

Does Junior Inherit?

Refinancing and the Blocking Power of Second Mortgages¹

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ABSTRACT

In most states, the law grants seniority to the oldest mortgage on a house, unless that mortgagee subordinates its claim. We show that this practice significantly impedes the refinancing of first mortgages by imparting blocking power to junior mortgagees. We identify the effect by building a database showing all mortgages of a large panel of homeowners, identifying those whose combined loan-to-value makes them candidates for refinancing their first mortgages, and contrasting the incidence of refinancing between the states following this standard and the states following an alternate standard by which a mortgage inherits the seniority of the mortgage it replaces, if the replacement does not impair junior claims.

JEL: D12, G18, H73, K11

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1. Introduction

Homeowners across the U.S. could benefit greatly from reducing their debt service. Low rates make refinancing a major source of potential relief, but to convert this potential a homeowner must overcome several obstacles. How many obstacles depends on how many mortgages she has: all homeowners must satisfy income, collateral and creditworthiness requirements, but those with multiple mortgages must also negotiate legal barriers specific to refinancing. Because many homeowners have multiple mortgages, these barriers can pose a significant economy-wide threat, and because the barriers vary across states, we can identify their impact in the variation of refinancing across states. This impact is the subject of this paper.

Second mortgages are widespread. As of March 2012, 23.5% of homes with a mortgage had more than one; as of December 2008 it was 36%.¹ In these cases, the mortgages' relative seniority is generally by age. The mortgage taken out first is the most senior, followed by the next mortgage taken out, and so on. This principle, which we label *time priority*, is convenient and easy to follow, but it has a potentially perverse effect on refinancing the first of multiple mortgages. This is because a replacement is newer than, and so by this principle junior to, mortgages that the original first mortgage was senior to. The originally junior mortgagees can waive this windfall of seniority with *subordination agreements*, i.e., documents affirming their subordination to the replacement mortgage, but they don't have to. Thus, in a refinancing situation, a second mortgagee can wield blocking power over the mortgagor.

We can identify the effect of the blocking power through its variation across states. This is because a subset of states follows a legal principle known as *equitable subrogation* that targets and largely eliminates the perverse effect. Subrogation is the inheritance by a new creditor of the seniority of the creditor it paid off; equitable subrogation provides that this inheritance occurs

¹ Federal Reserve Bank of New York/Equifax Consumer Credit Panel.

when the new mortgage does not disadvantage junior mortgagees, relative to the old mortgage. So if the new mortgage has principal and interest no higher, and maturity no shorter, than the mortgage it extinguished, then it enjoys the old mortgage's seniority, despite the violation of time priority. If the new mortgage, relative to the old, impairs the junior mortgagee on one of these dimensions, then it enjoys seniority to an extent equivalent to that of the old. By eliminating the second mortgagee's role in refinancings that do not disadvantage it, equitable subrogation removes its blocking power, which means we can observe the effect of this power in the contrast in refinancings between those in states that have adopted this principle and those in states sticking with time priority.²

Whether a refinancing is exposed to this blocking power depends not only on local state law but also on the mortgagor's remaining home equity, reflected in the home's combined loan-to-value ratio (CLTV). If the CLTV is low enough, then the mortgagor can refinance all mortgages at once, thereby avoiding bargaining by extinguishing all bargainers' claims. If the CLTV is high enough, then refinancing any mortgage is unlikely. It is in the middle region where refinancing the first of multiple mortgages arises and, therefore, where the second's bargaining power matters. Consequently, the identification is a triple difference: the difference across states of the difference between medium-CLTV refinancings and low- or high-CLTV refinancings of mortgages that either are or are not senior to second mortgages.

To run this identification, we assemble a database of recent mortgages, starting with 3.9 million mortgages originated between 2003 and 2007 from the LPS Mortgage Dataset. We associate them with junior liens by matching them to credit bureau data, and we keep our CLTV estimates current by updating house prices with zip-code-level indices. Our database of state

² We are grateful to Dale Whitman for assembling and providing the database showing the variation of the legal environment across states.

laws is current as of September 2008, so we focus on refinancing in 2009. This is a period of significant financial distress, which introduces other issues into refinancing, so to focus on the effect of the legal environment, we limit our sample to mortgagors who were current on all mortgages as of December 2008. In addition, as can be seen from Figure 1, mortgage rates dropped dramatically at the end of 2008, which spurred a wave of refinancing.³

Our main finding is that the legal environment significantly affects refinancing: in states which eliminate the second mortgagee's blocking power, homeowners in the middle range of CLTV refinance significantly more often. There is little or no effect when CLTV is too high or low, and the difference in the middle range is not only statistically but economically significant: overall, the refinancing rate among middle-CLTV homeowners was 12% in 2009, but among those in the friendly legal environment it was 10% higher, at 13.3%.

The rest of this paper is in five sections. In Section 2 we survey the related legal and economic literature, in Section 3 we describe the data, in Section 4 we develop an illustrative theoretical model to motivate the analysis, in section 5 we describe the empirical testing strategy and discuss its results, and in Section 6 we summarize and conclude.

2. Background and Literature

Junior mortgages figure heavily in both pre-crisis borrowing and in subsequent distress. There is an accordingly large and growing literature on the role of junior mortgagees in the resolution of distress. The focus of this literature is not on refinancings that potentially alter seniority, but rather on modifications that preserve seniority while forgiving principal. The main concern this literature addresses is the weak incentive of junior mortgagees to forgive and the

³ The refinancing originations are from the HMDA data, and the mortgage rates are the 30-year mortgage rates from the FHLMC primary mortgage market survey.

resulting difficulty reducing prohibitive indebtedness. Relevant studies include Agarwal et al. (2011), Cordell et al (2008), Goodman (2011), and Mayer et al. (2009).

The principle of time priority that we focus on is summarized in this passage from Schmudde (2004):

“The first mortgage on a property, being the first recorded, has first priority. All later recorded mortgages applying to a single property are called “junior” mortgages. The basic rule of mortgage priority is that it is set by the time of recording. Earlier recording grants earlier priority. This can only be changed when a mortgagee who has earlier recorded agrees to subordinate her interest.”⁴

The problem arising from this principle is that it ties a potentially deal-breaking wealth transfer to a run-of-the-mill refinancing. If a borrower refinances the senior of two mortgages, the replacement mortgage is newer than the old junior mortgage, making the old junior mortgage now the senior one. So this principle hands the old junior mortgage a large transfer from the entering mortgage without regard to whether the entering mortgage would make the old junior mortgage better off, even without this transfer, which it presumably would if it simply lowered the first mortgage’s coupon.

Countervailing the time-priority principle is the principle of equitable subrogation, also known as legal subrogation. It is articulated in §7.6(a) of American Law Institute (1997):

One who fully performs an obligation of another, secured by a mortgage, becomes by subrogation the owner of the obligation and the mortgage to the extent necessary to prevent unjust enrichment. Even though the performance would otherwise discharge the obligation and the mortgage, they are preserved and the mortgage retains its priority in the hands of the subrogee.⁵

⁴ Schmudde (2004), p. 113.

⁵ American Law Institute (1997), p. 508.

By this principle, which is explicated in depth in Nelson and Whitman (2006), Yoo (2011), and Been, Howell and Willis (2012), the refinancing mortgage inherits the refinanced mortgage's seniority, with or without subordination agreements from any intervening liens, provided the replacement of the old mortgage with the new does not disadvantage the lienholders.

