1.186	1.185	1.157								
	>6	0.913	0.923	0.907	0.892								
Investor Type in the Month of Modification [REF: Private Investor]													
	GSE	1.321***	1.339***	1.322***	1.324***	6.69	***	6.87	***	6.53	***	6.53	***
	Held in Portfolio	0.964	0.928	0.996	0.939								
	(missing investor type indicator)	1.012	1.042	0.997	1.025								
% Months the Loan was 60+ DPD before Modification X Origination Year													
	X 2004	1.012***	1.011***	1.011***	1.011***	0.03	***	0.03	***	0.03	***	0.03	***
	X 2005	1.010***	1.009***	1.009***	1.009***	0.03	***	0.02	***	0.02	***	0.02	***
	X 2006	1.008***	1.007***	1.007***	1.006***	0.02	***	0.02	***	0.02	***	0.02	***
	X 2007	1.010***	1.010***	1.010***	1.010***	0.03	***	0.03	***	0.03	***	0.03	***
	X 2008	1.018***	1.017***	1.018***	1.017***	0.05	***	0.04	***	0.05	***	0.04	***
Delinquency Status in the Month prior to Modification [REF: 90+DPD]													
	60DPD in the month prior to modification	0.790*	0.767**	0.796*	0.781**	-5.16	*	-5.67	**	-4.98	*	-5.33	**
	30DPD in the month prior to modification	1.057	0.976	1.018	0.974								
	Current in the month prior to modification	0.903	0.831**	0.832*	0.801**			-4.08	**	-4.07	*	-4.84	**
	(missing delinquency status indicator)	0.863	0.860	0.322**	0.304**								
Lis Pendens Filed before Modification		1.062	1.048	1.061	1.043								
Has a Junior Lien on the Property		0.992	1.006	1.001	1.004								
Current LTV [REF: <80%]													
	80-100%	1.050	1.039	1.030	1.035								
	100-120%	1.030	1.014	0.981	0.994								
	>120%	1.122	1.117	1.058	1.079								
	(missing LTV indicator)	4.677***	4.517***	4.478***	4.442***								
log (Current Unpaid Balance)		1.246***	1.255***	1.243**	1.245**	0.62	***	0.58	***	0.58	**	0.56	**
Loan Age		0.994	0.991	0.990	0.990								
Time since Modification		1.056***	1.041***	1.049***	1.042***								
Borrower and Property Characteristics													
Owner Occupier		0.914	0.912	0.915	0.915								
Current FICO Score [REF: <560]													

	560-620	0.621***	0.613***	0.617***	0.612***	-13.41	***	-13.53	***	-13.37	***	-13.48	***
	620-650	0.428***	0.421***	0.427***	0.421***	-21.57	***	-21.50	***	-21.27	***	-21.36	***
	650-680	0.424***	0.412***	0.425***	0.417***	-21.74	***	-21.90	***	-21.35	***	-21.54	***
	680-720	0.212***	0.205***	0.211***	0.205***	-31.92	***	-31.63	***	-31.41	***	-31.41	***
	>=720	0.177***	0.170***	0.172***	0.172***	-33.77	***	-33.41	***	-33.37	***	-33.06	***
	(missing FICO score)	0.564***	0.573***	0.560***	0.569***								
FICO Score Decline between Origination and Modification		1.000	1.000	1.000	1.000								
	(missing FICO score decline indicator)	0.923	0.913	0.923	0.915								
Borrower Race/Ethnicity [REF: Non-Hispanic White]													
	Non-Hispanic Black	1.099	1.088	1.108	1.100								
	Non-Hispanic Asian	0.887	0.918	0.919	0.932								
	Non-Hispanic Other	0.744	0.728	0.734	0.728								
	Hispanic	1.039	1.028	1.042	1.033								
	(missing race/ethnicity)	1.110	1.102	1.117	1.114								
Received Foreclosure Counseling before Modification		0.980	0.981	0.987	0.984								
Neighborhood Characteristics													
House Price Appreciation (%)		1.266	1.301	1.263	1.283								
Recent Foreclosure Rate [REF:<1]													
	1-2%	1.062	1.057	1.067	1.063								
	2-3%	1.077	1.076	1.088	1.082								
	>3%	0.995	1.004	1.009	1.010								
Neighborhood Racial Composition [REF: 0-20%]													
% Non-Hispanic Black	20-40%	1.035	1.037	1.033	1.028								
	40-60%	1.202*	1.202*	1.205*	1.198*	4.40	*	4.30	*	4.38	*	4.18	*
	60-80%	0.977	0.963	0.977	0.964								
	>80%	1.077	1.081	1.086	1.079								
% Hispanic	20-40%	0.955	0.976	0.961	0.970								
	>40%	0.972	0.986	0.981	0.984								
% Non-Hispanic Asian	20-40%	0.972	0.954	0.964	0.957								
	>40%	0.621	0.608	0.573*	0.575*					-10.48	*	-10.29	*
% Foreign Born [REF: 0-20%]													
	20-40%	0.995	1.011	0.986	1.005								
	40-60%	0.921	0.933	0.922	0.936								
	>60%	0.983	1.011	1.015	1.026								
Median Household Income (1999) [REF: $40,000-60,000]													
	$0-20,000	0.788*	0.782*	0.791*	0.791*	-5.18	*	-5.19	*	-4.967	*	-4.912	*
	$20,000-40,000	0.976	0.977	0.988	0.989								
	>$60,000	0.950	0.923	0.934	0.921								
Unemployment Rate (%)		1.020	1.017	1.016	1.015								

