FHFA Working Papers

Working Paper 11-1

The HAMP NPV Model: Development and Early Performance[1]

The foreclosure crisis that began in 2008 triggered the need for new approaches to treat distressed mortgages. A key component of the Obama Administration's Home Affordable Modification Program (HAMP) was the development of a standardized Net Present Value (NPV) model to identify troubled loans that were value-enhancing candidates for payment-reducing modifications. This paper discusses the development of the HAMP NPV model, its purpose, and some important constraints that dictated its structure and limitations. We describe the structure and the estimation of the model in detail. Furthermore, we describe the responsiveness of the model to key characteristics, such as loan to value and credit score and provide new evidence on the relationship between HAMP modification performance and key borrower and modification characteristics. The paper concludes with a discussion of model limitations and suggestions for further refinement of the model.

Steve Holden
Fannie Mae

Therese Scharlemann
U.S. Department of the Treasury

Austin Kelly
Federal Housing Finance Agency

Ryan Singer
Federal Deposit Insurance Corporation

Douglas McManus
Freddie Mac

John D. Worth
National Credit Union Administration

Authors' Note: The Home Affordable Modification Program (HAMP) is arguably the federal government's most important intervention into housing markets to encourage loan modifications for distressed homeowners. The creation and rollout of the Net Present Value (NPV) model was a critical innovation in HAMP and has played an important role in the program. James Berkovec played an important role in developing the first version of the NPV, directing the development of the default model and offering substantial leadership and guidance throughout the process.

[1] We would like to thank Richard Green, Jenney Shen, Binzi Shu and two anonymous referees for helpful comments. Patty Koscinski and Sameem Siddiqui provided excellent research assistance. The authors also thank participants in the WEAI conference for comments. The views expressed in this paper do not necessarily reflect the views of Fannie Mae, Freddie Mac, FHFA, U.S. Dept. of the Treasury, FDIC or NCUA.

The first decade of the 21st century was as tumultuous for the housing sector as any in recent history. A sharp increase in housing-market activity, marked by a dramatic acceleration in home prices and new mortgage originations, was followed by a bust, during which delinquencies soared and housing prices plummeted. The housing bust was marked by a nearly unprecedented increase in mortgage delinquencies and foreclosures; in the first quarter of 2010 the Mortgage Bankers Association's national delinquency survey experienced the highest ever rates of delinquency in the series' history. The spike in defaults and decline in home values resulting in the collapse of non-prime MBS values was one of the chief proximate causes of the financial crisis.

The federal government took a number of extraordinary actions to address the crisis, including a series of efforts aimed at foreclosure avoidance. The largest of these efforts was the Home Affordable Modification Program (HAMP), launched in early 2009 using funding from the Troubled Asset Relief Program (TARP). As of the first quarter of 2011, HAMP had initiated over 1.5 million trial modifications and made permanent over 670,000 modifications. Over one hundred servicers accounting for about 80 percent of outstanding residential mortgage debt being serviced signed up to participate in HAMP.

HAMP was designed to facilitate bulk processing of loan modifications by requiring and subsidizing a specific streamlined modification structure, which could be evaluated by a single, batch-process decision-making framework. Most pooling and servicing agreements require servicers to increase the value of cash flows to investors. In the context of modifications this can be interpreted as a requirement for present value improving modifications. HAMP was therefore designed to provide both a decision-making framework to neutrally assess the value of a specific modification structure and subsidies for mortgage investors to increase the value of modified loans.

HAMP emphasized bulk processing and a streamlined modification structure because at the beginning of the foreclosure crisis large mortgage servicers were unprepared for the overwhelming volumes of seriously delinquent loans and had minimal infrastructure for evaluating these loans for loss mitigation. The design of HAMP also reflects the understanding that in many cases loan modifications that would be value-improving for investors relative to foreclosure were not being identified and executed as a result of obstacles within the existing market structure.[2] In HAMP, value-enhancing modifications are identified using the Net Present Value (NPV) model. The NPV Model compares the expected discounted cash flows associated with the modification of a loan – considering probabilities of default – under two scenarios: the loan is modified according to HAMP terms and the loan is not modified (hereafter referred to as "mod" and "no-mod"). A loan that is NPV "positive" – where the value of the probability-weighted mod cash flows exceed the value of the probability-weighted no-mod cash flows – is considered to be a good candidate for modification. Testing modifications for positive NPV generally eliminates borrowers who are very unlikely to be foreclosed upon or who have substantial positive equity, because in both cases the mortgagee or lien-holder is unlikely to suffer meaningful losses in the no-mod case. The NPV test also eliminates borrowers for whom a modification does not meaningfully reduce their prospects of foreclosure. In these cases the costs of the modification in terms of reduced cash flows are not balanced by a reduced probability of foreclosure.

This paper provides a review of the development, mechanics, and operation of the HAMP NPV model, introduces initial measures of the performance of the model, and offers a view of future challenges to the evaluation of modifications[3]. The paper is organized as follows. Section I discusses the HAMP program design. Section II describes the development of the NPV model, Section III discusses the workings of the NPV model, Section IV provides simulation and empirical results that provide insight into the model outcomes. Section V discusses limitations of the model, describes future challenges and opportunities, and concludes.

I. HAMP Program Design

[2] See Cordell et al. (2008) for a discussion of institutional barriers to loan modification and Foote et al. (2009) and Adelino et al. (2009) discuss economic barriers to loan modification.
[3] The authors represent the working group tasked with development and enhancement of the NPV evaluation tool. The tool was designed to implement the administration's HAMP policy. A discussion of the policy choices that influenced the design of the NPV model is beyond the scope of this paper.

HAMP facilitates rapid, objective evaluation of loan modifications by providing a batch decision-making tool (the NPV model) and a standardized modification structure. The program provides subsidies for servicers to conduct modifications, potentially ameliorating a recognized misalignment in financial incentives in servicing contracts (see Cordell et al. (2008)). The program also increases the value of modifications to investors with the addition of subsidies to mortgage investors.

The program includes outreach and solicitation requirements to ensure fair and consistent treatment of all borrowers and helps to establish industry best practices in an area where few rules existed. Participating servicers must solicit all borrowers who become 60 or more days delinquent for a HAMP modification, and they are required to evaluate every eligible loan using the standardized modification terms and the standardized net present value (NPV) test.[4] The servicer is required to offer the homeowner a modification in cases where the proposed modification is NPV positive.[5]

a. The HAMP Modification

The HAMP modification is structured to achieve a first-lien mortgage-debt-service to income (hereafter "front-end DTI") target of 31 percent. For an otherwise eligible modification to qualify for HAMP subsidies, the borrower's monthly payments of principal and interest on their first lien, taxes, insurance, and homeowner association (HOA) fees must not exceed 31 percent of their gross monthly income.

The standard HAMP modification achieves the 31 percent DTI target through a uniform sequence of three steps (hereafter referred to as the modification "waterfall"). The waterfall consists of: (1) a rate reduction to as low as 2 percent; (2) if necessary, a term extension up to 40 years; and (3) as necessary, principal forbearance. The rate reduction remains in place for the first 5 years of the program. Following the fifth year, the borrower's interest rate rises by one percentage point each year until it reaches the Freddie Mac Primary Mortgage Market Survey (PMMS) rate for 30-year fixed-rate mortgages that was in effect at

[4] In addition, the HAMP program can modify borrowers who servicers determine to be at risk of imminent risk of default even if they are current or only 30-day delinquent on their mortgage.
[5] Fannie Mae and Freddie Mac require modification if the NPV exceeds negative $5,000.

the time the modification was underwritten.[6] Principal forbearance remains in place for the duration of the loan, taking the form of a zero-coupon balloon payment due at maturity or when the mortgage is paid off.

b. HAMP Incentives

HAMP directly subsidizes all parties involved in the modification.[7] The owner of the modified mortgage receives one-half the amount necessary to bring the mortgage payment from 38 DTI (or the current DTI, if lower) to the target DTI of 31 percent for the first five years of the program. Furthermore, the lien-holder will receive a $1500 payment for modifying current borrowers who are at imminent risk of default[8] and may receive a home price decline protection payment.[9] Servicers receive $1000 when a loan modification completes its trial plan, fulfills its documentation requirements, and becomes permanent; if the modification continues to perform, the servicer is eligible for an additional $1000 on each of the first three anniversaries of the modification as well as additional incentives for modifying imminent default borrowers. Homeowners are eligible for up to five one-time payments toward principal reduction equal to $1000 each year if they make their payments on time.

II. Practical Considerations in NPV Model Development

Policymakers understood that a framework for systematic, consistent evaluation of the cash flows associated with modifications was crucial for facilitating a broad modification program. An NPV tool ensures a basic degree of consistency across servicers, provides protection for investors, and mitigates some moral hazard concerns. As HAMP was designed, an inter-agency team was created to build the NPV tool. This team – comprised of staff from the Department of Treasury, Federal Housing Finance Agency, Housing and Urban Development, the Federal Reserve Board, the Federal Deposit Insurance Corporation,

---

[6] Information on the PMMS rate can be found at www.freddiemac.com/pmms/.
[7] For non-GSE mortgages, subsidies are financed by Treasury using Troubled Asset Relief Program (TARP) funds. The GSEs do not receive investor subsidies from TARP, and pay performance subsidies to borrowers from their own resources. However, when GSEs apply the NPV test, they calculate the NPV using the standard model, in effect acting as if they received TARP subsidies for performing the modifications.
[8] Borrower must successfully complete trial payments.
[9] Details of the home price protection payment are provided in section III.

Fannie Mae and Freddie Mac – was charged with quickly developing and implementing a model. The development team faced several challenges and constraints in designing the model, which shaped the final product in important ways.

a. Rapid Processing and Integration with Servicer Operations

The NPV team was tasked with being both as accurate as possible for the widest variety of mortgages and servicers and sufficiently simple so that the model could be integrated into servicer protocols. It was critical that the model used only information that was being collected and documented to verify borrower eligibility and monthly payments or was otherwise readily available to servicers. These constraints limited the ability to capture some elements that would ideally be included in a comprehensive view of default and prepayment probabilities.