The principle of equitable subrogation is not automatically incorporated into the laws of individual states. The state legislatures and judiciaries choose whether to incorporate it. An example of a state that chooses not to is Minnesota. This is spelled out in, for example, an Appeals Court decision filed July 26, 2005:

Jurisdictions around the country have adopted three different approaches in determining whether to apply equitable subrogation under circumstances in which a third party holds a lien on the property at the time the second lender pays off the former encumbrance. The first approach reasons that actual knowledge of an existing lien precludes the application of equitable subrogation, but constructive knowledge does not. *See, e.g., Osterman v. Baber*, 714 N.E.2d 735, 739 (Ind. Ct. App. 1999). The second approach bars the application of equitable subrogation when the party seeking subrogation possesses either actual or constructive notice of an existing lien. *See, e.g., Harms v. Burt*, 40 P.3d 329, 332 (Kan. Ct. App. 2002).

The third approach, adopted by the Restatement, disregards actual or constructive notice and concentrates on whether the junior lienholder will be prejudiced by subrogation. *See* Restatement (Third) of Property: Mortgages § 7.6 (1997). Under the Restatement, a mortgagee will be subrogated when it pays the entire loan of another as long as the mortgagee "was promised repayment and reasonably expected to receive a security interest in the real estate with the priority of the mortgage being discharged, and if subrogation will not materially prejudice the holders of intervening interests in the real estate." *Id.*

Minnesota has adopted the second approach (actual or constructive notice of an existing lien bars equitable subrogation) with the added criterion that when a sophisticated party – such as a professional lender – is seeking subrogation, it will be held to a higher standard for the purpose of determining whether it has acted under a justifiable or excusable mistake of fact in failing to duly investigate prior liens.⁶

⁶ State of Minnesota in Court of Appeals A04-1962, available online at: <http://www.lawlibrary.state.mn.us/archive/ctappub/0507/opa041962-0726.htm>.

In the language of the court, actual notice of a lien means a lender actually knew of it, whereas constructive notice means the lien was properly and promptly registered, so the lender could have known about it. So in Minnesota, a refinancing lender does not inherit the seniority of the refinanced mortgage with respect to an intervening mortgage he knew or could have known about, unless the holder of the intervening lien agrees.

The complete distribution of relevant state law, as of September 17, 2008, is reported in Table 1. In this table, “Restatement” indicates that the state courts have effectively adopted the principal of equitable subrogation as spelled out in the Restatement (American Law Institute (1997)), excerpted above. As the table indicates, states that have not adopted the Restatement wholesale exhibit various nuances in the positions they do take. In our empirical tests we do not attempt to capture these nuances; instead we simply contrast the Restatement states with the others. We denote the Restatement states as having “easy” subrogation laws, and the other states as “not easy.”⁷ The geographic distribution of these states is presented as Figure 2, which shows them to be widely dispersed across the country.

The empirical question we address is whether the blocking power imparted to the second lienholders by the absence of equitable subrogation reduces the incidence of refinancing. It is worth noting that this reduction could occur several ways. It could result from frictions when second lienholders with limited information bargain for rents. For example, a lender unable to distinguish between the various borrowers asking for subordination might make them all the same take-it-or-leave-it offer, which some would leave. Similarly, lenders or borrowers with some information might yet overplay their hands. Alternatively, failure could result from borrowers struggling to contact or even identify their current lenders or from lenders being willing but unable to subordinate due to contractual restrictions or complications, perhaps arising

⁷ We include the District of Columbia as an easy subrogation state, but our results are robust to this coding.

from securitization agreements. A servicer might also simply have too much paperwork or other time-consuming labor to pay it the proper attention. So it is some combination of these and related hazards peculiar to states without equitable subrogation that we hypothesize to reduce the incidence of refinancing.

3. Data Description

The dataset consists of mortgages originated between 2003 and 2007, from the LPS Mortgage Dataset. The LPS dataset consists of mortgages serviced by most of the top ten servicers and covers about two-thirds of all mortgages currently outstanding or originated in recent years. Approximately four million of these loans were matched to the Federal Reserve Bank of New York/ Equifax Consumer Credit Panel, a database of consumer credit bureau records, based on loan characteristics at origination. The matching procedure is described in more detail in Elul et al. (2010). The importance of this matching for evaluating the effect of equitable subrogation laws is that it provides information on other (second) mortgages held by the same borrower because these mortgages appear in bureau records.

From the LPS data, we obtain first-mortgage characteristics such as origination FICO score, interest rate, LTV ratio, etc. We calculated updated CLTVs as of 12/08 using the most current balances on the mortgages and the Corelogic zip code level house price index. From the consumer credit bureau data, we obtain the borrower's updated Equifax risk score and information about second mortgage balances. The second mortgages include both closed-end seconds and revolving home-equity lines.

For those mortgages that terminate (55% of the sample), we use the bureau data to determine whether this termination took place through a refinancing.⁸ A terminated mortgage is identified as a refinancing if the borrower did not move in a one-year window spanning the mortgage termination date (based on the address in credit bureau records) *and* a new mortgage account appears in the bureau data with an opening date that is within three months of the mortgage termination date.⁹ For our final sample, approximately one-half of all terminations are identified as refinancings, which is consistent with the findings of Clapp et al. (2001).

We restrict the sample to those residences that had active and non-delinquent first mortgages as of December 2008 (and if a second mortgage exists, it must also be current). In order to create a more uniform dataset, we also restrict attention to prime, owner-occupied conventional first mortgages, with balances greater than \$100,000, and to “primary” Equifax panel members (for whom data are available in every quarter).¹⁰ Table 2 summarizes the matched database along a number of dimensions. It also provides the same statistics for a random sample of mortgages from the LPS data that were not matched to the FRBNY/Equifax data, to help gauge whether the matching procedure biases the sample in any way.

The comparison between mortgage refinancings in easy and not-easy states drives the identification in the empirical tests. To document how the mortgages themselves compare, Table 3 separates the matched sample into easy vs. not-easy states and reports the mortgage characteristics in each.

⁸ Haughwout et al (2011) use a similar procedure to identify refinancings.

⁹ The new mortgage must further have a balance that is at least 90% that of the old mortgage just before termination; we also allow the refinancing mortgage to be a second mortgage in case the legal environment affects how the bureaus code the mortgages. We tested this algorithm out-of-sample on mortgage originations in LPS (for which there is a refinancing flag) and found that it identifies approximately 80% of all refinancings at origination. Conversely, we correctly identify about 75% of all purchase loans at origination.

¹⁰ See Lee and van der Klaauw (2010) for further detail on the FRBNY/Equifax Consumer Credit Panel.

4. An Illustrative Model of Refinancing

We now present a simple model to illustrate how the effect of subrogation law varies across CLTV regions. Assume that a homeowner has a first and second mortgage, with balances F_1 and F_2 and gross interest rates R_1 and R_2 , respectively, and that they mature on the same future date. So mortgage i can be paid down for F_i today or $F_i R_i$ at maturity. Assume also that the home's market value is currently V_0 and that its value at maturity will be $V = V_0 + \varepsilon$, where ε follows a normal distribution with mean 0 and standard deviation σ , and furthermore that the homeowner's valuation is and will be identical to the market valuation. Assume finally that if a mortgage goes into foreclosure, any current lender suffers a cost c in addition to any losses from recoveries falling short of the balance owed. This cost represents both labor and legal costs and any regulatory attention attracted by the loan's failure.

Suppose a new lender enters this economy, one willing to lend to refinance one or both mortgages, provided he at least breaks even in expectation. As we show in Appendix A, the effect of the subrogation regime on this potential refinancing is in one parameter region, the region where the lender would earn an expected profit from refinancing the first mortgage at its current rate R_1 , but an expected loss from refinancing both mortgages at their collective current rate $(F_1 R_1 + F_2 R_2) / (F_1 + F_2)$. In this region, the only gains from trade are from refinancing just the first mortgage, with the second mortgagee's cooperation.