Origination year [REF: 2004]					
	2005	1.271	1.281	1.291	1.291
	2006	1.269	1.252	1.260	1.251
	2007	1.231	1.199	1.200	1.176
	2008	1.158	1.094	1.049	1.044
Borough [REF: Queens]					
	Manhattan	1.188	1.139	1.159	1.140
	Bronx	0.943	0.924	0.928	0.923
	Brooklyn	1.096	1.079	1.075	1.074
Quarter of Loan Performance [REF: 2010 - 4]					
	2008 - 1	2.110	1.231	1.561	1.237
	2008 - 2	1.800*	1.116	1.280	1.047
	2008 - 3	2.793***	1.729*	1.990**	1.621
	2008 - 4	3.673***	2.279***	2.712***	2.197***
	2009 - 1	4.012***	2.601***	3.132***	2.542***
	2009 - 2	2.490***	1.756***	2.001***	1.709***
	2009 - 3	3.065***	2.343***	2.586***	2.286***
	2009 - 4	2.541***	2.078***	2.237***	2.032***
	2010 - 1	1.678***	1.457***	1.553***	1.442***
	2010 - 2	1.288**	1.175	1.240**	1.171
	2010 - 3	1.285***	1.227**	1.260**	1.223**
Servicer fixed effects included					
Pseudo-R2		0.1104	0.1168	0.1155	0.1182
N		42,380	42,380	42,380	42,380

Notes:

*** denotes results that are statistically significant at the 1 percent level

** denotes results that are statistically significant at the 5 percentlevel

* denotes results that are statistically significant at the 10 percent level

Table 4. Model with Temporal Variation of HAMP effect (Selected Variables)

	Effects on hazard of re-default (odds ratios)			
Variable	M1b	M2b	M3b	M4b
Modification Features				
Pre-HAMP Time Trend	0.925***	0.931***	0.936***	0.935***
Post-HAMP	1.062	0.948	1.075	0.966
Post-HAMP Time Trend	0.900***	0.894***	0.894***	0.891***
HAMP	0.394***	0.585*	0.532**	0.606*
Post-HAMP Time Trend X HAMP	1.048	1.029	1.050	1.035
Monthly Mortgage Payment Change (pre─ post mod, as % of pre mod)		0.984***		0.987***
(missing payment change indicator)		1.236*		1.184
Principal Balance Change (pre─ post mod, as % of pre mod)			0.987**	0.990*
(missing balance change indicator)			1.302**	1.212
Amount Principal Deferred (as % of pre mod balance)			0.989	0.997
(missing amount principal deferred indicator)			2.275**	2.462**
Interest Rate Change (pre─ post mod, in percentage points)			0.901***	0.959*
(missing rate change indicator)			0.796***	0.862*
Term Extension (Yes=1, No=0)			0.892	0.987
(missing term extension indicator)			0.476*	0.438*
Pseudo-R2	0.1134	0.1199	0.1182	0.1212
N	42,380	42,380	42,380	42,380

Notes:

All models include the same set of loan, borrower, property and neighborhood characteristics, and servicer fixed effects as the baseline models in Table 3.

*** denotes results that are statistically significant at the 1 percent level

** denotes results that are statistically significant at the 5 percentlevel

* denotes results that are statistically significant at the 10 percent level

Table 5. Models with Interactions between Modification Features and FICO and LTV (Selected Variables)

	Effects on hazard of re-default (odds ratios)		
Variable	M2c	M3c	M4c
Modification Features			
HAMP	0.653***	0.699***	0.708***
Monthly Mortgage Payment Change (pre− post mod, as % of pre mod)	0.983***		0.988***
(missing payment change indicator)	1.113		1.047
Monthly Mortgage Payment Change X FICO<560	1.000		0.994
Monthly Mortgage Payment Change X LTV>100%	1.002		1.003
Principal Balance Change (pre− post mod, as % of pre mod)		1.002	1.007
(missing balance change indicator)		1.298**	1.253*
Principal Balance Change X FICO<560		0.997	0.998
Principal Balance Change X LTV>100%		0.977**	0.975**
Amount Principal Deferred (as % of pre mod balance)		0.984	0.988
(missing amount principal deferred indicator)		2.305**	2.509**
Amount Principal Deferred X FICO<560		1.006	1.008
Amount Principal Deferred X LTV>100%		0.990	0.995
Interest Rate Change (pre− post mod, in percentage points)		0.869***	0.935
(missing rate change indicator)		0.833**	0.920
Interest Rate Change X FICO<560		1.035	1.079**
Interest Rate Change X LTV>100%		1.023	0.981
Term Extension (Yes=1, No=0)		0.782**	0.858
(missing term extension indicator)		0.445*	0.425*
Term Extension X FICO<560		0.921	0.959
Term Extension X LTV>100%		1.173	1.152
Pseudo-R2	0.1168	0.1164	0.1193
N	42,380	42,380	42,380

Notes:

All models include the same set of loan, borrower, property and neighborhood characteristics, and servicer fixed effects as the baseline models in Table 3.