The default and prepayment probability models reflect these input constraints. Both models use inputs from a short list of sources: first-lien balance and delinquency information readily available from servicers' databases, income information collected from the borrower for the purpose of identifying the appropriate payment level, the first-lien loan-to-value (LTV) ratio, and the borrower's and coborrower's FICO scores[10]. A more complete view of the loan's history and viability – including information on second liens, other financial obligations, and original underwriting documentation – is not consistently available for all borrowers. Credit information can often, but not always, yield some insight into other liens and financial obligations, but auditable algorithms would be required to standardize treatment of ambiguous lien information or optional monthly payments (e.g. payments on credit card debts). Ultimately, the NPV team and HAMP program designers determined that the process changes were operationally burdensome in the context of the program, and that these additional information requirements introduced documentation and validation risks that would differentially impact borrowers based on the composition of their mortgage and non-mortgage debt.

[10] The first-lien LTV, updated for any changes to the principal balance of the mortgage or estimated value of the house, will be referred to as mark-to-market LTV (MTMLTV) to distinguish it from origination LTV.

b. Limited Relevant Historical Data

The NPV development team had little direct information or experience from which to parameterize the components of the NPV model. Historical mortgage industry data is of limited use in calibrating default and prepayment behavior generated by HAMP modifications, both because the HAMP modification is structurally different from modifications that preceded the program and because loan-level datasets are not sufficiently seasoned to capture historical periods with high default rates or widespread negative equity for the types of mortgages that were predominant among seriously delinquent loans. There was scant experience with modifications that resulted in substantial payment reductions. Prior to HAMP, most large servicers and the GSEs relied on capitalization of arrearages and short-term forbearance, neither of which resulted in meaningful payment reductions, as their primary approach for dealing with seriously delinquent loans (OCC 2009). These loss-mitigation strategies were adequate to deal with delinquency stemming from brief periods of income interruption, but generally servicers did not have adequate tools for handling long-term affordability problems or serious negative equity.[11]

The NPV team used performance data from a variety of sources to set key parameters such as default responsiveness to MTMLTV, FICO, and pre- and post-modification DTI. The most difficult and critical task was to determine the change in default probabilities generated by changes in DTI. This was an analytically challenging problem in part because loan level datasets do not include updated income information and because of measurement issues with this variable.

III. Conceptual Framework of the Net Present Value (NPV) Model

The role of the HAMP NPV model is to assess whether or not a loan modification (and associated subsidy payments) will be beneficial from the investor's perspective.[12] A

---

[11] See Capone (1996), for a history of loan workouts from the 1940's to the 1990's and Ghent (2011) for an analysis of loan workouts in the 1930's. Cutts and Green (2005) document the reduction of default rates through traditional modification. Comeau and Cordell (1998) describe Freddie Mac's development of automated loan modification tools. Swagel (2009) describes post-financial crisis, pre-HAMP mortgage foreclosure avoidance policy development from a U.S. Treasury perspective.

[12] For an academic study of the trade-offs in modification see Ambrose and Capone (1996)

modification is 'NPV positive' when the total discounted value of expected cash flows for the modified loan is higher than those for the unmodified loan. This section lays out the framework and key concepts of the NPV model currently in use (NPV Version 4.0). A full discussion of the parameterization of the model and the data used for model calibration is available on the program's administrative website[13].

The HAMP NPV model uses a simple framework to evaluate four static paths: the modified loan cures, the modified loan redefaults, the unmodified loan cures, and the unmodified loan proceeds through the foreclosure process. For ease of communication these paths will be referred to as "Mod Cure," "Mod Default," "No Mod Cure" and "No Mod Default." The present value of cash-flows in each of the two paths associated with the modified loan (mod cure, mod default) are weighted by the path probabilities to obtain a present value of the modified loan. The present values of the two paths associated with the non-modified loan are similarly weighed. The Net Present Value is the difference between the probability-weighted cash flows in the mod and no-mod scenarios. Figure 1 illustrates this simple framework.

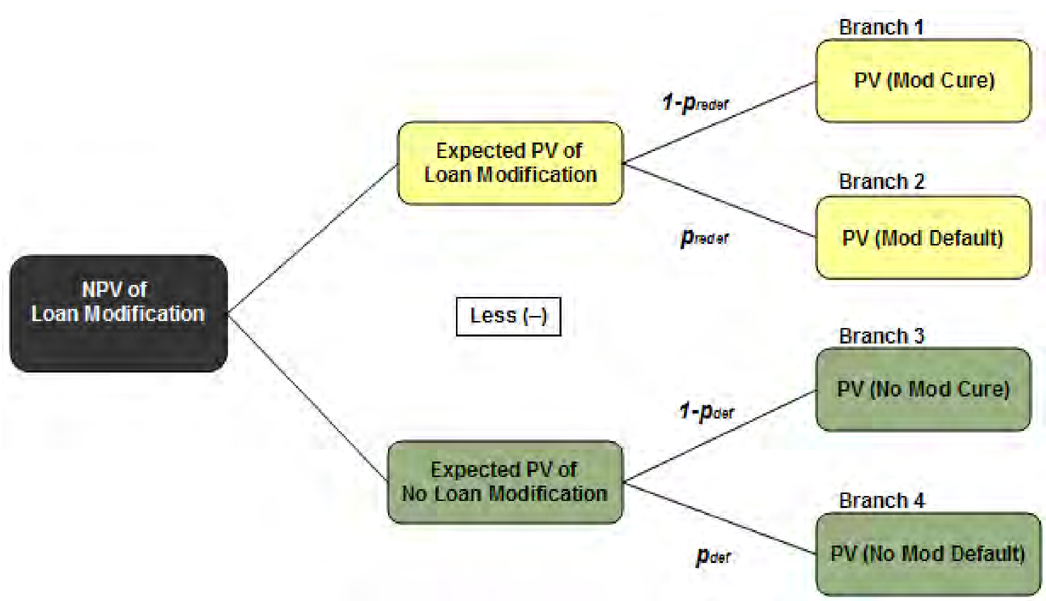


Figure 1: Structure of NPV Model

[13] http://www.hmpadmin.com, in the "servicer documents" section of the website

The next section evaluates each of the separate components of the model: the discount rate, the default model, the prepayment model, cure cash flows (branches 1 and 3 of Figure 1), and default cash flows (branches 2 and 4).

a. The Discount Rate

Discounting is performed at a rate appropriate for mortgage cash flows. The baseline discount rate is the Freddie Mac PMMS weekly rate for 30-year fixed-rate conforming loans. Servicers can override the baseline discount rate for private-label loans or loans in their portfolio by adding a risk premium of no more than 250 basis points to the PMMS weekly rate.

b. The Default Model

The default model is based on a logistic regression framework, and is therefore nonlinear in its inputs. The variables determining default probability are the MTMLTV of the first-lien mortgage, the borrower's current credit score, the borrower's DTI before the modification, and the delinquency status of the loan.[14] An additional term reflects the payment relief generated by the reduction in DTI: in the "no-mod" case it is set to zero and in the "mod" case it is the percentage change in DTI granted by the modification.

For the standard HAMP modification, which changes the borrower's monthly payment but does not change the principal balance, the difference between the default probabilities in the mod and no-mod scenarios is generated entirely by the change in the borrower's DTI. Where principal write down is used, the modification reduces both the MTMLTV of the loan and the borrower's DTI. In this case, the reduction in the default probability reflects both a lowered LTV ratio and a reduced mortgage payment.

Consistent with intuition, predicted default rates increase with MTMLTV and starting DTI and decrease with FICO scores. The model specifies a linear spline in the MTMLTV levels which allows kinks in the slope of the MTMLTV curve at the knot points located at 100 and

[14] DTI refers to the front-end ratio. Front-end DTI is the ratio of principal, interest, taxes, insurance (including homeowners' insurance and hazard and flood insurance), and homeowners' association and/or condominium fees (PITIA) to gross monthly income. Private mortgage insurance is excluded from the PITIA calculation.

120 LTV.[15] The benefit of the spline is that it allows a better representation of the default behavior for high LTV loans.

Predicted redefault rates are generally decreasing with starting DTI but can increase at very high DTI levels. An increase in starting DTI increases the borrower's risk of default, but the borrower also receives a greater reduction in monthly payments, which reduces the chance of redefault. Over low DTI ranges, the stabilizing feature of the payment reduction outweighs the influence of the starting DTI, and redefault probability declines in DTI. At very high starting DTI levels, the redefault probability suggested by the high initial DTI outweighs the stabilizing influence of the payment reduction, and overall redefault probability increases.

The model coefficients are calibrated to observed default rates for a broad loan population using data selected from HAMP modifications, Fannie Mae and Freddie Mac seasoned loans, ABS/MBS data from First American CoreLogic, and other data It is not a purely empirical specification as there are very limited data on modifications with HAMP-like contract terms. As the mortgage market gains experience with relevant modifications, the model will be increasingly empirically grounded.

c. The Prepayment Model

In contrast to the default model, which allocates default probabilities to a single point in time, the prepayment model calculates a prepayment probability for each month of the loan's scheduled amortization period. The model is estimated using a logistic regression model on a sample of GSE delinquent loans. The model is identical for loans in the mod and no-mod scenarios, though the inputs reflect the characteristics of the loan along each path. The key inputs of the model include delinquency level, refinancing incentive (effective spread to the PMMS rate), MTMLTV, previous 12-months' house price growth rate, current FICO, and the original loan amount. Separate models are estimated for each loan delinquency status.

d. Cash Flows in Default (Figure 1: Branches 2 and 4)

[15] Operationally, a linear spline with knot point, k, adds a variable into the regression of the form: max[0,MTMLTV – k].