Figure 3 illustrates the solution to this model for a particular parameter vector, $(F_1, R_1, R_2, V_0, \sigma, c) = (80, 1.10, 1.12, 150, 50, 10)$, with F_2 ranging from 10 to 100 to capture the effect of rising CLTV. When CLTV is low, we see that refinancing either the first mortgage or both at current rates is profitable, so the first mortgage will be refinanced, one way or another. When CLTV is in the middle, refinancing only the first mortgage is profitable, so this is the region

where the second's cooperation, if the law requires it, adds value. When CLTV is high, neither refinancing is profitable, so the first mortgage will not be refinanced, with or without cooperation. The figure illustrates the dynamics defining the middle range: The line representing the first mortgage hits zero at a higher CLTV than does the line representing both, since the former bends down due to the rising expected foreclosure cost, whereas the latter bends down due to *both* the rising expected foreclosure cost *and* the falling expected recovery, and thus hits zero sooner.

The model is too stylized to identify the bounds for our tests, but it does provide some intuition: The lower bound reflects the recovery and foreclosure risks of the combined mortgages, and the upper bound reflects just the foreclosure risk, given the prevailing uncertainty over future house prices. Uncertainty was high in our sample period, so we set the lower bound a little below the standard 80% cutoff, at 75%, and the upper bound close to zero home equity at 95%.

5. Empirical Tests

The test design is a logit model where each observation is a homeowner with a first mortgage and the dependent variable indicates whether the homeowner's first mortgage was refinanced in 2009.¹¹ More formally, for homeowner i , let D_{ij} be a dummy variable indicating whether homeowner i lives in state j . $Easy_j$ is a dummy variable taking the value 1 if state j is an "easy" state that facilitates equitable subrogation, i.e., one listed as having adopted the Restatement in Table 1, and 0 otherwise. So $Easy_j \cdot D_{ij} = 1$ if borrower i lives in an easy state and 0 otherwise. Z_i is equal to 1 if the homeowner also has a second mortgage. Recall that the homeowner's combined CLTV can be in the low, medium, or high region. Let $CLTV_{M,i}$ be a

¹¹ We obtain similar results with a Probit regression.

dummy variable indicating whether homeowner i falls in the low CLTV region, $CLTV_{M,i}$ whether he falls in the medium CLTV region, and $CLTV_{H,i}$ the high CLTV region. X_i is a vector of other characteristics (for example, credit score, interest rate, etc., as described below). Since there is potentially other cross-state variations that could affect the likelihood of refinancing (including, for example, other state laws), we will include state fixed effects and interact these with the other variables in some of our regressions.

Then under the most general logit model, the probability of homeowner i refinancing satisfies: $\Pr(\text{refinance}) = \frac{e^Z}{1+e^Z}$, where

$$\begin{aligned}
Z = & \sum_j [(CLTV_{L,i}\beta_{Easy \times CLTV,L} + CLTV_{M,i}\beta_{Easy \times CLTV,M} + CLTV_{H,i}\beta_{Easy \times CLTV,H}) \\
& + 2_i(CLTV_{L,i}\beta_{Easy \times 2 \times CLTV,L} + CLTV_{M,i}\beta_{Easy \times 2 \times CLTV,M} \\
& + CLTV_{H,i}\beta_{Easy \times 2 \times CLTV,H})] \cdot Easy_j \cdot D_{ij} \\
& + \sum_j [X_i\beta_{X \times j} + (CLTV_{L,i}\beta_{CLTV,L \times j} + CLTV_{M,i}\beta_{CLTV,M \times j} + CLTV_{H,i}\beta_{CLTV,H \times j}) \\
& + 2_i(CLTV_{L,i}\beta_{CLTV,L \times j} + CLTV_{M,i}\beta_{2 \times CLTV,M \times j} + CLTV_{H,i}\beta_{2 \times CLTV,H \times j})] \cdot D_{ij}
\end{aligned}$$

Observe that, under this general model, we allow every covariate to interact with the state fixed effects D_{ij} .

Here, the coefficients $\beta_{Easy \times CLTV,M}$, etc. capture the incremental effect of the law being “easy”. We wish to estimate

$$\delta_M = \beta_{Easy \times 2 \times CLTV,M} - \beta_{Easy \times 2 \times CLTV,L}$$

$$\delta_H = \beta_{Easy \times 2 \times CLTV,H} - \beta_{Easy \times 2 \times CLTV,L}$$

which together give the marginal effect of moving from the low CLTV region to the middle/high region, for borrowers who both have a second mortgage and live in an easy subrogation state.

Since the subrogation law varies only at the state level, however, the above regression is not identified and so, without further assumptions, $\beta_{Easy \times CLTV, M}$ cannot be separately estimated from $\beta_{CLTV, M \times j}$, for example. We make the identifying assumption that if all states had the same “hard” subrogation law, then the incremental effect on refinancing of an increase in the CLTV for a borrower with a second mortgage is constant across states. This will imply that the only impact of CLTV on refinancing for borrowers varies only through the state subrogation law.

Formally, we assume that there exist $\gamma_{CLTV, M}$ and $\gamma_{CLTV, H}$ such that for all states j ,

$$\beta_{2 \times CLTV, M \times j} - \beta_{2 \times CLTV, L \times j} = \gamma_{CLTV, M}$$

$$\beta_{2 \times CLTV, H \times j} - \beta_{2 \times CLTV, L \times j} = \gamma_{CLTV, H}$$

Defining

$$\gamma_{CLTV, L \times j} = \beta_{Easy \times CLTV, L} \cdot Easy_j + \beta_{CLTV, L \times j}$$

$$\gamma_{CLTV, M \times j} = \beta_{Easy \times CLTV, M} \cdot Easy_j + \beta_{CLTV, M \times j}$$

$$\gamma_{CLTV, H \times j} = \beta_{Easy \times CLTV, H} \cdot Easy_j + \beta_{CLTV, H \times j}$$

under these identifying restrictions the above regression becomes the following (see Appendix B

for details): $\Pr(refinance) = \frac{e^Z}{1+e^Z}$, for

$$\begin{aligned}
Z = & 2_i \cdot (CLTV_{M,i} \cdot \gamma_{2 \times CLTV,M} + CLTV_{H,i} \cdot \gamma_{2 \times CLTV,H}) \\
& + \sum_j [2_i \cdot (CLTV_{M,i} \cdot \delta_M + CLTV_{H,i} \cdot \delta_H)] \cdot Easy_j \cdot D_{ij} \\
& + \sum_j [X_i \beta_{X \times j} + (CLTV_{L,i} \gamma_{CLTV,L \times j} + CLTV_{M,i} \gamma_{CLTV,M \times j} + CLTV_{H,i} \gamma_{CLTV,H \times j}) \\
& + 2_i \cdot \gamma_{2,j}] \cdot D_{ij}
\end{aligned}$$

This last regression, which we denote by model A, is fully identified. As discussed above, our illustrative model predicts that the marginal effect of the subrogation law should be apparent only in the middle CLTV region. That is, δ_M should be significantly different from 0, while δ_H should not.