*** denotes results that are statistically significant at the 1 percent level

** denotes results that are statistically significant at the 5 percentlevel

* denotes results that are statistically significant at the 10 percent level

Table 6. Baseline Models - Alternative Specifications (Selected Variables)

A. Logit Models with Random Effects

	Effects on hazard of re-default (odds ratios)							
	Logit models (from Table 3)				Logit models with random effects			
Variable	M1	M2	M3	M4	M1	M2	M3	M4
Modification Features								
HAMP	0.514***	0.653***	0.692***	0.712***	0.502***	0.647***	0.685***	0.705***
Monthly Mortgage Payment Change (pre─ post mod, as % of pre mod)		0.984***		0.987***		0.982***		0.986***
(missing payment change indicator)		1.113		1.027		1.193		1.087
Principal Balance Change (pre─ post mod, as % of pre mod)			0.987**	0.990*			0.987**	0.990
(missing balance change indicator)			1.324**	1.292*			1.365**	1.306*
Amount Principal Deferred (as % of pre mod balance)			0.990	0.998			0.989	0.998
(missing amount principal deferred indicator)			2.332**	2.506**			2.692***	2.989***
Interest Rate Change (pre─ post mod, in percentage points)			0.902***	0.953**			0.893***	0.947**
(missing rate change indicator)			0.834**	0.908			0.817**	0.892
Term Extension (Yes=1, No=0)			0.835**	0.922			0.816**	0.910
(missing term extension indicator)			0.447*	0.426*			0.403**	0.365***
N	42,380	42,380	42,380	42,380	42,380	42,380	42,380	42,380

Notes:

The logit models with random effects include the same set of loan, borrower, property and neighborhood characteristics, and servicer fixed effects as the baseline models in Table 3. The full specifications of the logit models with random effects are shown in the Appendix Table, Panel A.

*** denotes results that are statistically significant at the 1 percent level; ** denotes results that are statistically significant at the 5 percent level; * denotes results that are statistically significant at the 10 percent level.

B. Bivariate Probit Models

	Effects on hazard of re-default (coefficients)							
	Probit models				Bivariate probit models			
Variable	M1	M2	M3	M4	M1	M2	M3	M4
Modification Features								
HAMP	-0.294***	-0.188***	-0.161***	-0.153***	-0.358***	-0.233***	-0.187***	-0.185**
Monthly Mortgage Payment Change (pre─ post mod, as % of pre mod)		-0.007***		-0.006***		-0.007***		-0.006***
(missing payment change indicator)		0.057		0.015		0.059		0.017
Principal Balance Change (pre─ post mod, as % of pre mod)			-0.005*	-0.004			-0.005*	-0.004
(missing balance change indicator)			0.126**	0.114*			0.126**	0.113*
Amount Principal Deferred (as % of pre mod balance)			-0.003	-0.0002			-0.003	-0.0001
(missing amount principal deferred indicator)			0.413**	0.455**			0.414**	0.456**
Interest Rate Change (pre─ post mod, in percentage points)			-0.054***	-0.025***			-0.053***	-0.025***
(missing rate change indicator)			-0.093**	-0.050			-0.093**	-0.049
Term Extension (Yes=1, No=0)			-0.081**	-0.037			-0.080**	-0.036
(missing term extension indicator)			-0.385**	-0.416**			-0.386**	-0.418**
rho	NA	NA	NA	NA	0.051	0.036	0.021	0.025
Wald test of rho=0 (Prob > chi2)	NA	NA	NA	NA	0.2412	0.4149	0.6428	0.5764
N	42,380	42,380	42,380	42,380	42,380	42,380	42,380	42,380

Notes:

The probit regressions and the (second level) redefault equation in the bivariate probit models include the same set of loan, borrower, property and neighborhood characteristics, and servicer fixed effects as the baseline models in Table 3. The parameter rho measures the correlation between the error terms of the redefault and selection (HAMP vs. Non-HAMP) equations of the bivariate probit models. The full specifications of the bivariate probit models are shown in the Appendix Table, Panel B.

*** denotes results that are statistically significant at the 1 percent level; ** denotes results that are statistically significant at the 5 percent level; * denotes results that are statistically significant at the 10 percent level.

Table 7. Models with Temporal Variation of HAMP Effect - Alternative Specifications (Selected Variables)

A. Logit Models with Random Effects

	Effects on hazard of re-default (odds ratio)							
	Logit models (from Table 4)				Logit models with random effects			
Variable	M1b	M2b	M3b	M4b	M1b	M2b	M3b	M4b
Modification Features								
Pre-HAMP Time Trend	0.925***	0.931***	0.936***	0.935***	0.907***	0.917***	0.920***	0.921***
Post-HAMP	1.062	0.948	1.075	0.966	1.080	0.946	1.089	0.965
Post-HAMP Time Trend	0.900***	0.894***	0.894***	0.891***	0.897***	0.889***	0.890***	0.886***
HAMP	0.394***	0.585*	0.532**	0.606*	0.354***	0.553**	0.490**	0.571*
Post-HAMP Time Trend X HAMP	1.048	1.029	1.050	1.035	1.058	1.035	1.059	1.042
Monthly Mortgage Payment Change (pre─ post mod, as % of pre mod)		0.984***		0.987***		0.983***		0.986***
(missing payment change indicator)		1.236*		1.184		1.330**		1.259*
Principal Balance Change (pre─ post mod, as % of pre mod)			0.987**	0.990*			0.987**	0.991
(missing balance change indicator)			1.302**	1.212			1.341**	1.226
Amount Principal Deferred (as % of pre mod balance)			0.989	0.997			0.989	0.997
(missing amount principal deferred indicator)			2.275**	2.462**			2.666***	2.958***
Interest Rate Change (pre─ post mod, in percentage points)			0.901***	0.959*			0.892***	0.954*
(missing rate change indicator)			0.796***	0.862*			0.784**	0.849
Term Extension (Yes=1, No=0)			0.892	0.987			0.876	0.980
(missing term extension indicator)			0.476*	0.438*			0.424**	0.371**
N	42,380	42,380	42,380	42,380	42,380	42,380	42,380	42,380