The model utilizes a simplified approach to the timing of default. In the non-modification scenario (branch 4), the model assumes that if the loan defaults, it defaults immediately and makes no further payments. In the modification scenario (branch 2), the model assumes that the loan defaults 6 months after beginning the modified loan payments. The immediate default in the no-mod scenario reflects the fact that loans entering the program are generally either already quite delinquent or deemed by the servicer to be severely distressed and in imminent default. The 6-month timeline for redefault in the mod scenario reflects the observed median time to redefault, conditional on eventually defaulting.

Once the loan defaults, it is assumed to proceed to foreclosure according to state-level foreclosure timelines, adjusting for the number of months the loan is delinquent at the time of evaluation for HAMP.[16]

In default the cash flow consists of proceeds minus costs: the REO net property disposition value minus taxes, insurance, and homeowners' association fees. All disposition-related cash flows are assumed to occur on the date of REO sale. These include state-varying foreclosure costs and REO disposition costs, mortgage insurance proceeds, and state-varying net REO sales proceeds (estimated using the current property value and a state-varying REO discount). Thus the present value of the cash flows in the case of a loan default is:

$$PV\{LoanDefaults\} = \sum_{j=1}^{S}\left[\frac{-C}{(1+\delta)^j}\right] + \frac{NPDV}{(1+\delta)^S}$$

where: C is taxes and insurance and homeowners' association fees, δ is the monthly discount rate; S the time until REO sale, and NPDV is the net property disposition value[17]. The determination of the NPDV effectively embeds a simple severity model into the cash-flow structure.

For the modified loan along the default path, the cash flows also include incentive payments paid by the government to the investor during the 6-month period that the loan performs.

[16] The foreclosure timelines are derived from Freddie Mac and Fannie Mae foreclosure data.
[17] NPDV includes all other costs advanced by the servicer and borne by the investor. For simplicity, the timing of such payments occur at REO disposition.

e. Cure Cash Flows (Figure 1: Branches 1 and 3)

The mod and no-mod cure scenarios are evaluated using the same basic framework. Each month, the cash flows are estimated to be: (1) the scheduled principal and interest payment, weighted by the probability the loan will not prepay in that period and (2) the remaining unpaid principal balance (UPB) of the loan, weighted by the probability that the loan will prepay in that month.

Hence, the basic framework for both branches 1 and 3 in Figure 1 is:

$$PV\{LoanCures\} = \sum_{i=1}^{T} \frac{1}{(1+\delta)^i} \left\{ [\mathrm{UPB}_{i\text{-}1} - \mathrm{P}_i][\prod_{k=1}^{i\text{-}1}(1-\mathrm{SMM}_k) - \prod_{k=1}^{i}(1-\mathrm{SMM}_k)] + [\mathrm{P}_i + \mathrm{I}_i]\prod_{k=1}^{i\text{-}1}(1-\mathrm{SMM}_k) \right\} + MDLQ(P_0 + I_0)$$

where: MDLQ = Months delinquent, T = Remaining term, δ = Monthly discount rate, UPB = Unpaid principal balance, P = Principal , I = Interest, and SMM_k = Single month mortality (for prepayment) in month *k.*

Unmodified loans that cure (branch 3) may have an arrearage that also must be accounted for. Here we make the simplifying assumption that the principal and interest arrearage is paid immediately which is reflected in the MDLQ ($P_0 + I_0$) term in the present value formula. For the Mod scenario (branch 1), the cash flows reflect the three types of incentives paid to the investor and the cash-flow implications of the borrower incentives. These incentives offset some of the reduction in cash flows resulting from the modified loan terms. Servicer incentives are not included in the investor's cash-flows and have no direct impact on the NPV model. The incentives included in the cash-flows are:

(1) Payment Reduction Cost Share: 50% of the cost of lowering monthly payments from a level consistent with a 38% DTI to that consistent with the target DTI of 31%, for up to five years. *For example, a borrower with an income of $1,000 per month and a housing payment (first lien mortgage, taxes, insurance, HOA dues) of $400 per month would start with a front-end DTI of 40%. The investor would first reduce the mortgage payment by $20 per month to get the DTI to 38%, then reduce the payment*

again by $70 per month to get the DTI to 31%, and Treasury would compensate the investor for half of the $70, or $35 per month.

(2) Imminent Default Modification Incentive: If the borrower is current at the beginning of the trial period (i.e., determined by the servicer to be in imminent default) *and* current at the end of the trial period, the investor will be paid $1,500 by the HAMP.

(3) Borrower Pay-for-Performance Incentive: Borrowers who make timely monthly payments are eligible to accrue up to $1,000 of reduction in principal each year for five years. These payments are advanced immediately to the investor as principal curtailment. Because these payments are credited to the borrower through reduced principal, they alter the loan to value ratio and therefore have an impact on prepayment and loss severities.[18]

(4) Home Price Decline Protection Incentive (HPDP): HPDP is an investor incentive to offset some of the investors' risk of loss exposure due to near-term negative momentum in the local market home prices. The HPDP incentive payments are calculated based upon the following three characteristics of the mortgage loan receiving a HAMP modification:

(i) An estimate of the cumulative projected home price decline over the next year, as measured by changes in the home price index over the previous two quarters in the applicable local market (MSA or non-MSA region) in which the related mortgaged property is located;

(ii) The UPB of the mortgage loan prior to modification under HAMP; and

(iii) The MTMLTV of the mortgage loan based on the UPB of the mortgage loan prior to modification under HAMP.

IV. NPV Performance

[18] The pay-for-performance incentives are not reflected in the default model because, as noted, modification redefault is assumed to occur six-months after modification, prior to the accrual of any pay-for performance incentives.

The NPV model compares the expected cash flows of a loan and its corresponding HAMP modification. For a modification to generate an NPV positive result, the cost of the modification – the reduction in the expected value of scheduled mortgage payments relative to the unmodified loan terms, adjusted for prepayment timing and government subsidies – must be recovered by an increase in the probability of avoiding a costly foreclosure. Grossly oversimplified, the reduction in the default probability caused by the modification, times the expected loss if there is a default, must exceed the cost (net of government subsidies) of providing the modification. As section III described in depth, the NPV model consists of three separate, interacting models: the default probability model, the prepay probability model, and the discounted cash-flow model. This section briefly discusses the intuition and key concepts in each of the separate models and follows with some illustrative comparative statics exercises.

a. NPV Performance General Discussion: Key Concepts

Default Model – Key Concepts

It is important to emphasize that value within the NPV model is primarily generated by the change in the default probability resulting from the modification rather than the level of the default probability of the modified loan. Holding constant the change in cash flows, a modification that reduces the default probability by 30 percentage points, from 90 percent to 60 percent, generates more value than a modification that lowers the default probability by 5 percent, from 20 percent to 15 percent, though the latter modification has a much lower default probability. An NPV-improving modification might have high-expected re-default rates; therefore a high default probability does not indicate that the investor is made worse through modification.[19]

Prepayment Model – Key Concepts

The prepayment model dictates when the borrower will voluntarily prepay the remaining principal balance of the loan. The value of receiving that money at a given time – relative to

[19] The initial level of default probability influences the modification value indirectly, in that it determines the extent to which a payment reduction translates into a reduction in default probability in the logistic specification.

receiving the amortizing payments – depends on the coupon rate of the loan relative to the investor's discount rate. Increasing the rate of prepayment lowers the value of a loan with a coupon higher than the discount rate (because it shortens the time a premium over the market rate is earned) and increases the value of a loan with a coupon lower than the discount rate (because it allows the released funds to be reinvested at a higher interest rate).

Discounted Cash Flow Model – Key Concepts

The cash flow model in the case where the loan performs is a straightforward amortization of the loan according to the terms. However, the default branches of the cash flows – in both the mod and no-mod scenarios – introduce regional variation in foreclosure costs with impacts worth discussing.

The NPV model includes state-level REO sales discounts and foreclosure timelines because (1) the legal fees and administrative costs associated with foreclosing on a property, (2) the length of time to complete a foreclosure transaction, and (3) the amount below the estimated home value a foreclosed property is likely to receive in an REO sale are all expected to vary geographically, based on state foreclosure laws and other factors. Combined with MSA-level home price projections, these parameters determine the value the investor receives upon foreclosure of the home, which forms a crucial threshold in the NPV model. If the loan balance is below this amount – less a small cushion reflecting the government subsidies to the investor – the NPV test almost never delivers a positive result. When the present value of the home in foreclosure less associated costs exceeds the remaining loan balance, an improvement in the default probability from the no-mod to the mod scenario is highly unlikely to recover the loss in cash flows to the investor from modification, and the modification is therefore almost always NPV negative.

b. <u>Key Variables and Comparative Statics – the Operation of the Model</u>

The NPV test is nonlinear in most of its inputs, which makes the influence of specific inputs difficult to directly characterize. To provide some intuition for the behavior of the model under various conditions, we present both an analysis of the NPV accept decisions and a series of comparative static exercises.

The analysis of NPV accept decisions is based on a sample of 69,625 loan submissions to the NPV model after October 1, 2010.[20] In this sample, 92.9% of the submissions passed the NPV test. Loans are determined to pass the NPV test if the NPV value is greater than $0 or in the case of Freddie Mac or Fannie Mae loans greater than negative $5000. Table 1 shows the distribution of NPV test pass rates stratified by key variables and Table 2 shows the results of a logistic regression on NPV outcome using the same data.

Not surprisingly given the different thresholds for an NPV pass, loans guaranteed by Freddie Mac or Fannie Mae pass at a higher rate than loans on portfolio or serviced on behalf of an investor (95.6% GSE/ 89.2% non-GSE) and the indicator variable for GSE loans has a positive and significant coefficient in the logistic regression results. In the same vein, a higher discount rate applied to long-term cash flows tends to result in lower pass rates, because loan modifications extend the period over which cash flows are received. The discount premium (which is applicable only to loans not guaranteed by Freddie Mac or Fannie Mae and allows the discount rate to be increased between 0 and 2.5%) and higher PMMS rates are associated with lower pass rates and have negative coefficients in the logistic regression.