The theoretical model also has other implications. In particular, that the subrogation law should not affect the probability of refinancing in the low CLTV region. That is, $\beta_{Easy \times 2 \times CLTV,L} = 0$. The reason is that a borrower with low CLTV who seeks to refinance would be able to replace both mortgages with a new first mortgage. To be able to identify this coefficient, we add the restriction that $\beta_{2 \times CLTV,L \times j}$ is independent of state j and equals γ_2 for all j . Under this identifying restriction, $\gamma_{2,j} = \gamma_2 + \beta_{Easy \times 2 \times CLTV,L} \cdot Easy_j$, and we obtain model B:

$$\begin{aligned}
Z = & 2_i \cdot (\gamma_2 + CLTV_{M,i} \cdot \gamma_{2 \times CLTV,M} + CLTV_{H,i} \cdot \gamma_{2 \times CLTV,H}) \\
& + \sum_j [2_i \cdot (\beta_{Easy \times 2 \times CLTV,L} CLTV_{L,i} + CLTV_{M,i} \cdot \delta_M + CLTV_{H,i} \cdot \delta_H)] \cdot Easy_j \cdot D_{ij} \\
& + \sum_j [X_i \beta_{X \times j} + (CLTV_{L,i} \gamma_{CLTV,L \times j} + CLTV_{M,i} \gamma_{CLTV,M \times j} + CLTV_{H,i} \gamma_{CLTV,H \times j})] \\
& \cdot D_{ij}
\end{aligned}$$

To be able to identify the coefficients corresponding to the standard mortgage-related variables likely to affect refinancing, we also estimate models in which we add the additional assumption that these covariates all affect refinancing in the same way across states, i.e. that $\beta_{X \times j} = \beta_X$ for all j . When applied to model A, we term this model C, and when applied to model B, this becomes model D. Finally, we also estimate model E, which includes state fixed-effects, but leaves out all their interactions with the other covariates.

The independent variables include standard mortgage and borrower characteristics from the LPS dataset (e.g., initial LTV, FICO score and term) observed at origination. We control for several other likely influences on refinancing, all dated December 2008: the county-level unemployment rate (from the BLS), the current mortgage interest rate (from LPS), the updated Equifax risk score (from the bureau data), the vintage year of the mortgage, the fixed period of a fixed/floating mortgage, the current coupon and loan amount, the type of investor holding the mortgage, and whether it qualified, as of 12/08, as a Jumbo mortgage.

To motivate our analysis, we begin by presenting the incidence of refinancing in 2009 in Table 4, sorted by the presence of a second mortgage and by CLTV range. This table gives a sense of the relevant three-way interaction, i.e., whether residing in an easy state makes refinancing more likely when there is a second mortgage and the CLTV ratio is in the middle range.

The table shows an interaction in the predicted direction. In the low and high CLTV ranges, there is little marginal impact from being in an easy state on the effect of a second mortgage on the likelihood of refinancing. That is, in the low range, the presence of a second mortgage associates with a 0.6 percentage point higher probability of refinancing in the not-easy states (17.4% with a second mortgage, versus 16.8% without), and 0.9 percentage point higher in

the easy states (16.2% versus 15.3%). In the high CLTV range, it associates with a 0.9 percentage point decrease in the refinancing probability in not-easy states and a 0.4 percentage point decrease in the easy states. By contrast, in the middle CLTV range, the effect of being in an easy state on the effect of a second mortgage on refinancing is strongly positive (13.6% versus 11.5%), whereas in the not-easy states it is actually slightly negative.

For a formal hypothesis test, we now estimate the logit model described above. The results are in Table 5.

Before getting to the key test statistics, it is worth noting that, in models C and D, the variables capturing the benefit of refinancing to the homeowner have the expected signs.¹² Loans with higher interest rates are more likely to be refinanced, as are mortgages with larger balances. Fixed-rate loans, as well as ARMS with long fixed periods, are more likely to be refinanced than ARMS with short fixed-rate periods. Other explanatory variables also enter as expected: Loans with high risk scores (either the FICO score at origination or the Equifax risk score as updated in December 2008,) are more likely to be refinanced, and subprime loans are less likely to be refinanced, as are higher-LTV loans.¹³ Loans with balances above the conforming loan limit as of December 2008 (i.e., \$417,000) are less likely to be refinanced, reflecting the tighter underwriting conditions since the financial crisis began. Loans with prepayment penalties are also less likely to refinance.

We now turn to the variables at the center of our analysis: the presence of a second mortgage, the state legal environment, and the CLTV ratio. Being in a higher CLTV range is associated with a lower refinancing probability, relative to the omitted category of CLTV<75%

¹² See Elul (2012) for further discussion of the determinants of refinancing and how they have changed over time.

¹³ In addition, 40-year mortgages are less likely to be refinanced, as these loans were typically taken out by riskier, liquidity-constrained borrowers. By contrast, 30-year mortgages are more likely to refinance (relative to the omitted category, 15-year) reflecting the borrower benefit.

(this coefficient is only identified in model E, the one with no state-fixed-effect interactions). Borrowers with second mortgages are more likely to refinance, most likely so that they can roll both mortgages into a single, new loan (this coefficient is only identified under the additional restrictions of models B, D and E).

Finally, consider the interaction terms that are at the heart of our analysis. First, the two-way interaction between the second mortgage indicator and easy subrogation laws is insignificant (this coefficient is again only identified in models B, D and E). Since we also include a three-way interaction with the middle and high CLTV regions, as discussed below, this two-way interaction actually captures the effect of subrogation law on borrowers with second mortgages in the low CLTV region. The fact that it is insignificant is consistent with our model, which predicts a significant effect only for the middle CLTV region. Finally, the three-way interactions between the CLTV category, the second mortgage indicator, and easy subrogation laws are also consistent with our earlier predictions in each model. The interaction δ_M with the middle CLTV region is positive and statistically significant, while the interaction δ_H with the high CLTV region is insignificant, as predicted.

To help interpret these results, in Panel B of this table we compute the marginal effect of a second mortgage on the probability of refinancing. It is only in the middle CLTV region that there is a significant difference in the impact of a having a second mortgage between the easy and not-easy states: In the easy subrogation states, borrowers with second mortgages are 3 percentage points more likely to refinance in 2009, whereas in the not-easy states the marginal effect of a second mortgage on the refinancing probability is only 1.8 percentage points. This constitutes a significant increase in the probability of refinancing, as compared with the average refinancing probability for 2009 of 12%.

6. Summary and Conclusion

This paper addresses the conflicting legal principles at stake when a homeowner wishes to refinance the senior of multiple mortgages. It does so by relating the incidence of refinancing to both the cross section of state legal environments and mortgage circumstances. The key finding is that those states that resolve the conflict by allowing the second mortgage to block the refinancing show significantly less such refinancing. This is a potentially significant barrier to refinancing whose economic significance is heightened by today's historically low rates.

The test results identify a negative effect of time priority, and also identify the remedy. States can prevent second lien holders from blocking refinancings that don't impair them by adopting the principle of equitable subrogation. This adoption has already begun. If mortgage lenders value this blocking power, they might respond to adoption with higher rates: first-mortgage lenders, because they lose when homeowners gain from refinancing, and second-mortgage lenders, because they get rents from blocking. Whether these effects on origination are near the order of magnitude of the effects upon refinancing that we identify is an interesting area for future research.