B. Bivariate Probit Models

	Effects on hazard of re-default (coefficients)							
	Probit models				Bivariate probit models			
Variable	M1b	M2b	M3b	M4b	M1b	M2b	M3b	M4b
Modification Features								
Pre-HAMP Time Trend	-0.037***	-0.034***	-0.032***	-0.032***	-0.037***	-0.034***	-0.032***	-0.033***
Post-HAMP	0.021	-0.036	0.023	-0.027	0.021	-0.036	0.023	-0.026
Post-HAMP Time Trend	-0.048***	-0.051***	-0.051***	-0.053***	-0.047***	-0.052***	-0.052***	-0.054***
HAMP	-0.403***	-0.217*	-0.269**	-0.211*	-0.406***	-0.196	-0.232*	-0.178
Post-HAMP Time Trend X HAMP	0.020	0.010	0.020	0.014	0.020	0.010	0.021	0.014
Monthly Mortgage Payment Change (pre─ post mod, as % of pre mod)		-0.007***		-0.006***		-0.007***		-0.006***
(missing payment change indicator)		0.110**		0.086		0.109**		0.086
Principal Balance Change (pre─ post mod, as % of pre mod)			-0.005*	-0.004			-0.005*	-0.004
(missing balance change indicator)			0.119*	0.082			0.119*	0.082
Amount Principal Deferred (as % of pre mod balance)			-0.004	-0.001			-0.004	-0.001
(missing amount principal deferred indicator)			0.398**	0.441**			0.397**	0.440**
Interest Rate Change (pre─ post mod, in percentage points)			-0.054***	-0.023**			-0.054***	-0.023**
(missing rate change indicator)			-0.112***	-0.073*			-0.112***	-0.074*
Term Extension (Yes=1, No=0)			-0.053	-0.007			-0.053	-0.008
(missing term extension indicator)			-0.349*	-0.400**			-0.347*	-0.398**
rho	NA	NA	NA	NA	0.003	-0.017	-0.030	-0.027
Wald test of rho=0 (Prob > chi2)	NA	NA	NA	NA	0.9501	0.696	0.4934	0.5407
N	42,380	42,380	42,380	42,380	42,380	42,380	42,380	42,380

Notes:

All regressions include the same set of loan, borrower, property and neighborhood characteristics, and servicer fixed effects as the baseline models in Table 6

*** denotes results that are statistically significant at the 1 percent level; ** denotes results that are statistically significant at the 5 percent level; * denotes results that are statistically significant at the 10 percent level

Appendix Table. Detailed Results for Baseline Models with Alternative Specifications

A. Logit Models with Random Effects

		Effects on hazard of re-default (odds ratios)			
Variable		M1	M2	M3	M4
Modification Features					
HAMP		0.502***	0.647***	0.685***	0.705***
Monthly Mortgage Payment Change (pre− post mod, as % of pre mod)			0.982***		0.986***
	(missing payment change indicator)		1.193		1.087
Principal Balance Change (pre− post mod, as % of pre mod)				0.987**	0.990
	(missing balance change indicator)			1.365**	1.306*
Amount Principal Deferred (as % of pre mod balance)				0.989	0.998
	(missing amount principal deferred indicator)			2.692***	2.989***
Interest Rate Change (pre− post mod, in percentage points)				0.893***	0.947**
	(missing rate change indicator)			0.817**	0.892
Term Extension (Yes=1, No=0)				0.816**	0.910
	(missing term extension indicator)			0.403**	0.365***
Loan Characteristics					
Credit Class Non-Prime		1.179**	1.189**	1.171*	1.182**
	(missing credit class indicator)	3.487***	3.651***	3.439***	3.533***
Product Description [REF: FRM]					
	ARM 2/28	0.971	1.029	1.042	1.045
	ARM 3/27	0.796	0.826	0.851	0.840
	ARM (other)	0.748*	0.864	0.848	0.883
	Other	0.838	0.876	0.892	0.889
Interest Only at Origination		0.908	0.954	0.955	0.983
	(missing interest only indicator)	0.621*	0.601*	0.525**	0.564*
Full Documentation		1.101	1.100	1.092	1.097
	(missing full documentation indicator)	1.913	1.772	1.864	1.765
Product Group [REF: Conventional]					
	Government (FHA, VA)	1.323*	1.300*	1.315*	1.308*
	Conventional with PMI	0.789**	0.852	0.818**	0.855
	Other	1.206	1.174	1.229	1.198
Relative Interest Rate after Modification (FRMs) [REF: <0]					
	0-1	1.494***	1.179	1.272**	1.154
	1-2	1.482***	1.178	1.257*	1.142
	2-3	1.442***	1.178	1.267*	1.150