Characteristics associated with higher expected default rates are correlated with higher NPV pass rates. Loans are at higher risk of default as they become more delinquent; loans classified as 90+ days delinquent pass at a higher rate than less delinquent loans. Current and 30-days delinquent loans are eligible for a HAMP modification only if they are determined to be at imminent risk of default. In the NPV model, these loans are treated as though they are 60-89 days delinquent in order to reflect the imminent default determination.[21]

---

[20] Servicers could access the NPV model either through coding the model into their systems or using the NPV transaction portal maintained by the US Treasury Department. These data were taken from loans submitted to the portal and evaluated using the V4 NPV model. The data was also subject to some reasonableness data edits and restricted to HAMP eligible loans.

[21] Perhaps surprisingly, the pass rate for imminent default loans is slightly higher than for loans that are 60-89 days delinquent (91.1% versus 88.8%) and this higher pass rate is also reflected in the logistic regression results. This result reflects other characteristics of imminent default borrowers and the additional investor subsidies offered these loans.

The MTMLTV parameter estimated in the logistic regression is positive – suggesting that in general a higher MTMLTV results in a higher probability of an NPV pass. However, the relationship of MTMLTV to pass rates described in Table 1 is non-monotonic. Lower FICO scores are associated with a higher probability of an NPV pass, but the degree to which this relationship holds varies with MTMLTV.

Loans that require greater financial concessions tend to have lower pass rates. This is most clearly seen in the principal forbearance results in Table 1 and Table 2. Loans requiring great amounts of principal forbearance are less likely to be NPV positive. Similarly, the logistic regression results indicate that loans with higher initial front-end DTI levels have a lower probability of an NPV pass; however Table 1 shows that pass rates are not monotonically decreasing as DTI rises, which we explore in more detail in the comparative statics exercises.

Some of the costs associated with default (including some of the foreclosure and disposition costs) are large and fixed, and so investor losses in foreclosure as a percentage of UPB tend to be larger for lower UPB homes. Similarly, as a proportion of UPB both the investor incentives for imminent default loans and the borrower incentives will be larger for lower UPB homes. This motivates why lower loan balance loans (UPB Before Mod) are associated with higher pass rates

Table 1. NPV Pass Rates by Loan Attribute

	NPV Pass (>=-5k for GSE)		Total	
	Count	Percent	Count	Percent
GSE Flag				
Non-GSE	26,732	89.2%	29,954	43.0%
GSE	37,927	95.6%	39,671	57.0%
Imminent Default Flag				
Imminent Default	11,253	91.1%	12,350	17.7%
60-89 days past due	6,167	88.8%	6,948	10.0%
90+ days past due	47,239	93.9%	50,327	72.3%
Front-end DTI				
≤ 0.35	11,543	96.4%	11,979	17.2%
(0.35,0.38]	9,204	98.0%	9,396	13.5%
(0.38,0.41]	8,249	96.1%	8,586	12.3%
(0.41,0.45]	9,273	94.8%	9,784	14.1%
(0.45,0.50]	9,059	93.0%	9,737	14.0%
(0.50,0.55]	6,364	91.7%	6,940	10.0%
> 0.55	10,967	83.1%	13,203	19.0%
Mark-to-market LTV				
≤ .60	3,684	80.3%	4,585	6.6%
(.60,.80]	6,292	81.2%	7,745	11.1%
(.80,1.00]	13,227	92.2%	14,339	20.6%
(1.00,1.20]	14,553	96.5%	15,078	21.7%
(1.20,1.40]	9,962	96.4%	10,333	14.8%
(1.40,1.60]	6,224	97.2%	6,402	9.2%
(1.60,1.80]	3,933	96.5%	4,074	5.9%
(1.80,2.00]	2,551	96.6%	2,642	3.8%
> 2.00	4,233	95.6%	4,427	6.4%
FICO				
≤ 540	22,997	93.4%	24,623	35.4%
(540, 600]	19,708	93.3%	21,122	30.3%
(600,675]	13,956	92.6%	15,068	21.6%
> 675	7,998	90.8%	8,812	12.7%
UPB Before Mod				
≤ 100,000	9,937	94.6%	10,505	15.1%
(100,000, 200,000]	24,792	94.2%	26,307	37.8%
(200,000, 300,000]	16,007	93.6%	17,103	24.6%
> 300,000	13,923	88.6%	15,710	22.6%
Principal Forbearance Amount				
0	45,653	95.7%	47,682	68.5%
≤ 100,000	14,970	91.4%	16,374	23.5%
> 100,000	4,036	72.5%	5,569	8.0%
Freddie PMMS Rate				
<= .0425	10,076	94.0%	10,722	15.4%
(.0425,.045]	7,804	93.5%	8,343	12.0%
(.045,.0457]	12,162	93.0%	13,071	18.8%
(.0475,.05]	32,329	92.3%	35,012	50.3%
> .05	2,288	92.4%	2,477	3.6%
Discount Rate Premium				
0	62,652	93.5%	66,997	96.2%
(0,.025)	534	86.6%	616	0.9%
0.025	1,473	73.3%	2,012	2.9%
All	64,659	92.9%	69,625	100

Table 2: Logistic Regression: NPV Pass
(Standard errors in parentheses)

Variable		Estimate	
Intercept		6.3167	***
		(0.3466)	
GSE Flag		0.7629	***
		(0.0370)	
Delinquency Status			
	Imminent Default	-0.1741	***
		(0.0305)	
	60-89 days past due	-0.441	***
		(0.0318)	
	90+ days past due	0	***
Front-end DTI		-0.0399	***
		(0.0014)	
Mark-to-market LTV		0.0295	***
		(0.0006)	
FICO		-0.00115	***
		(0.0002)	
UPB Before Mod ($K)		-0.00166	***
		(0.0001)	
Principal Forbearance Amount ($k)		-0.00857	***
		(0.0003)	
Freddie PMMS Rate (bps)		-0.848911	***
		(0.0677)	
Discount Rate Premium (bps)		-0.775715	***
		(0.0260)	

Note:*** denotes coefficients that are statistically significant at a >99 percent confidence level.

Further insight into the working of the NPV model can be obtained by illustrating the change in NPV values in response to changes in loan and borrower characteristics in specific examples. For these examples, we use a hypothetical loan that is NPV positive (NPV of HAMP modification = $19,664). This baseline loan is described in Table 3. The loan is an underwater (MTMLTV = 120) fixed-rate mortgage, originated in 2008 in the Miami area. The HAMP modification for this loan includes a temporary reduction in the note rate to 2 percent, a term extension to 480 months, and forbearance of $24,840. The new re-payment terms reduce the borrower's DTI from 50 to 31 and payment from $1,274 to $592.

Table 3: Attributes of Baseline Loan

- Loan Type: 30yr Fixed Rate	- Origination Year: 2008
- Current Note Rate: 6.5%	- Current FICO: 550
- Current Income: $3,600	- Delinquency Level: 11 Months
- MSA: Miami-Fort Lauderdale-Pompano Beach	- MTMLTV: 120%
- Pre-Mod Payment: $1,274	- Post-Mod Payment: $592
- Taxes/Insurance/HOA: $524	- Pre-Mod DTI: 50%

We illustrate the NPV impact of changes to key variables, holding other variables constant. The extent to which the illustrated changes in the dollar value of the NPV test translate into NPV acceptances or rejections in the HAMP program depends upon the composition of loans evaluated for modification. Theoretically, for every dollar change illustrated, a loan exists that may be converted from NPV positive to negative. To reinforce this logical framework, we illustrate the NPV-impacts of changing individual variables in terms of the resulting changes in NPV relative to the baseline loan. The present value cash flows of the unmodified and modified loans and the net present value are set to zero for the baseline loan. The values associated with all other loan characteristics are represented as differences from the baseline values, scaled by the unpaid balance of the loan.

Mark-to-market LTV

As discussed above, MTMLTV is an important variable in determining NPV outcomes. MTMLTV is a critical input to the prepayment and default models, reducing likelihood of prepayment and increasing likelihood of default. The MTMLTV is also critical to determining losses that the note-holder will incur in the event of foreclosure (essentially whether the value of the home is sufficient to pay off the first-lien unpaid balance and foreclosure costs). Figure 2 shows the impact on the baseline loan's NPV results when this loan's MTMLTV is changed, all other things equal. The illustrated change in MTMLTV reflects adjustments to the value of the home, so that the terms of the modification are not affected. For LTV ranges between 80 and around 150 the NPV of the loan increases with MTMLTV. The intuition of this result is that the cost of the modification is sufficiently high in terms of foregone income that it is profitable only when the modification sufficiently reduces the probability that the investor will face very substantial principal losses. When negative equity becomes extreme, the NPV can begin falling, because the redefault probability becomes extremely high. In the case of this hypothetical loan, NPV relative to the baseline loan falls beyond 150 MTMLTV.