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Figure 1
Mortgage Rates and New Refinancings: 2008-2010

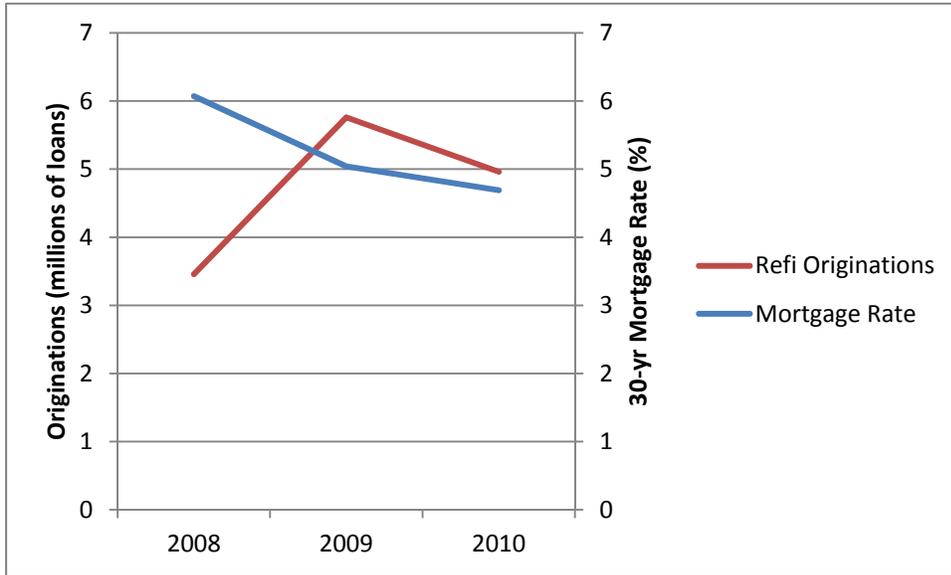


Figure 2

Geographic Distribution of Easy Subrogation States

States With Easy Subrogation Laws

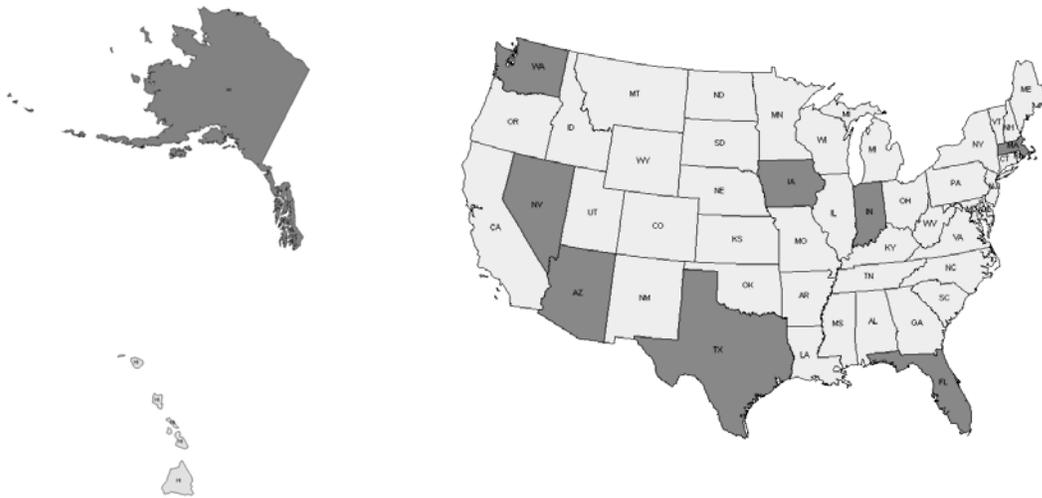


Figure 3

Model of Mortgage Refinancing: Numerical Example

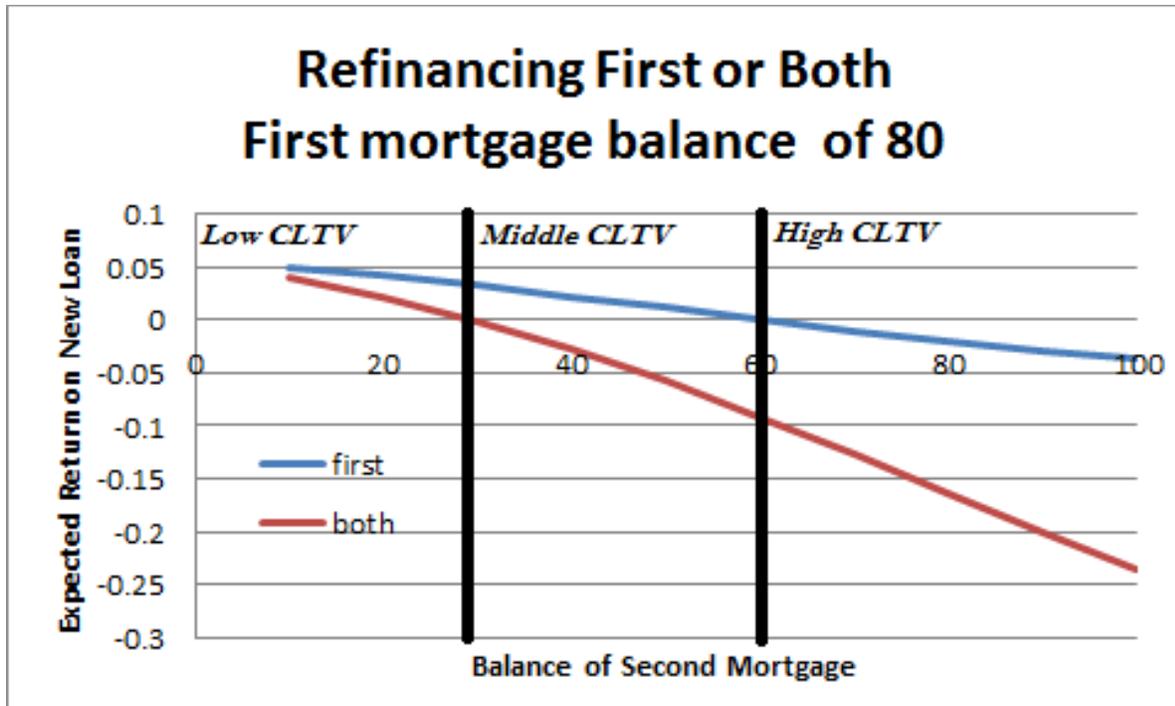


Table 1**Cross Section of State Law Pertaining to Subrogation of Mortgages**

This table was compiled by Dale Whitman and was current as of September 17, 2008. The following notes were included with the table: "Restatement" indicates the court would grant subrogation even if the refinancing lender had actual knowledge of the intervening lien. "Yes if constructive notice, no if actual knowledge" indicates the court would grant subrogation if the refinancing lender had only constructive notice from the recording of the intervening lien but would not do so if the refinancing lender had actual knowledge of it. "No if actual or constructive notice" indicates that the court would not grant subrogation if the refinancing lender had either actual knowledge of the intervening lien or constructive notice from the recording of the intervening lien.

State	Legal position	Controlling case	Notes and comments
Alabama (AL)	Yes if constructive notice, no if actual knowledge.	In re Hubbard, 89 B.R. 920 (Bankr.N.D.Ala.1988)	
Alaska (AK)	Restatement	Rush v. Alaska Mortg. Group, 937 P.2d 647 (Alaska 1997)	Technically not a subrogation case, since prior lender and refinancing lender were the same.
Arizona (AZ)	Restatement	Lamb Excavation, Inc. v. Chase Manhattan Mortgage Corp., 95 P.3d 542 (Ariz.App.2004)	
Arkansas (AR)	Yes if constructive notice, no if actual knowledge.	United States v. Hughes, 499 F.2d 322 (8th Cir.1974)	
California (CA)	Yes if constructive notice, no if actual knowledge.	Lawyers Title Ins. Corp. v. Feldsher, 42 Cal.App.4th 41, 49 Cal.Rptr.2d 542 (1996)	
Colorado (CO)	Restatement (?)	Hicks v. Londre, 125 P.3d 452 (Colo. 2005); AmeriquestMortg. Co. v. Land Title Ins. Corp., 2007 WL 2128203 (Colo.App. 2007).	Ct indicated it might not grant subrog under Rest. to a sophisticated commercial lender
Connecticut (CT)	No if actual or constructive notice	Independence One Mortg. Corp. v. Katsaros, 43 Conn.App. 71, 681 A.2d 1005 (1996)	
Delaware (DE)	Unclear; probably yes if constr. Notice, no if actual knowledge	Stoeckle v. Rosenheim, 10 Del.Ch. 195, 87 A. 1006 (Del.Ch. 1913)	
Dist. Of Columbia (DC)	Restatement (?)	Eastern Savings Bank, FSB, v. Pappas, 829 A.2d 953 (D.C.2003);	The ct. cited Rest. favorably but did not decide whether to follow the Rest. in an actual knowledge case, as there was none here.
Florida (FL)	Restatement	Suntrust Bank v. Riverside Nat'l Bank of Florida, 792 So.2d 1222 (Fla. App.2001)	Technically not a subrogation case, since prior lender and refinancing lender were the same.