	>3	1.731***	1.640***	1.630***	1.607***
	(missing interest rate indicator)	0.757**	0.765*	0.794	0.790*
Relative Interest Rate after Modification (ARMs) [REF: <0]					
	0-2	0.777	0.699	0.715	0.703
	2-4	1.550**	1.247	1.358	1.240
	>4	1.999***	1.719***	1.727***	1.662***
	(missing interest rate indicator)	0.762	0.849	0.778	0.848
Number of Months Post-Adjustment (ARMs) [REF: <0]					
	0-3	0.882	0.866	0.887	0.865
	4-6	1.146	1.140	1.146	1.119
	>6	0.895	0.901	0.890	0.874
Investor Type in the Month of Modification [REF: Private Investor]					
	GSE	1.346***	1.365***	1.358***	1.357***
	Held in Portfolio	0.956	0.916	0.992	0.930
	(missing investor type indicator)	1.027	1.063	1.008	1.040
% Months the Loan was 60+ DPD before Modification X Origination Year					
	X 2004	1.013***	1.012***	1.013***	1.012***
	X 2005	1.012***	1.011***	1.011***	1.010***
	X 2006	1.009***	1.008***	1.009***	1.008***
	X 2007	1.012***	1.012***	1.012***	1.012***
	X 2008	1.021***	1.019***	1.021***	1.020***
Delinquency Status in the Month prior to Modification [REF: 90+DPD]					
	60DPD in the month prior to modification	0.796*	0.765**	0.794*	0.777*
	30DPD in the month prior to modification	1.071	0.989	1.026	0.984
	Current in the month prior to modification	0.894	0.817**	0.813**	0.783**
	(missing delinquency status indicator)	0.887	0.889	0.287**	0.268***
Lis Pendens Filed before Modification		1.053	1.042	1.057	1.040
Has a Junior Lien on the Property		0.999	1.012	1.008	1.011
Current LTV [REF: <80%]					
	80-100%	1.047	1.030	1.024	1.026
	100-120%	1.012	0.990	0.961	0.971
	>120%	1.099	1.086	1.036	1.053
	(missing LTV indicator)	5.833***	5.609***	5.578***	5.516***
log (Current Unpaid Balance)		1.273***	1.281***	1.267**	1.272**
Loan Age		0.993	0.991	0.990	0.989
Time since Modification		1.088***	1.072***	1.081***	1.073***
Borrower and Property Characteristics					
Owner Occupier		0.893	0.888	0.895	0.892
Current FICO Score [REF: <560]					

	560-620	0.598***	0.591***	0.593***	0.589***
	620-650	0.403***	0.396***	0.401***	0.396***
	650-680	0.388***	0.376***	0.387***	0.380***
	680-720	0.189***	0.182***	0.186***	0.180***
	>=720	0.155***	0.148***	0.150***	0.150***
	(missing FICO score)	0.503***	0.512***	0.504***	0.512***
FICO Score Decline between Origination and Modification		1.000	1.000	1.000	1.000
	(missing FICO score decline indicator)	0.937	0.928	0.933	0.925
Borrower Race/Ethnicity [REF: Non-Hispanic White]					
	Non-Hispanic Black	1.123	1.109	1.138	1.124
	Non-Hispanic Asian	0.886	0.918	0.921	0.933
	Non-Hispanic Other	0.730	0.702	0.724	0.707
	Hispanic	1.044	1.031	1.051	1.038
	(missing race/ethnicity)	1.137	1.124	1.146	1.138
Received Foreclosure Counseling before Modification		0.974	0.975	0.979	0.977
Neighborhood Characteristics					
House Price Appreciation (%)		1.211	1.247	1.208	1.227
Recent Foreclosure Rate [REF:<1]					
	1-2%	1.063	1.059	1.067	1.064
	2-3%	1.080	1.079	1.092	1.085
	>3%	0.989	0.997	1.002	1.002
Neighborhood Racial Composition [REF: 0-20%]					
% Non-Hispanic Black	20-40%	1.043	1.047	1.042	1.039
	40-60%	1.212	1.217	1.211	1.209
	60-80%	0.987	0.977	0.985	0.976
	>80%	1.077	1.083	1.083	1.080
% Hispanic	20-40%	0.951	0.970	0.956	0.965
	>40%	0.977	0.994	0.987	0.992
% Non-Hispanic Asian	20-40%	0.980	0.960	0.976	0.965
	>40%	0.612	0.595	0.565*	0.565*
% Foreign Born [REF: 0-20%]					
	20-40%	0.986	1.003	0.979	0.998
	40-60%	0.903	0.915	0.903	0.917
	>60%	0.960	0.992	0.991	1.006
Median Household Income (1999) [REF: $40,000-60,000]					
	$0-20,000	0.763*	0.754*	0.768*	0.764*
	$20,000-40,000	0.985	0.985	0.998	0.997
	>$60,000	0.961	0.932	0.942	0.931
Unemployment Rate (%)		1.023	1.021	1.020	1.019