Figure 2: NPV and Cash Flows Relative to Baseline: By MTMLTV

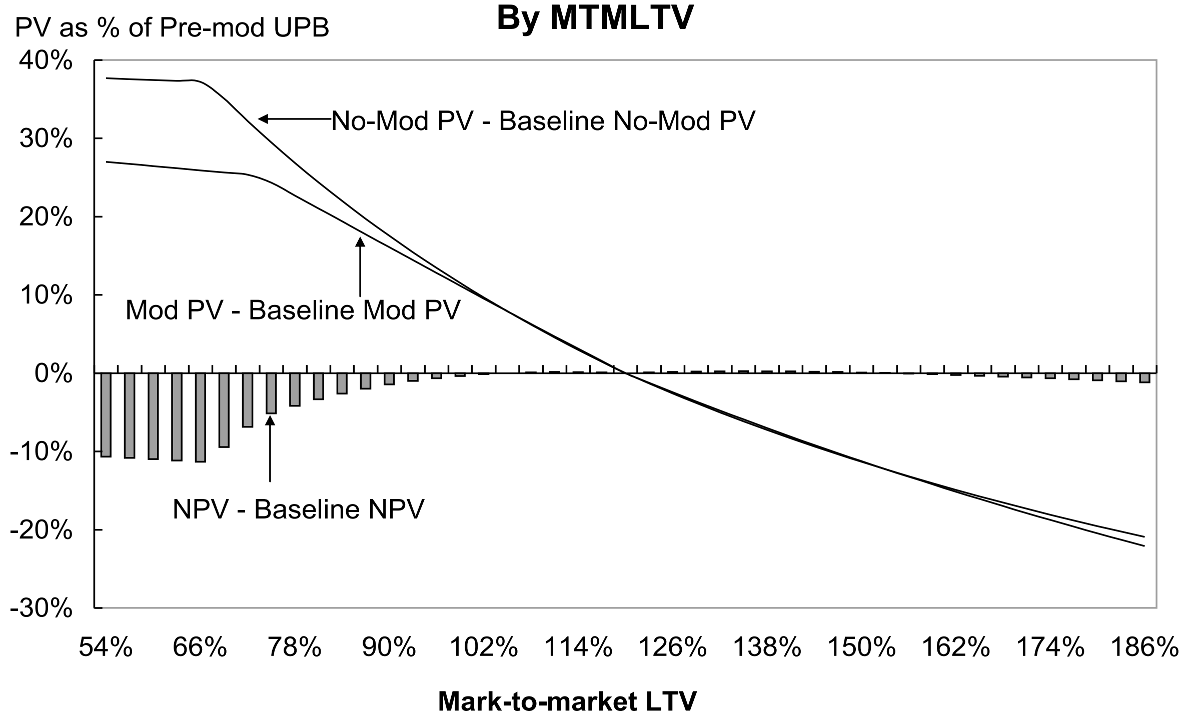
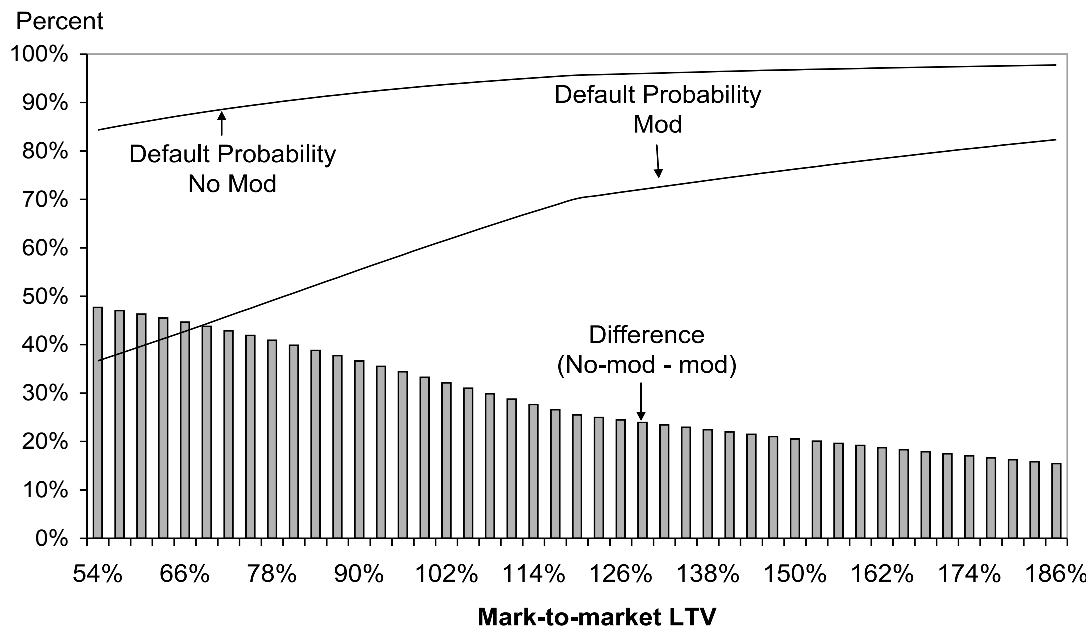


Figure 3 illustrates the role of the MTMLTV in the probability of default and redefault. Both the no-modification default and the modification redefault probabilities rise over the entire range shown. In this borrower's case, the spread between the no modification default and the modification redefault narrows over the entire range of MTMLTVs. In other cases, the spread increases over lower ranges of MTMLTV and then begins to decrease at higher MTMLTVs. The general result is that the narrowing of the spread in default probabilities as MTMLTV becomes extreme accounts for the potential for a decline in the NPV values for high MTMLTV levels.

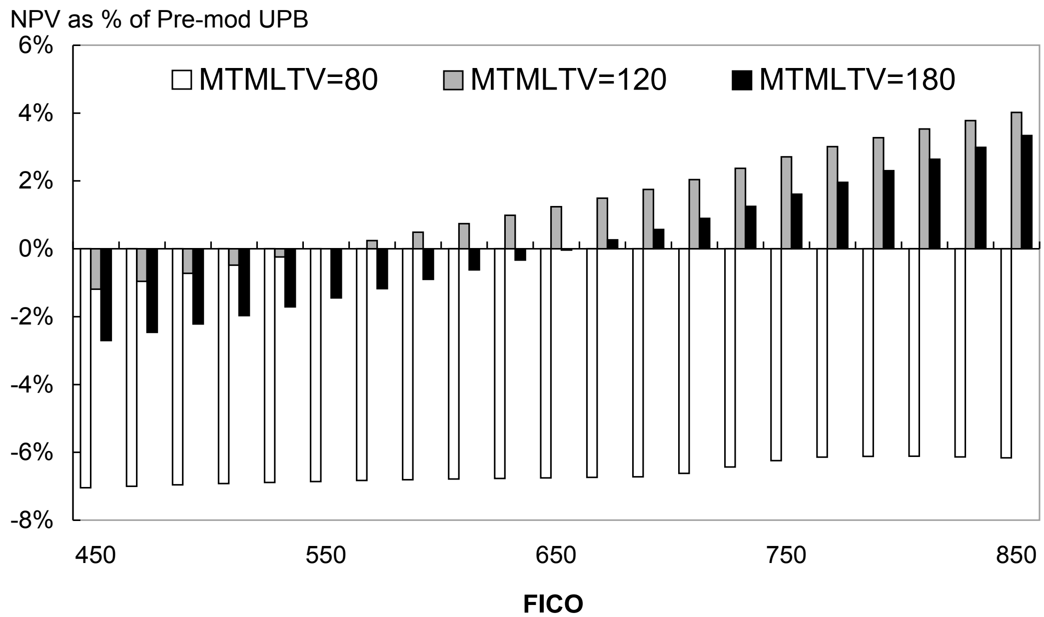
Figure 3: Default Probabilities: By MTMLTV



FICO

The impact of the borrower's credit score or FICO on her NPV outcome depends heavily on the borrower's equity position. To illustrate, Figure 4 compares NPV outcomes for the hypothetical loan (as a percentage of pre-modification UPB) across a wide range of FICO scores with three alternative MTMLTV scenarios. For borrowers with positive equity, NPV results are largely insensitive to FICO scores. As shown in figure 4, NPV remains mostly flat until around 700 and thereafter improves slightly. This is, in part, because FICO effects the NPV calculation only through the default and prepayment models. For borrowers with significant equity, losses are expected to be low and differences in default probabilities do not translate into large changes in NPV.

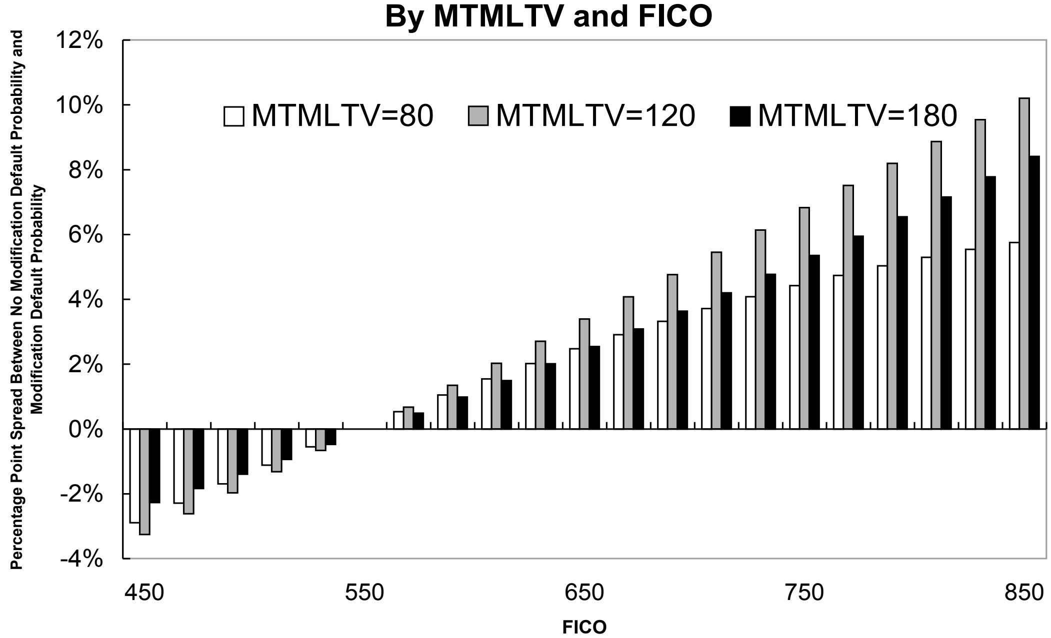
Figure 4: NPV relative to baseline: By FICO and MTMLTV



For a borrower with negative equity (MTMLTV = 120 and MTMLTV =180) the NPV is generally increasing with respect to FICO. The increase in NPV over the FICO ranges is partly driven by an increasing spread between the mod and no-mod default probabilities over that range. Figure 5 plots the difference between the no modification–modification default probability spread at the base FICO score (550) and each other FICO point for three MTMLTV scenarios (80, 120, and 180).