Georgia (GA)	Not if actual or constructive notice	McCollum v. Lark, 187 Ga. 292, 200 S.E. 276 Ga. 1938	
Hawaii (HI)	Unclear; court's analysis is too cursory.	Strouss v. Simmons, 66 Haw. 32, 657 P.2d 1004 (Hawaii,1982)	
Idaho (ID)	Yes if constructive notice, no if actual knowledge.	Metropolitan Life Ins. Co. v. First Security Bank, 94 Idaho 489, 491 P.2d 1261 (1971)	
Illinois (IL)	No if actual or constructive notice	Mortgage Electronics Registration Systems, Inc. v. Phylactos, 2005 U.S. Dist. LEXIS 6295 (N.D. Ill. 3/ 30/05)	But Illinois has been extremely liberal in finding an agreement, leading to "conventional subrogation."
Indiana (IN)	Restatement	Bank of New York v. Nally, 820 N.E.2d 644 (Ind.2005)	
Iowa (IA)	Restatement	Klotz v. Klotz, 440 N.W.2d 406 (Iowa App.1989)	
Kansas (KS)	No if actual or constructive notice	National City Mortg. Co. v. Ross, 117 P.3d 880 (Kan.App.2005)	
Kentucky (KY)	Unclear (but it is clear that court would not allow subrog. if refi lender had actual knowledge)	Minix v. Maggard, 652 S.W.2d 93 (Ky.App.1983)	
Louisiana (LA)	No subrogation in favor of a refinancing mortgagee	Pelican Homestead Ass'n v. Security First Nat. Bank, 532 So.2d 397 (La.App.1988)	Louisiana will not grant subrogation if the old first mortgage has been discharged of record.
Maine (ME)	Yes if constructive notice, no if actual knowledge.	United Carolina Bank v. Beesley, 663 A.2d 574 (Me.1995)	
Maryland (MD)	Yes if constructive notice, no if actual knowledge.	Citibank Federal Savings Bank. v. New Plan Realty Trust, 748 A.2d 24 (Md.App.2000)	
Massachusetts (MA)	Restatement	East Boston Sav. Bank v. Ogan, 428 Mass. 327, 701 N.E.2d 331 (1998)	
Michigan (MI)	No subrog.in absence of fraud, mistake, or misconduct by the lender being subordinated.	AmeriquestMortg. Co. v. Alton, 271 Mich.App. 660 (Mich.App.2006)	The Michigan cases are a conflicting mess. Other recent MI cases reject Restatement; see Washington Mut. Bank v. ShoreBank Corp., 703 N.W.2d 486 (Mich.App.2005). No Sup.Ct. case.
Minnesota (MN)	No if actual or constructive notice	Ripley v. Piehl, 700 N.W.2d 540 (Minn.App.2005) (based on much older Sup.Ct. cases.)	
Mississippi (MS)	Yes if constructive notice, no if actual knowledge.	Home Owners' Loan Corporation v. Moore, 185 So. 253 (Miss.1939)	

Missouri (MO)	No if actual or constructive notice	184 Miss. 283, 185 So. 253	
Montana (MT)	No case law	Miss. 1939.	
Nebraska (NE)		American National Bank v. Clark, 660 N.W.2d 530 (Neb.App.2003)	Ostensibly based on "conventional subrogation."
Nevada (NV)	Restatement	Houston v. Bank of America, 78 P.3d 71 (Nev.2003)	
New Hampshire (NH)	Unclear; probably yes if constr. notice, no if actual knowledge	Hammond v. Barker, 61 N.H. 53, 1881 WL 4658 (N.H. 1881)	No modern case law.
New Jersey (NJ)	Yes if constructive notice, no if actual knowledge.	First Union National Bank v. Nelkin, 808 A.2d 856 (N.J. Super. App. Div. 2002)	
New Mexico (NM)	Yes if constructive notice, no if actual knowledge.	In re Beltramo, 367 B.R. 825, 2007 WL 1307917 (Bkrcty.D.N.M.2007)	A bankruptcy court predicting NM law.
New York (NY)	Yes if constructive notice, no if actual knowledge.	Gerenstein v. Williams, 23 N.Y.S.2d 257 (N.Y. App.Div.2001)	
North Carolina (NC)	No if actual or constructive notice	First Union Nat'l Bank v. Lindley Laboratories, Inc., 510 S.E.2d 187 (N.C.App.1999)	
North Dakota (ND)			
Ohio (OH)	Unclear	First Union Nat. Bank v. Harmon, 2002 WL 1980705 (Ohio App.2002) follows Rest.; contra, see IndyMac Bank v. Bridges, --- N.E.2d ---, 2006 WL 3095774 (Ohio App. 2006); Washington Mut. Bank, FA v. Aultman, 876 N.E.2d 617 (Ohio App.2007)	Unclear whether actual knowledge by lender would have denied subrogation.
Oklahoma (OK)	Yes if constructive notice, no if actual knowledge.	Mortgage Electronic Registration Systems, Inc. v. U.S. ex rel. Internal Revenue Service, 134 P.3d 913 (Okla.Civ.App.2006)	Remanded for determination as to whether refinancing mortgagee exercised due diligence in determining existence of intervening lien.
Oregon (OR)	Yes if constructive notice, no if actual knowledge.	Rusher v. Bunker, 99 Or.App. 303, 782 P.2d 170 (Or.App.1989); Dimeo v. Gesik, 993 P.2d 183 (Or.App.1999)	In Dimeo, ct remanded for finding as to whether lender's reliance on erroneous final title report was negligent.
Pennsylvania (PA)	No subrogation in favor of a refinancing mortgagee	1313466 Ontario, Inc. v. Carr, 954 A.2d 1 (Pa.Super.2008)	The Superior Ct. likes the Rest. but can't adopt it because of old precedent, which treats all refi lenders as "volunteers."
Rhode Island (RI)	No case law		
South Carolina (SC)	Yes if constructive notice, no if actual knowledge.	Pee Dee State Bank v. Prosser, 367 S.E.2d 708 (S.C. 1988)	

South Dakota (SD)			
Tennessee (TN)	Apparently no subrog.in absence of fraud or mistake by the lender being subordinated	Restatement	Bankers Trust Co. v. Collins, 124 S.W.3d 576 (Tenn.Ct.App.2003)
Texas (TX)		Restatement	Farm Credit Bank v. Ogden, 886 S.W.2d 305 (Tex.App.1994)
Utah (UT)	No if actual or constructive notice		Richards v. Security Pacific Nat. Bank, 849 P.2d 606 (Utah App.1993)
Vermont (VT)	Unclear		No modern cases
Virginia (VA)	No if actual or constructive notice		Centreville Car Care, Inc. v. North American Mortg. Co., 559 S.E.2d 870 (Va.2002)
Washington (WA)		Restatement	Bank of America v. Prestance Corp., 2007 WL 1631420 (Wash. 2007)
West Virginia (WV)	No case law		
Wisconsin (WI)	Yes if constructive notice, no if actual knowledge.		Pierner v. Computer Resources & Technology, Inc., 577 N.W.2d 388 (Wis.App.1998)(unpub); Ocwen Loan Servicing, LLC v. Williams, 305 Wis.2d 772, 741 N.W.2d 474 (Wis.App.2007)
Wyoming (WY)	Yes if constructive notice, no if actual knowledge.		Countrywide Home Loans, Inc. v. First Nat'l Bank of Steamboat Springs, 144 P.3d 1224 (Wyo.2006)
			There are several earlier Texas cases taking the same view as early as 1969.
			The <i>Pierner</i> court does not discuss the effect of actual knowledge, as there was none. The opinion is very liberal, and the ct. may yet adopt the Rest.