Origination year [REF: 2004]					
	2005	1.283	1.289	1.307	1.303
	2006	1.290	1.271	1.283	1.272
	2007	1.236	1.210	1.204	1.184
	2008	1.160	1.096	1.041	1.035
Borough [REF: Queens]					
	Manhattan	1.164	1.105	1.130	1.102
	Bronx	0.919	0.900	0.902	0.899
	Brooklyn	1.103	1.081	1.080	1.076
Quarter of Loan Performance [REF: 2010 - 4]					
	2008 - 1	2.130	1.130	1.530	1.152
	2008 - 2	1.786	1.024	1.226	0.960
	2008 - 3	2.886***	1.643	1.988**	1.543
	2008 - 4	4.024***	2.322***	2.887***	2.236***
	2009 - 1	4.695***	2.913***	3.578***	2.830***
	2009 - 2	2.782***	1.891***	2.197***	1.835***
	2009 - 3	3.405***	2.525***	2.836***	2.462***
	2009 - 4	2.778***	2.227***	2.427***	2.179***
	2010 - 1	1.797***	1.538***	1.650***	1.521***
	2010 - 2	1.338***	1.209*	1.280**	1.203*
	2010 - 3	1.312***	1.247**	1.283***	1.243**
Servicer fixed effects included					
Log-likelihood		-6943.95	-6893.3	-6902.97	-6882.102
N		42,380	42,380	42,380	42,380

Notes:

*** denotes results that are statistically significant at the 1 percent level; ** denotes results that are statistically significant at the 5 percentlevel; * denotes results that are statistically significant at the 10 percent level.

Appendix Table. Detailed Results for Baseline Models with Alternative Specifications (continued)

B. Bivariate Probit Models

	Coefficients							
	M1		M2		M3		M4	
Variable	Redefault Equation	HAMP Equation	Redefault Equation	HAMP Equation	Redefault Equation	HAMP Equation	Redefault Equation	HAMP Equation
Modification Features								
HAMP	-0.358***		-0.233***		-0.187***		-0.185**	
Monthly Mortgage Payment Change (pre─ post mod, as % of pre mod)			-0.007***				-0.006***	
(missing payment change indicator)			0.059				0.017	
Principal Balance Change (pre─ post mod, as % of pre mod)					-0.005*		-0.004	
(missing balance change indicator)					0.126**		0.113*	
Amount Principal Deferred (as % of pre mod balance)					-0.003		-0.0001	
(missing amount principal deferred indicator)					0.414**		0.456**	
Interest Rate Change (pre─ post mod, in percentage points)					-0.053***		-0.025***	
(missing rate change indicator)					-0.093**		-0.049	
Term Extension (Yes=1, No=0)					-0.080**		-0.036	
(missing term extension indicator)					-0.386**		-0.418**	
Loan Characteristics								
Credit Class Non-Prime	0.066*	-0.221***	0.069**	-0.221***	0.069**	-0.221***	0.070**	-0.221***
(missing credit class indicator)	0.555***	0.817***	0.576***	0.814***	0.555***	0.811***	0.563***	0.812***
Product Description [REF: FRM]								
ARM 2/28	0.027	0.318	0.060	0.317	0.055	0.317	0.066	0.317
ARM 3/27	-0.039	0.057	-0.017	0.057	-0.013	0.058	-0.011	0.058
ARM (other)	-0.098	0.847***	-0.041	0.846***	-0.048	0.846***	-0.033	0.846***
Other	-0.067	-0.212**	-0.045	-0.212**	-0.039	-0.212**	-0.039	-0.212**
Interest Only at Origination	-0.041	-0.186***	-0.017	-0.186***	-0.017	-0.186***	-0.004	-0.186***
(missing interest only indicator)	-0.189	-4.112***	-0.197	-4.113***	-0.272*	-4.115***	-0.231	-4.115***
Full Documentation	0.043	0.180***	0.042	0.180***	0.040	0.180***	0.042	0.180***
(missing full documentation indicator)	0.308	-3.308***	0.280	-3.308***	0.293	-3.309***	0.271	-3.309***
Product Group [REF: Conventional]								
Government (FHA, VA)	0.109*	-2.234***	0.105	-2.234***	0.113*	-2.235***	0.109*	-2.235***
Conventional with PMI	-0.112***	0.087	-0.081*	0.087	-0.099**	0.087	-0.082*	0.087
Other	0.080	0.550***	0.071	0.551***	0.085	0.551***	0.079	0.551***
Relative Interest Rate at Origination (FRMs)		-8.248***		-8.236***		-8.232***		-8.232***
Relative Interest Rate after Modification (FRMs) [REF: <0]								