Figure 5 illustrates the increasing difference in the spread between the no modification and modification default probabilities as FICO rises. This increasing differential causes the NPV to increase as FICO rises, reflecting the higher probability of a successful (non-redefaulting modification). Figure 5 also shows that this effect is magnified when the borrower is in a negative equity position, but is not monotonically increasing with MTMLTV. The impact of FICO on the spread between no modification and modification default probabilities is quite different across MTMLTV categories. Between FICO=450 and 850, the spread between the no-modification and modification default probabilities increases by 8.6 percentage points for a MTMLTV=80 loan, compared to 13.5 and 10.6 percentage points respectively for MTLTV=120 and 180 loans. This illustrates why the NPV improvement across the FICO spectrum in the MTMLTV= 80 scenario is much smaller than for the MTMLTV 100 and 120 scenarios in Figure 4. The fact that the increase in the spread between the no-modification and modification default probabilities is less pronounced at MTMLTV = 180 than it is at MTMLTV = 120 reflects the fact that at very high MTMLTV levels improvements in default rates are less pronounced because very high MTMLTV borrowers are generally very likely to default.

Figure 5: Default Probability Spread Relative to Baseline: By MTMLTV and FICO



Front-end Debt-to-Income Ratio

The original front-end DTI ratio of the borrower determines the monthly payment reduction required to achieve the requisite 31 percent. Initial DTIs much greater than 31 percent require large payment reductions, and are therefore expensive modifications relative to initial DTIs close to the target. NPV generally declines with DTI above 38 percent, but in many circumstances NPV is flat or increasing at lower levels of DTI. This interesting result is driven by the dual role DTI plays in the model. Front-end DTI impacts the borrower’s default probability in both the modification and the no-modification scenarios. Borrowers with high front-end DTIs have high-predicted default rates, but a high DTI also allows for substantial stabilization through the large payment reduction required to achieve the target DTI. The increased expense of modification for high-DTI borrowers can therefore be counteracted by a substantial decline in the predicted probability of redefault. Conversely, a borrower with a starting DTI close to 31 will receive a small payment reduction that will not sufficiently impact the redefault rate and hence, the result will be a negative NPV. Figures 6 and 7 illustrate.

Figure 6: NPV and Cash Flows Relative to Baseline: By DTI

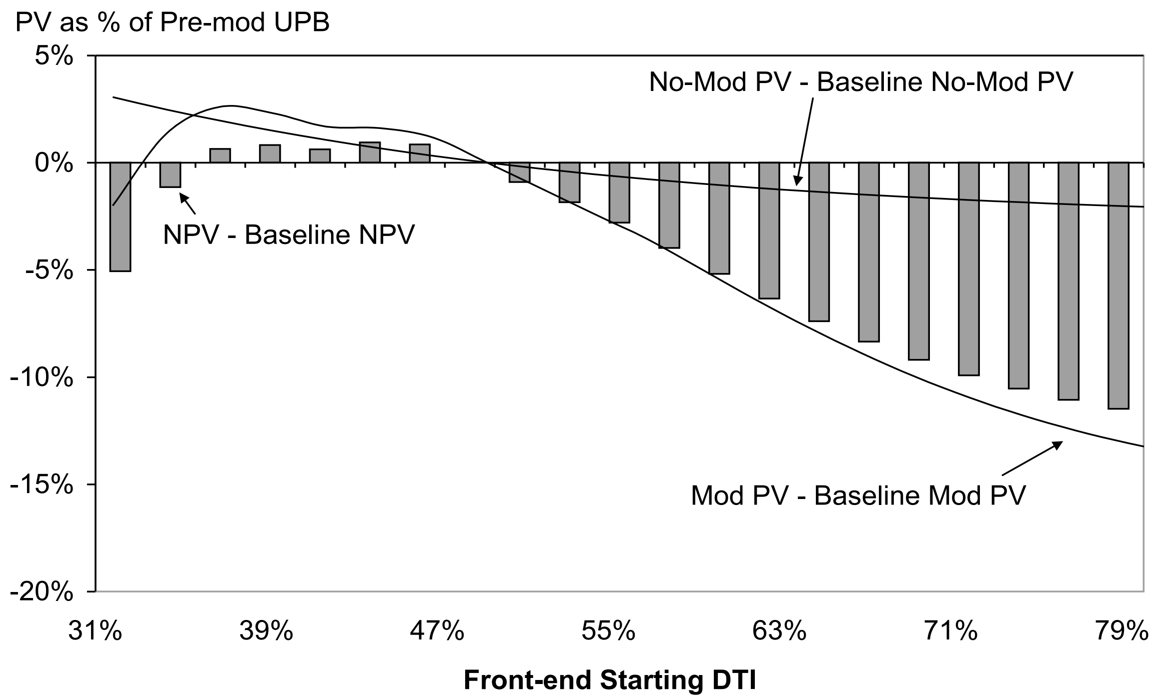
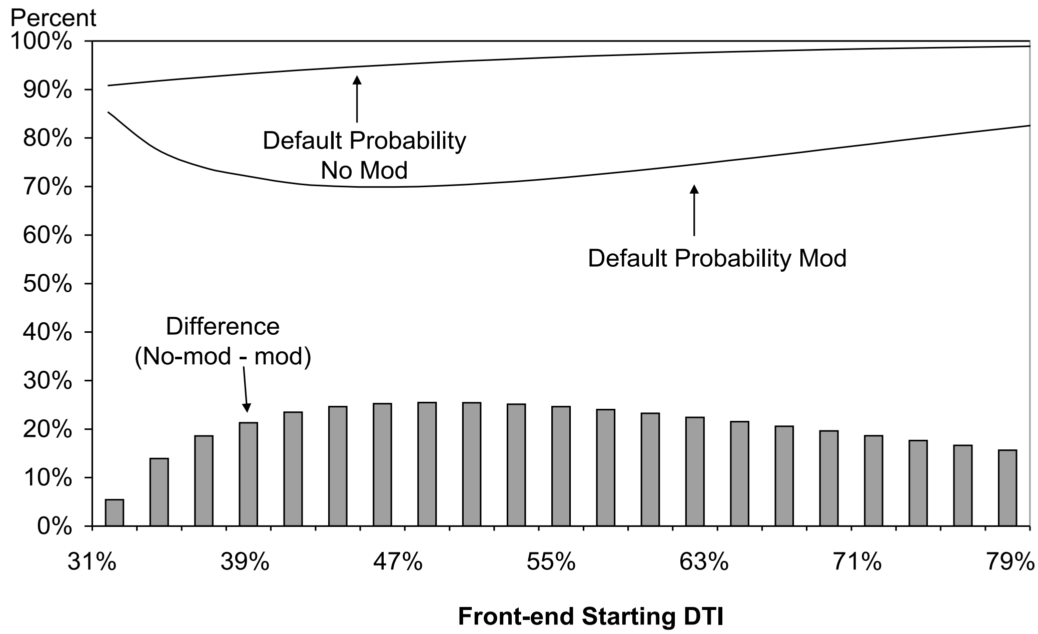


Figure 7: Default Probabilities: By DTI



Geographical Variants

The state-level variation in the REO discount values, foreclosure costs, and foreclosure timelines, along with the metropolitan statistical area (MSA)-level variation in home price expectations – partially mitigated by home price decline protection (HPDP) payments – generate significant regional variation in NPV outcomes. Figure 8 shows the NPV for the hypothetical loan in different MSAs. Table 4, provides a decomposition on the components that drive the regional variation relative to the Miami area. A number of results stand out. Areas with less negative home price trajectories are more likely to receive modifications because the cost of a delayed foreclosure in the case of redefault is higher in areas with larger projected home price declines. The Home Price Decline Protection Incentive serves to ameliorate the impact of home price forecasts on NPV outcomes and encourage more NPV positive modifications in areas with large projected home price declines.

Higher REO discount values and foreclosure costs and longer foreclosure timelines have a dramatic positive impact on the NPV of modification, because each makes the foreclosure more costly. For example, if the hypothetical base loan were located in California rather than in Florida, the shorter foreclosure timelines associated with the California market would reduce the NPV of modification by 1.13 percent of pre-modification UPB. The impact of the REO discount (or "stigma") is even more dramatic.