Table 2
Data Description and Comparison with Unmatched Sample

The column labeled “Matched Sample Mean” characterizes the mortgages in the sample resulting from the match of LPS data with FRBNY/Equifax data. The column labeled “Unmatched Sample Mean” characterizes a random sample of mortgages drawn from the LPS data, but not matched to the FRBNY/Equifax data.

<u>Variable</u>	<u>Matched Sample Mean</u>	<u>Unmatched Sample Mean</u>
Refinanced in 2009	0.12	
Easy Subrogation State	0.24	0.25
<u>First Mortgage Characteristics (at Orig.)</u>		
FICO Score @ Origination	722	725
Loan Amt.	\$246,692	\$251,736
LTV @ Orig.	73.34	72.13
First Mortgage Origination Yr.		
	2003	0.12
	2004	0.15
	2005	0.22
	2006	0.20
	2007	0.31
Fixed rate	0.85	0.82
ARM		
24-mon. fixed period	0.00	0.01
36-mon.	0.01	0.01
60-mon.	0.08	0.10
84-mon.	0.03	0.03
120-mon.	0.03	0.03
Term		
180-mon	0.09	0.09
360-mon.	0.90	0.90
480-mon.	0.01	0.01
"Investor"		
Portfolio	0.07	0.07
GSE	0.75	0.75
Private Securit.	0.18	0.18
<u>As of Dec 2008</u>		
Second Mortgage	0.35	
Second Mortgage Balance (conditional on having a second)	\$50,522	
Combined LTV	85.48	
Cty Unemp. Rate (%)	7.00	7.09
First Mortgage Int. Rate (%)	6.02	6.03
Updated Equifax Risk Score	741	
Jumbo Principal Bal. on 1st (Dec. 2008)	0.10	

Table 3
Mortgage Statistics: Easy vs. Not-Easy States

The column labeled “Not-Easy State” reports the average for the portion of the matched sample representing mortgages of properties in not-easy states, as defined in the text. The column “Easy State” addresses the easy states.

		Not- Easy State	Easy State
Refinanced		0.13	0.11
FICO @ Orig.		722	719
LTV @ Orig.		72.92	75.31
Prepayment Penalty		0.04	0.04
Origination Year	2003	0.12	0.11
	2004	0.15	0.14
	2005	0.22	0.22
	2006	0.20	0.21
	2007	0.30	0.32
FRM		0.84	0.87
ARM fixed period (months)	24	0.00	0.00
	36	0.01	0.01
	60	0.08	0.07
	84	0.03	0.03
	120	0.03	0.02
Term (months)	180	0.09	0.08
	360	0.90	0.91
	480	0.01	0.01
Investor:	GSE	0.75	0.78
	Private Securitization	0.19	0.15
	Portfolio	0.07	0.06
Cty. Unemployment Rate		7.02	6.91
Jumbo		0.11	0.07
Balance (\$)		253,009	228,040
Updated Equifax Risk Score		743	735
Second Mortgage		0.36	0.32
Interest Rate (%)		6.01	6.06
CLTV \leq 75		0.36	0.31
CLTV \in (75,95]		0.32	0.31
CLTV $>$ 95		0.32	0.38
N		599,944	187,104

Table 4
Refinancing Rate by CLTV, State Law, and Second Mortgage (2009)

Low CLTV Range (CLTV<75)

	Not Easy	Easy
No Second	16.82%	15.33%
Second	17.35%	16.22%

Middle CLTV Range (75≤CLTV<95)

	Not Easy	Easy
No Second	13.77%	11.46%
Second	13.46%	13.56%

High CLTV Range (CLTV≥95)

	Not Easy	Easy
No Second	8.31%	6.24%
Second	7.15%	5.83%

Table 5
Logit Model of Refinancing in 2009

This table reports the output from a Logit model in which each observation is a residence with a first mortgage and the dependent variable indicates that the first mortgage was refinanced in 2009. There are 601,272 observations, and “**” indicates statistical significance at the 5% level. State fixed effects (and their interactions, depending on the model) are included but not reported. Panel A contains the Logit results, showing coefficients for each model. Panel B uses the Panel A interaction results to report the marginal effect of the presence of a second mortgage on the probability of refinancing for model E.

Panel A

<i>Explanatory Variable</i>	<i>Model A</i>		<i>Model B</i>		<i>Model C</i>		<i>Model D</i>		<i>Model E</i>	
	<i>Coef.</i>	<i>SE</i>								
FICO @ Orig.					0.003	0.000**	0.003	0.000**	0.003	0.000**
12/08 Equifax Score					0.008	0.000**	0.008	0.000**	0.008	0.000**
LTV @ Orig.					-0.003	0.000**	-0.003	0.000**	-0.004	0.000**
Orig. Year:										
2004					0.204	0.017**	0.206	0.017**	0.199	0.017**
2005					0.120	0.017**	0.121	0.017**	0.102	0.017**
2006					0.491	0.019**	0.492	0.019**	0.467	0.019**
2007					0.561	0.018**	0.562	0.018**	0.555	0.018**
Investor:										
Priv. Sec.					-0.252	0.015**	-0.252	0.015**	-0.236	0.015**
Portfolio					-0.444	0.022**	-0.445	0.022**	-0.424	0.021**
ARM fixed period										
2 years					-0.680	0.121**	-0.678	0.121**	-0.730	0.121**
3 years					-0.376	0.060**	-0.376	0.060**	-0.394	0.060**
5 years					0.204	0.017**	0.205	0.017**	0.183	0.017**
7 years					0.251	0.024**	0.252	0.024**	0.232	0.023**
10 years					0.179	0.025**	0.180	0.025**	0.166	0.024**
Term										
30 years					0.171	0.016**	0.170	0.016**	0.193	0.016**
40 years					-0.112	0.059*	-0.115	0.059*	-0.131	0.059**
Prepay Penalty					-0.393	0.028**	-0.391	0.028**	-0.398	0.028**
Coupon (12/08)					0.411	0.010**	0.412	0.010**	0.429	0.010**
ln(loan amt) (12/08)					0.678	0.013**	0.677	0.013**	0.629	0.012**
Jumbo (12/08)					-0.983	0.021**	-0.981	0.021**	-1.004	0.021**
Unemp (12/08)					-0.029	0.003**	-0.029	0.003**	-0.039	0.003**
CLTV \in (75,95]									-0.419	0.015**
CLTV>95									-1.297	0.023**
CLTV \in (75,95]&Easy									-0.055	0.027**
CLTV>95&Easy									-0.042	0.040**
2			0.090	0.014**			0.109	0.014**	0.142	0.014**
2&Easy			-0.024	0.034			-0.035	0.033	-0.016	0.033
CLTV \in (75,95]&2	0.073	0.022**	0.079	0.022**	0.072	0.022**	0.061	0.022**	0.034	0.021
CLTV>95&2	0.120	0.029**	0.118	0.028**	0.137	0.029**	0.121	0.027**	0.147	0.027**
CLTV \in (75,95]&2&Easy	0.114	0.051**	0.123	0.050**	0.125	0.050**	0.145	0.049**	0.117	0.049**
CLTV>95&2&Easy	0.043	0.063	0.047	0.062	0.048	0.062	0.059	0.060	0.044	0.059

Panel B

	Marginal
CLTV \leq 75&Not Easy Subrog.	0.019
CLTV \leq 75&Easy Subrog.	0.017
CLTV \in (75,95]&Not Easy Subrog.	0.018
CLTV \in (75,95]&Easy Subrog.	0.030
CLTV $>$ 95&Not Easy Subrog.	0.016
CLTV $>$ 95&Easy Subrog.	0.018

Appendix A: Illustrative Model

Because the borrower's valuation is identical to the market valuation, the borrower will repay his mortgage or mortgages in full on the maturity date if the market value V is greater than the balance due, and will otherwise give up the house to foreclosure. So absent any refinancing, there are three cases:

- If $V > F_1R_1 + F_2R_2$, the first and second mortgagees are paid in full.
- If $F_1R_1 < V < F_1R_1 + F_2R_2$, the first mortgagee is paid in full, the second mortgagee suffers a recovery loss, and both mortgagees pay the foreclosure cost c .
- If $V < F_1R_1$, the first mortgagee suffers a recovery loss, the second mortgagee is wiped out, and both mortgagees pay the foreclosure cost c .