	0-1	0.166***		0.067		0.091*		0.056	
	1-2	0.167***		0.072		0.093*		0.056	
	2-3	0.158***		0.071		0.099*		0.059	
	>3	0.241***		0.217***		0.220***		0.209***	
	(missing interest rate indicator)	-0.101	0.072	-0.096	0.073	-0.078	0.073	-0.081	0.073
Relative Interest Rate at Origination (ARMs)			2.741***		2.744***		2.745***		2.745***
Relative Interest Rate after Modification (ARMs) [REF: <0]									
	0-2	-0.109		-0.148		-0.142		-0.147	
	2-4	0.152*		0.065		0.093		0.059	
	>4	0.276***		0.213***		0.210***		0.195***	
	(missing interest rate indicator)	-0.132	0.692***	-0.094	0.692***	-0.125	0.692***	-0.093	0.692***
Number of Months Post-Adjustment (ARMs) [REF: <0]									
	0-3	-0.076		-0.091		-0.077		-0.093	
	4-6	0.028		0.018		0.027		0.012	
	>6	-0.075		-0.081		-0.078		-0.093	
Investor Type in the Month of Modification [REF: Private Investor]									
	GSE	0.140***	0.695***	0.140***	0.695***	0.132***	0.695***	0.134***	0.695***
	Held in Portfolio	-0.014	-0.046	-0.030	-0.045	0.001	-0.045	-0.023	-0.045
	(missing investor type indicator)	-0.012	-1.312***	0.007	-1.312***	-0.015	-1.311***	-0.001	-1.312***
% Months the Loan was 60+ DPD before Modification X Origination Year									
	X 2004	0.005***	0.002	0.005***	0.002	0.005***	0.002	0.005***	0.002
	X 2005	0.005***	0.009***	0.005***	0.009***	0.005***	0.009***	0.004***	0.009***
	X 2006	0.004***	0.005***	0.004***	0.005***	0.004***	0.005***	0.004***	0.005***
	X 2007	0.005***	0.001	0.005***	0.001	0.005***	0.001	0.005***	0.001
	X 2008	0.009***	-0.001	0.008***	-0.001	0.009***	-0.001	0.009***	-0.001
Delinquency Status in the Month prior to Modification [REF: 90+DPD]									
	60DPD in the month prior to modification	-0.096*	0.163*	-0.111**	0.163*	-0.095*	0.163*	-0.104*	0.163*
	30DPD in the month prior to modification	0.028	-0.333***	-0.002	-0.332***	0.013	-0.332***	-0.003	-0.332***
	Current in the month prior to modification	-0.055	-0.105	-0.091**	-0.105	-0.090**	-0.105	-0.106**	-0.105
	(missing delinquency status indicator)	-0.092	-0.334	-0.089	-0.335	-0.552**	-0.335	-0.581**	-0.335
Lis Pendens Filed before Modification		0.022	-0.109*	0.019	-0.109*	0.026	-0.110*	0.019	-0.110*
Has a Junior Lien on the Property		-0.005		0.001		-0.003		-0.001	
Has a Junior Lien at the Time of Modification			-0.005		-0.005		-0.005		-0.005
LTV at Origination			0.827***		0.826***		0.825***		0.825***
	(missing LTV at origination indicator)		0.182		0.181		0.182		0.182
Current LTV [REF: <80%]									
	80-100%	0.016		0.008		0.006		0.007	
	100-120%	0.011		-0.000		-0.010		-0.006	
	>120%	0.047		0.038		0.022		0.028	
	(missing LTV indicator)	0.838***		0.820***		0.815***		0.811***	

log (Current Unpaid Balance)		0.105***		0.107***		0.103**		0.104***	
log (Unpaid Balance at the Time of Modification)			-0.166**		-0.166**		-0.166**		-0.166**
Loan Age		-0.001		-0.003		-0.004		-0.004	
Loan Age at the Time of Modification			0.085***		0.085***		0.085***		0.085***
Time since Modification		0.025***		0.019***		0.022***		0.019***	
Borrower and Property Characteristics									
Owner Occupier		-0.043	0.342***	-0.044	0.342***	-0.042	0.342***	-0.043	0.342***
FICO Score at Origination			0.000		0.000		0.000		0.000
	(missing FICO score at origination indicator)		1.180**		1.179**		1.177**		1.178**
Current FICO Score [REF: <560]									
	560-620	-0.228***		-0.231***		-0.230***		-0.232***	
	620-650	-0.398***		-0.406***		-0.402***		-0.407***	
	650-680	-0.402***		-0.413***		-0.404***		-0.410***	
	680-720	-0.662***		-0.675***		-0.664***		-0.675***	
	>=720	-0.730***		-0.746***		-0.736***		-0.740***	
	(missing current FICO score)	-0.305***		-0.297***		-0.307***		-0.301***	
FICO Score Decline between Origination and Modification		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(missing FICO score decline indicator)	-0.028	-1.116***	-0.031	-1.115***	-0.031	-1.114***	-0.033	-1.115***
Debt-to-Income Ratios before Modification									
	Front-End Ratio X (Front-End Ratio <= 0.31)		0.027***		0.027***		0.027***		0.027***
	Front-End Ratio X (Front-End Ratio > 0.31)		0.006***		0.006***		0.006***		0.006***
	(missing Front-End Ratio indicator)		-1.124***		-1.124***		-1.124***		-1.124***
	Back-End Ratio		0.007***		0.007***		0.007***		0.007***
	(missing Back-End Ratio indicator)		1.237***		1.238***		1.238***		1.238***
	(Front-End Ratio > Back-End Ratio) indicator		-0.428***		-0.428***		-0.428***		-0.428***
Borrower Race/Ethnicity [REF: Non-Hispanic White]									
	Non-Hispanic Black	0.063	-0.015	0.057	-0.015	0.066	-0.014	0.061	-0.014
	Non-Hispanic Asian	-0.039	0.097	-0.024	0.097	-0.023	0.096	-0.018	0.096
	Non-Hispanic Other	-0.126	-0.102	-0.137	-0.102	-0.128	-0.102	-0.136	-0.102
	Hispanic	0.028	0.140	0.023	0.140	0.028	0.140	0.024	0.140
	(missing race/ethnicity)	0.060	0.056	0.054	0.057	0.061	0.057	0.058	0.057
Received Foreclosure Counseling before Modification		-0.017	0.101	-0.021	0.100	-0.016	0.100	-0.019	0.100
Neighborhood Characteristics									
HP Appreciation between Origination and Modification (%)			-0.009***		-0.009***		-0.009***		-0.009***
House Price Appreciation (%)		0.109		0.119		0.110		0.115	
Recent Foreclosure Rate before Modification (%)			1.448		1.445		1.440		1.441
	(missing recent foreclosure rate before mod indica		-0.576*		-0.575*		-0.575*		-0.575*