Figure 8: Regional Variation in NPV Relative to Baseline: By MSA

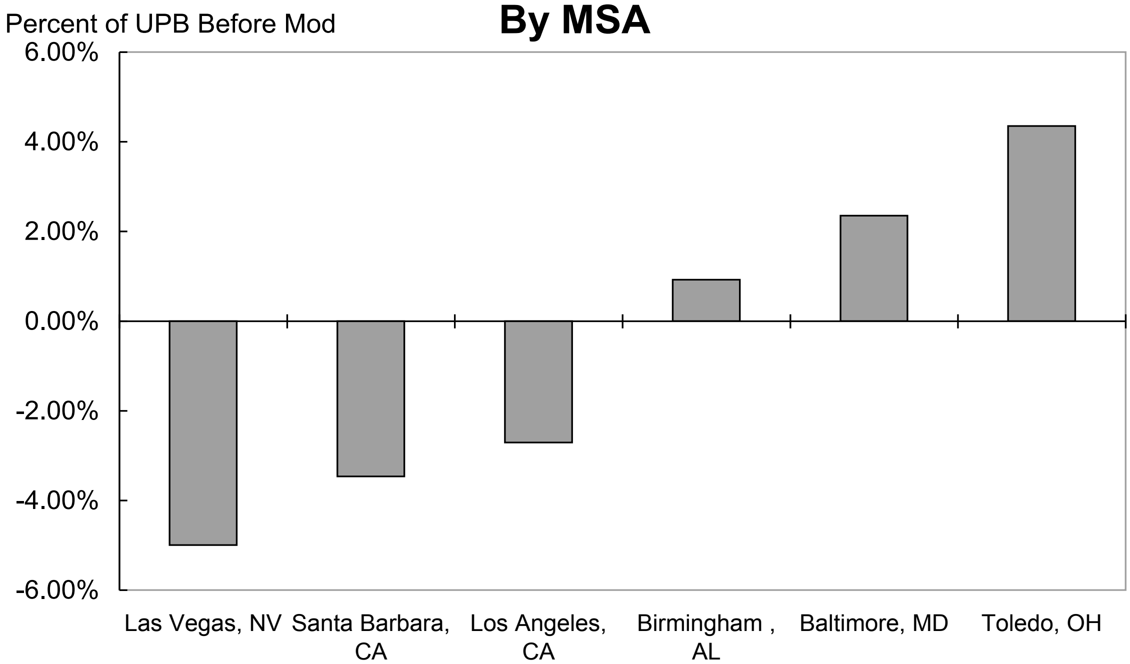


Table 4: Effect of Regional Variables on NPV by MSA (Base MSA: Miami-Fort Lauderdale-Pompano Beach, FL)

Regional Variables	Las Vegas-Paradise, NV	Santa Barbara-Santa Maria-Goleta, CA	Los Angeles-Long Beach-Santa Ana, CA	Birmingham-Hoover, AL	Baltimore-Towson, MD	Toledo, OH
	Percent of UPB Before Mod					
Projected Home Price Indices only	-0.58%	-0.55%	-0.10%	-0.44%	-0.41%	-0.98%
Foreclosure & REO Disposition Timelines & Costs only	-0.40%	-1.09%	-1.09%	0.27%	-0.48%	2.10%
REO Sale Value Parameters only	-2.85%	-1.40%	-1.40%	1.64%	3.00%	2.62%
Home Price Decline Protection Incentive only	0.08%	0.10%	0.00%	0.13%	0.05%	0.62%
All Corresponding Regional Data Intact	**-4.99%**	**-3.46%**	**-2.71%**	**0.92%**	**2.35%**	**4.35%**

c. Redefault Model Assessment

For an early assessment of the performance of the redefault model, we used a dataset constructed from HAMP administrative records consisting of 361,577 permanent HAMP modifications. These records included all modifications made permanent between August 2009 and July 2010 for which all inputs to the default model were available. Of these, 20,469 were 90 or more days delinquent six months after becoming a permanent modification, implying about a 5.7% redefault rate in 6 months[22]. We used this subset of HAMP loans to evaluate the performance of the default model to date.

Table 5 shows the distribution of loans across relevant characteristics, including initial front-end DTI, vintage, their back-end DTI, MTMLTV, FICO, months past due, and the payment change. Disqualification rates (indicating 90+ days delinquency) are also shown by loan characteristic. Note that some fields used in the regression such as the FICO score, were not required at the inception of the program and hence early modifications may be disproportionately excluded from this sample.

[22] This rate is not directly comparable to HAMP redefault rates published in the OCC and OTS Mortgage Metrics Report. The OCC/OTS report uses a 60 day delinquency rate when reporting on HAMP performance. Furthermore the report only reflects modifications from OCC and OTS regulated institutions.

Table 5. Distribution of Sample Population

	Loan Count	Share of Sample Population	Share Disqualified at 6-months (90+ days delinquent)
Front-end DTI			
≤ 0.35	44,378	12.3%	10.7%
(0.35,0.38]	43,247	12.0%	8.5%
(0.38,0.41]	43,541	12.0%	7.1%
(0.41,0.45]	53,493	14.8%	5.7%
(0.45,0.50]	55,458	15.3%	4.5%
(0.50,0.55]	41,133	11.4%	3.7%
(0.55,0.60]	28,025	7.8%	3.2%
(0.60,0.65]	18,675	5.2%	2.6%
> 0.65	33,627	9.3%	1.7%
Modification Vintage			
2009:Q3	197	0.1%	15.2%
2009:Q4	21,333	5.9%	4.5%
2010:Q1	141,045	39.0%	4.9%
2010:Q2	161,545	44.7%	6.4%
2010:Q3	37,457	10.4%	6.1%
Back-end DTI			
≤ 0.40	77,404	21.4%	6.6%
(0.40,0.50]	45,805	12.7%	6.6%
(0.50,0.60]	36,438	10.1%	6.0%
(0.60,0.70]	37,153	10.3%	6.1%
(0.70,1.00]	102,020	28.2%	5.3%
≥ 1.00	62,757	17.4%	4.0%
Mark-to-market LTV			
≤ 1.00	106,802	29.5%	4.9%
(1.00,1.20]	78,153	21.6%	5.7%
(1.20,1.40]	57,630	15.9%	5.6%
(1.40,1.60]	39,323	10.9%	5.7%
(1.60,1.80]	25,915	7.2%	6.0%
(1.80,2.00]	16,836	4.7%	6.1%
> 2.00	36,918	10.2%	7.2%
FICO			
≤ 540	139,874	38.7%	8.5%
(540, 600]	97,225	26.9%	5.5%
(600,675]	71,404	19.8%	3.2%
> 675	53,074	14.7%	1.9%
Days delinquent			
< 60	94,509	26.1%	3.2%
≥ 60	267,068	73.9%	6.5%
Payment Change			
≥ -10%	27,750	7.7%	11.4%
[-20%, -10%)	44,322	12.3%	8.9%
[-30%, -20%)	56,291	15.6%	7.3%
< -30%	233,214	64.5%	4.0%
All	361,577	100.0%	5.7%

Table 6 shows the results of a logistic regression of an indicator variable for modification disqualification (indicating 90+ day delinquency) on the covariates used in the NPV default model. We have also included an additional control for the vintage of the loan.

Table 6: Logistic Regression: 90+ Delinquency 6 months post-modification

(Standard errors in parentheses)

Variable		Estimate	
Intercept		-4.5487	***
		(0.0596)	
Front-end DTI			
	<= 0.35	2.0066	***
		(0.0449)	
	(0.35,0.38]	1.7499	***
		(0.0456)	
	(0.38,0.41]	1.551	***
		(0.0461)	
	(0.41,0.45]	1.3061	***
		(0.0461)	
	(0.45,0.50]	1.0363	***
		(0.0468)	
	(0.50,0.55]	0.8084	***
		(0.0496)	
	(0.55,0.60]	0.6391	***
		(0.0542)	
	(0.60,0.65]	0.4254	***
		(0.0624)	
	>0.65	0	
Mark-to-market LTV			
	<=1.00	-0.5976	***
		(0.0252)	
	(1.00-1.20]	-0.3615	***
		(0.0259)	
	(1.20-1.40]	-0.3164	***
		(0.0276)	
	(1.40-1.60]	-0.2592	***
		(0.0301)	
	(1.60-1.80]	-0.1863	***
		(0.0336)	
	(1.80-2.00]	-0.1629	***
		(0.0386)	
	>2.0	0	
FICO			
	<=540	1.3763	***
		(0.0344)	
	(540, 600]	0.9517	***
		(0.0358)	
	(600,675]	0.4637	***
		(0.0389)	
	>675	0	
Modification Vintage			
	2009:Q3	0.867	***
		(0.2050)	
	2009:Q4	-0.3445	***
		(0.0399)	
	2010:Q1	-0.253	***
		(0.0253)	
	2010:Q2	0.0234	
		(0.0243)	
	2010:Q3	0	
Days Delinquent			
	<60	-0.5128	***
		(0.0208)	
	>=60	0	

Note:*** denotes coefficients that are statistically significant at a >99 percent confidence level.

At this early stage, the initial performance of modified loans can provide some insight into whether the predicted relationships between the variables are qualitatively consistent with the observed drivers of redefault in the HAMP program. The results are mostly monotonic and directionally consistent with the NPV redefault model, providing support for the underlying default specification. Figure 3 above shows an increasing probability of default (after modification) as MTMLTV increases; this relationship is evident in the results. All else equal, we see a pattern of higher default probability in higher MTMLTV ranges. Similarly, as described in Figure 5, high FICOs result in lower redefault probabilities. The effect of delinquency status at time of modification shows the same basic structure as the redefault model: borrowers who have never been delinquent or came into the program just after becoming delinquent have a lower chance of redefaulting than borrowers who are two or more periods delinquent when they entered the program.

The one area where qualitative results suggest a meaningful difference between the empirical results and the structure of the redefault model is front-end DTI. Because all HAMP mods produce a DTI of 31%, the change in DTI is completely determined by the pre-mod DTI. As discussed above, the NPV redefault model is non-linear in front-end DTI (Figure 7) with redefault increasing at high pre-mod DTI levels. Instead, the early empirical evidence reported in Table 6 shows a monotonic relationship suggesting that the change in DTI dominates the starting level of DTI as a driver of default. As modifications continue to age this relationship will become clearer and the structure of the redefault models may be modified to reflect this.

It also should be emphasized the early program data will not reveal whether the redefault model is accurately predicting the level of redefault probability. The redefault model in the NPV tool assigns a predicted lifetime redefault probability, whereas the data currently available for evaluation consist of only the first several months after a modification successfully completes its trial and is made permanent. Moreover, because HAMP trials can be cancelled for reasons other than nonpayment, we can be sure a HAMP cancellation is due to nonpayment only after the modification has completed the trial payments, seasoning for at least 3 months. Finally, the limited seasoning of this sample precludes capturing the impacts of mortgage rate step-ups after the 5-year initial mod period. The predicted default levels are therefore not expected to align with the observed redefault rate at this point.