Given the assumption that $V = V_0 + \varepsilon$, where ε is $N(0, \sigma)$, the first mortgagee's expected repayment, net of foreclosure costs, which we denote E_1 , is

$$E_1 = (1 - \Phi\left(\frac{F_1R_1 - V}{\sigma}\right))F_1R_1 + \Phi\left(\frac{F_1R_1 - V}{\sigma}\right)\left(V_0 - \frac{\sigma\varphi\left(\frac{F_1R_1 - V}{\sigma}\right)}{\Phi\left(\frac{F_1R_1 - V}{\sigma}\right)}\right) - \Phi\left(\frac{F_1R_1 + F_2R_2 - V}{\sigma}\right)c$$

Since the new lender needs only to break even in expectation, it follows that if $E_1 > F_1$, there exists an $R < R_1$ such that the lender would refinance the first mortgage at rate R , and this would make the borrower better off, since his repayment at maturity would be lower. It would also make the second mortgagee better off, since the balance senior to him would be lower, and the probability of foreclosure would be lower.

We can similarly determine whether the new lender would refinance both mortgages. Let $R_B = (F_1R_1 + F_2R_2)/(F_1 + F_2)$, i.e., the interest rate on both mortgages put together. If the new lender refinanced both mortgages at this rate, the borrower's repayment at maturity would be unchanged, and the new lender's expected repayment, which we denote E_B , would be

$$E_B = (1 - \Phi\left(\frac{F_1R_1 + F_2R_2 - V_0}{\sigma}\right))(F_1R_1 + F_2R_2) + \Phi\left(\frac{F_1R_1 + F_2R_2 - V_0}{\sigma}\right)\left(V_0 - \frac{\sigma\varphi\left(\frac{F_1R_1 + F_2R_2 - V_0}{\sigma}\right)}{\Phi\left(\frac{F_1R_1 + F_2R_2 - V_0}{\sigma}\right)} - c\right)$$

If $E_B > F_1 + F_2$, then there exists an $R < R_B$ such that the lender would refinance both mortgages at R , and the borrower would be better off.

Therefore, the parameter region where the first mortgage is refinanced if and only if the second mortgage cooperates is where $E_1 > F_1$ and $E_B < F_1 + F_2$. To illustrate this parameter region, Figure 2 plots $E_1/F_1 - 1$ ("first," the blue line) and $E_B/(F_1 + F_2) - 1$ ("both," the red line) for the parameter vector indicated in the text.

Appendix B: Identification

Substituting in for $\gamma_{CLTV,M}$, $\gamma_{CLTV,H}$, δ_M and δ_H , the argument of the original cdf above becomes

$$\begin{aligned}
& \sum_j (CLTV_{L,i} \cdot \beta_{Easy \times CLTV,L} + CLTV_{M,i} \cdot \beta_{Easy \times CLTV,M} + CLTV_{H,i} \cdot \beta_{Easy \times CLTV,H} \\
& + 2_i \cdot CLTV_{L,i} \cdot \beta_{Easy \times 2 \times CLTV,L} + 2_i \cdot CLTV_{M,i} \cdot \beta_{Easy \times 2 \times CLTV,L} + 2_i \cdot CLTV_{M,i} \cdot \delta_M \\
& + 2_i \cdot CLTV_{H,i} \cdot \beta_{Easy \times 2 \times CLTV,L} + 2_i \cdot CLTV_{H,i} \cdot \delta_H) \cdot Easy_j \cdot D_{ij} \\
& + (X_i \cdot \beta_{X_j} + CLTV_{L,i} \cdot \beta_{CLTV,L \times j} + CLTV_{M,i} \cdot \beta_{CLTV,M \times j} + CLTV_{H,i} \cdot \beta_{CLTV,H \times j} \\
& + 2_i \cdot CLTV_{L,i} \cdot \beta_{2 \times CLTV,L \times j} + 2_i \cdot CLTV_{M,i} \cdot \beta_{2 \times CLTV,L \times j} + 2_i \cdot CLTV_{M,i} \cdot \gamma_{CLTV,M} \\
& + 2_i \cdot CLTV_{H,i} \cdot \beta_{2 \times CLTV,L \times j} + 2_i \cdot CLTV_{H,i} \cdot \gamma_{CLTV,H}) \cdot D_{ij}
\end{aligned}$$

which using $CLTV_{L,i} + CLTV_{M,i} + CLTV_{H,i} = 1$ and $\sum_j D_{ij}$ equals,

$$\begin{aligned}
& 2_i \cdot CLTV_{M,i} \cdot \gamma_{CLTV,M} + 2_i \cdot CLTV_{H,i} \cdot \gamma_{CLTV,H} \\
& + \sum_j (CLTV_{L,i} \cdot \beta_{Easy \times CLTV,L} + CLTV_{M,i} \cdot \beta_{Easy \times CLTV,M} + CLTV_{H,i} \cdot \beta_{Easy \times CLTV,H} \\
& + 2_i \cdot \beta_{Easy \times 2 \times CLTV,L} + 2_i \cdot CLTV_{M,i} \cdot \delta_M + 2_i \cdot CLTV_{H,i} \cdot \delta_H) \cdot Easy_j \cdot D_{ij} \\
& + (X_i \cdot \beta_{X_j} + CLTV_{L,i} \cdot \beta_{CLTV,L \times j} + CLTV_{M,i} \cdot \beta_{CLTV,M \times j} + CLTV_{H,i} \cdot \beta_{CLTV,H \times j} \\
& + 2_i \cdot \beta_{2 \times CLTV,L \times j}) \cdot D_{ij}.
\end{aligned}$$

Substituting in for $\gamma_{CLTV,L \times j}$, $\gamma_{CLTV,M \times j}$, $\gamma_{CLTV,H \times j}$ and $\gamma_{2,j}$, this simplifies to

$$\begin{aligned}
& 2_i \cdot CLTV_{M,i} \cdot \gamma_{CLTV,M} + 2_i \cdot CLTV_{H,i} \cdot \gamma_{CLTV,H} \\
& + \sum_j (2_i \cdot CLTV_{M,i} \cdot \delta_M + 2_i \cdot CLTV_{H,i} \cdot \delta_H) \cdot Easy_j \cdot D_{ij} \\
& + (X_i \cdot \beta_{X_j} + CLTV_{L,i} \cdot \gamma_{CLTV,L \times j} + CLTV_{M,i} \cdot \gamma_{CLTV,M \times j} + CLTV_{H,i} \cdot \gamma_{CLTV,H \times j} \\
& + 2_i \cdot \gamma_{2,j}) \cdot D_{ij},
\end{aligned}$$

which coincides with the expression in the text.