Recent Foreclosure Rate [REF:<1]									
	1-2%	0.017		0.017		0.019		0.018	
	2-3%	0.032		0.032		0.036		0.034	
	>3%	-0.010		-0.004		-0.003		-0.003	
Neighborhood Racial Composition [REF: 0-20%]									
% Non-Hispanic Black	20-40%	0.027	-0.045	0.027	-0.044	0.026	-0.044	0.024	-0.044
	40-60%	0.090*	-0.020	0.092*	-0.020	0.091*	-0.020	0.090*	-0.020
	60-80%	-0.003	-0.141	-0.006	-0.141	-0.002	-0.141	-0.006	-0.141
	>80%	0.036	-0.254***	0.040	-0.254***	0.040	-0.254***	0.039	-0.254***
% Hispanic	20-40%	-0.013	-0.135*	-0.003	-0.135*	-0.011	-0.135*	-0.006	-0.135*
	>40%	-0.006	-0.144	0.003	-0.144	-0.001	-0.144	0.002	-0.144
% Non-Hispanic Asian	20-40%	-0.004	-0.012	-0.011	-0.012	-0.004	-0.012	-0.008	-0.012
	>40%	-0.174	0.170	-0.187	0.170	-0.208	0.170	-0.206	0.170
% Foreign Born [REF: 0-20%]									
	20-40%	-0.007	0.001	-0.000	0.001	-0.010	0.001	-0.002	0.001
	40-60%	-0.046	0.042	-0.042	0.042	-0.048	0.042	-0.042	0.042
	>60%	-0.002	-0.061	0.010	-0.061	0.009	-0.061	0.014	-0.061
Median Household Income (1999) [REF: $40,000-60,000]									
	$0-20,000	-0.129**	-0.437***	-0.133**	-0.438***	-0.126**	-0.438***	-0.128**	-0.438***
	$20,000-40,000	-0.011	-0.012	-0.012	-0.012	-0.005	-0.012	-0.006	-0.012
	>$60,000	-0.017	0.225***	-0.032	0.225***	-0.027	0.225***	-0.033	0.225***
Unemployment Rate at the Time of Modification (%)			8.114***		8.115***		8.114***		8.115***
Unemployment Rate (%)		0.011*		0.009		0.009		0.008	
Origination year [REF: 2004]									
	2005	0.113	1.077***	0.110	1.077***	0.113	1.077***	0.112	1.077***
	2006	0.122	2.330***	0.108	2.331***	0.105	2.331***	0.103	2.331***
	2007	0.129	3.565***	0.105	3.565***	0.093	3.565***	0.087	3.565***
	2008	0.109	4.566***	0.065	4.567***	0.026	4.567***	0.026	4.567***
Borough [REF: Queens]									
	Manhattan	0.036	-1.092***	0.019	-1.092***	0.027	-1.092***	0.019	-1.092***
	Bronx	-0.037	-0.071	-0.045	-0.071	-0.044	-0.071	-0.045	-0.071
	Brooklyn	0.045	-0.036	0.037	-0.036	0.036	-0.036	0.035	-0.036
Quarter of Loan Performance [REF: 2010 - 4]									
	2008 - 1	0.453		0.175		0.318		0.212	
	2008 - 2	0.289*		0.055		0.115		0.027	
	2008 - 3	0.505***		0.272*		0.337**		0.247*	
	2008 - 4	0.631***		0.398***		0.478***		0.383***	
	2009 - 1	0.692***		0.490***		0.563***		0.475***	
	2009 - 2	0.445***		0.288***		0.335***		0.271***	
	2009 - 3	0.532***		0.409***		0.449***		0.397***	

2009 - 4	0.434***	0.343***	0.371***	0.332***
2010 - 1	0.238***	0.177***	0.201***	0.172***
2010 - 2	0.113**	0.075	0.092*	0.071
2010 - 3	0.112***	0.094**	0.104**	0.094**
Servicer fixed effects included				
Constant	-3.718*** -8.371***	-3.405*** -8.371***	-3.386*** -8.369***	-3.292*** -8.370***
Log-likelihood	-18724.64	-18675.561	-18688.074	-18668.871
rho	0.051	0.036	0.021	0.025
Wald test of rho=0 (Prob > chi2)	0.241	0.415	0.643	0.576
N	42380	42380	42380	42380

Notes:

*** denotes results that are statistically significant at the 1 percent level; ** denotes results that are statistically significant at the 5 percentlevel; * denotes results that are statistically significant at the 10 percent level.