V. Concluding Thoughts: Limitations of the Model and Challenges for the Future

The HAMP NPV model was developed in recognition of the critical need for a standardized, defensible and timely mechanism for evaluating the net benefit of a loan modification. Given the many different loan types and stakeholders, a single set of default, prepay, and cash-flow assumptions cannot perfectly capture the true NPV for each mortgage investor. However, aside from these inherent limitations, the existing model has some simplifications and shortcomings that are critical to understanding what the model does and does not accomplish. They also form an agenda for future model enhancements that can be divided into three categories: improving existing behavioral assumptions, adding additional variables and introducing additional richness in model inputs.

Improving Behavioral Assumptions

The assumptions behind the default probability model and the prepayment model are likely to be the largest major source of change in model performance going forward. As shown in Section V, the early performance of HAMP modifications is directionally consistent with the assumptions in the NPV default model. As part of the development process, the parameters of the default model have been tested against the performance of more mature IndyMac modifications and found reasonable.[23] Nevertheless, the model remains far from a pure empirical specification and several information-rich datasets are emerging that will inform these assumptions.

---

[23] Prior to HAMP, the FDIC systematically modified troubled mortgages in the IndyMac Federal Bank portfolio or serviced by IndyMac using modification terms similar to those adopted in HAMP. The FDIC program targeted sustainable payments at a 38 percent DTI (later adjusted to 31 DTI) and followed a standard waterfall process that required first reducing the interest rate to as low as 3 percent and then as required to hit the target DTI, extending the amortization term up to 40 years and forbearing principal.

Additional Variables

A comprehensive measure of the borrower's financial obligations and total indebtedness in the default probability and prepayment models would undoubtedly improve the accuracy of the model. Of these concerns, the enhancements that would most impact NPV performance are a comprehensive LTV measure – including all subordinate liens – and a measure of mortgage-related back-end DTI. Where principal is used or where mortgage-related back-end DTI is changed through HAMP's companion modification program for second liens (2MP), the default model does not adequately capture the change in the default probability generated by the combined HAMP and 2MP modifications, which is critical to determining the modification's relative value. In most standard HAMP modifications, where LTV or back-end DTI are not independently altered, these omissions have a smaller impact, since the coefficients were specified using a loan population likely resembling the HAMP population in its junior lien distribution. Over time, better data may become available on borrowers' total mortgage debt burdens, if not total debt burdens.

A related issue is the treatment of principal reductions on borrower performance. Because principal forgiveness had been rare before HAMP, and consequently its impact on redefault could not independently be assessed, the NPV default model assumes that principal reductions would impact redefault rates as would equity from any other source, such as a down payment or a change in house prices. This assumption may prove faulty. Unobservable borrower characteristics are likely correlated with negative equity, especially within geographic regions, and principal reduction to 115 MTMLTV may not deliver the same performance as the 115 MTMLTV loans we currently observe. Likewise, the model assumes that payment reductions would produce identical reductions in default, no matter how the sequence of waterfall steps produces the reduced payment. The empirical question of whether, for example, a borrower responds similarly to a term extension as to a rate reduction with the same payment impact has yet to be resolved.

Model Inputs

A criticism of the NPV model could be the lack of granularity in its geographically varying inputs. Those familiar with local real estate markets often note that REO discounts and foreclosure timelines can vary dramatically by city-block. Though there are practical limitations to the granularity we can obtain consistently across regions, the observation that the model's accuracy would be improved by better capturing the local real estate market is correct. The statistical obstacles to doing so, however, are formidable, and making such changes without sufficient statistical power would introduce considerable noise to the model.

Model performance would also be improved by richer data on the time-path of redefault. When several years of performance data are available, it will be possible to revisit the assumption that all redefaults occur 6 months after the initiation of the modification. At that time, the model may be recast in various ways to capture the dynamic behavior of default. For example, as a competing risks hazard model, with a conditional default rate curve to complement the conditional prepayment rate curve.

Path forward

The HAMP program was developed in recognition of the need for a standardized process for the evaluation and modification of at-risk homeowners. The NPV model has played an important role toward that end. HAMP has changed the landscape of loan modifications – encouraging the use of payment reducing modifications for borrowers with serious affordability issues. Similarly, HAMP has encouraged the systematic evaluation of borrowers using well-documented, defensible models. Going forward, we expect that NPV evaluation will remain part of the standard servicing toolkit and that NPV modeling will continue to improve as the results of HAMP and other modification experiences improve our understanding of the behavior of at-risk homeowners and information systems broaden the scope and richness of feasible inputs. Ultimately widespread use of well -specified NPV models will result in fewer missed opportunities for value-enhancing modifications, fewer non-value-enhancing modifications, and better outcomes for investors, homeowners, and servicers. This may be one of the enduring legacies of HAMP.

Appendix: Additional HAMP Features

Investor restrictions on permissible modification structures take precedence over the HAMP modification, so individual borrowers may have modification terms that are somewhat different than the standard HAMP modification. Aside from investor restrictions, servicers are allowed discretion only in the use of principal reduction, which they may introduce at any stage of the waterfall.

In addition, as of October 1, 2010, servicers are required to evaluate borrowers with substantial negative equity, e.g., LTV greater than 115 percent, using an alternative waterfall that includes as its first step a principal write-down to 115 LTV. This principal reduction is phased over 3 years, so that a borrower who remains successful for the first three years of the modification gets one-third of the principal reduction at the end of each year. The borrower also receives the value of the write-down upon prepayment, either through refinance or through sale of the home. The investor receives an extra subsidy for principal write-down offered with this 3-year phased structure, but principal reduction is not required, regardless of whether it appears NPV-improving relative to the HAMP modification.

HAMP directs additional subsidies toward preventive modifications. Both servicers and investors are eligible for additional compensation for modifying at-risk current borrowers, or borrowers in “imminent default”. This incentive encourages servicers to proactively evaluate their servicing portfolios for imminently distressed loans and compensates the investor for the inevitable “Type II” errors resulting from pre-emptive modification: some loans will be modified that may not have ultimately defaulted.

Investors are also eligible for additional subsidies in areas with recent price declines. A source of risk in modifying a delinquent loan in an area where prices continue to appear unstable is that redefault restarts the foreclosure timeline and lowers the investor's recovery in foreclosure by the intervening price depreciation. The risk of further price depreciation increases the appeal of an immediate foreclosure. The Home Price Depreciation payment compensates investors directly for this risk. The size of the payment reflects the unpaid principal balance and LTV of the loans and the MSA's recent price declines.

All of these incentives have a pay-for-success structure. The incentive payments continue only for as long as the borrower remains in an active, performing modification.

Servicer implementations of the NPV model are subject to a compliance regime to ensure that both the model logic and their input definitions were consistent with the Treasury-supported web-based model used by smaller servicers. The compliance process evolved considerably and eventually the entire modification pipeline fell under the NPV compliance agents' purview, including input management, data logic, output management, and data submission. Ultimately, the NPV model has been the most thoroughly monitored component of the HAMP program.

References

Adelino, M., K. Gerardi, and P.S. Willen. 2009. Why Don't Lenders Renegotiate More Home Mortgages? Redefaults, Self-Cures, and Securitization. *Federal Reserve Bank of Boston Public Policy Discussion Papers*.

Ambrose, B.W. and C.A. Capone. 1996. Cost-Benefit of Single-Family Foreclosure Alternatives. *Journal of Real Estate Finance and Economics*, Vol. 13 No. 2.

Capone, C. A.. 1996. *Providing Alternatives to Mortgage Forclosure: A Report to Congress.* Retrieved from U.S. Department of Housing and Urban Development: http://www.huduser.org/Publications/pdf/alt.pdf

Comeau, P., and L. Cordell. 1998. Case Study: Beating The Odds: Loss Mitigation Scores Helped Wells Fargo Save Resources, Assist Borrowers In Avoiding Foreclosure. *Servicing Management* .

Cordell, L., K. Dynan, A. Lehnert, N. Liang, and E. Mauskopf. 2008. The Incentives of Mortgage Servicers: Myths and Realities. *Finance and Economics Discussion Series.* Retrieved from the Federal Reserve Board: http://www.federalreserve.gov/pubs/feds/2008/200846/revision/200846pap.pdf

Cutts, A.C. and R.K. Green. 2005. Innovative Servicing Technology: Smart Enough To Keep People In Their Houses? In N. Retsinas and E. Belsky editors, *Building Assets, Building Credit: Creating Wealth In Low-Income Communities*, pp. 348–377. Washington, DC: The Brookings Institution Press.

Foote, C., K. Gerardi, L. Goette, and P. Willen. 2010. Reducing Foreclosures: No easy Answers. In *NBER Macroeconomics Annual 2009, Volume 24*, edited by Daron Acemoglu, Kenneth Rogoff, and Michael Woodford, University of Chicago Press Journals.

Frame, S.W. 2010. Estimating the Effect of Mortgage Foreclosures on Nearby Property Values: A Critical Review of the Literature. Unpublished manuscript. www.chicagofed.org/digital_assets/others/in_focus/foreclosure_resource_center/more_frame_externalities.pdf

Ghent, A. C.(2011) Securitization and Mortgage Renegotiation: Evidence from the Great Depression. Manuscript, Baruch College/CUNY http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1754142

Lin, Z., E. Rosenblatt, and V.W. Yao. 2009. Spillover Effects of Foreclosures on Neighborhood Property Values. *Journal of Real Estate Finance and Economics, 38* (4).

Office of the Comptroller of the Currency, Office of Thrift Supervision. 2009. *OCC and OTS Mortgage Metrics Report: First Quarter 2009*. Washington: Government Printing Office.

Swagel, P. 2009. The Financial Crisis: An Inside View. In D. Romer and J. Wolfers editors, *Brookings Papers on Economic Activity* Washington, DC: The Brookings Institution Press