Does Junior Inherit?

Refinancing and the Blocking Power of Second Mortgages[1]

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ABSTRACT

In most US states, mortgage seniority follows time priority: older mortgages are paid first. This potentially impedes refinancing of senior mortgages, because replacement mortgages are junior unless the existing junior lienholders consent to resubordination. We exploit legal variation across states to provide evidence that time priority reduces refinancing, especially of smaller mortgages (suggesting a significant fixed cost of obtaining resubordination) and also of mortgages close to the conforming loan limit. On the other hand, we find evidence that time priority renders second mortgages more valuable to lenders, in that it increases the likelihood that a borrower obtains a second mortgage.

JEL: D12, G18, H73, K11

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1. Introduction

Mortgage debt represents the bulk of household indebtedness.[6] Homeowners' access to better mortgage terms therefore significantly affects the economy; as one policymaker points out, "[t]raditionally, refinancing activity has been an important channel through which lower interest rates support spending and employment."[7] The steep fall in mortgage rates since 2007 holds the potential to deliver these benefits, and the US government has attempted to facilitate refinancing in a variety of ways, including the Home Affordable Refinance Program (HARP).[8] However, the amount of refinancing that occurred in the years following 2007 fell short of many observers' hopes, especially among heavily indebted borrowers who would have especially benefited from refinancing.

Two leading explanations for the disappointing pace of refinancing are (i) suboptimal behavior by borrowers,[9] and (ii) the existence of legal and institutional impediments to successful refinancing. In this paper, we provide quantitative evidence for (ii), and in particular, legal impediments arising from second mortgages.[10]

Second mortgages, present in many households both now and especially during the crisis (17.5% of homeowners with a first mortgage as of September 2014, and 36% as of December

[6] Source: Federal Reserve Survey of Consumer Finances (2012)
[7] Speech by William C. Dudley, January 6, 2012.
[8] A stated goal of such efforts is to reduce default rates and hence stabilize the housing market: see, e.g., the speech by President Barack Obama on Oct 24, 2011, announcing changes to the HARP program. http://www.whitehouse.gov/the-press-office/2011/10/24/remarks-president-economy-and-housing
[9] The optimality of homeowners' refinancing decisions has been studied extensively in the literature. See for example Andersen et al (2015) and Agarwal et al (2015), and the references therein.
[10] Junior mortgages figure heavily in both pre-crisis borrowing and in the 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 of already-distressed mortgages that preserve seniority while forgiving principal. The main concern this literature addresses is the weak incentive of junior mortgagees to forgive and the resulting difficulty in reducing prohibitive indebtedness. Relevant studies include Agarwal et al. (2011b), Cordell et al. (2011), Goodman (2011), and Mayer et al. (2009).

2008[11]) can interfere with the refinancing of first mortgages. This is true even when, as would often be the case, such refinancing would actually *benefit* the second mortgage. This is because most states in the U.S. assign mortgage seniority by the principle of *time priority* – i.e., a mortgage is senior to another if it is older – which means that a second mortgage becomes senior, and thus the first mortgage, when the old first mortgage is refinanced. To prevent this loss of seniority, the lender refinancing the first mortgage needs permission from the holder of the second. Specifically, she needs the holder of the second to waive the windfall of seniority with a 'resubordination agreement' that passes the seniority of the old first mortgage on to the new one. So in the states adhering to time priority, second mortgagees can block refinancing of the first, either actively or passively, by not granting this permission. The homeowner can work around this impediment if she can roll both old mortgages into one new mortgage, but if the combined loan-to-value (CLTV) of the old mortgages is too high, this will not work.

In this paper, we exploit legal differences across U.S. states to identify the impact of time priority on refinancing. We find that it is significantly negative, reducing refinancing by 2.2 percentage points, or approximately 15 percent of the average refinancing rate of 15 percent, with the hardest impact on smaller mortgages.

The legal difference allowing us to identify the impact of time priority arises from the application in some states of a countervailing principle, that of *equitable subrogation*.[12] In general, this principle holds that a debt inherits the claim of the debt it extinguishes. In the states applying this principle, this means that a replacement mortgage that does not impinge on junior liens, i.e. one that does not increase principal or interest, and does not shorten maturity (so that the monthly

[11] Federal Reserve Bank of New York/Equifax Consumer Credit Panel.
[12] We are grateful to Dale Whitman for assembling and providing the database showing the variation in the legal environment across states.

payment does not rise) inherits the seniority of the mortgage it extinguishes, despite the violation of time priority, with no need for permission from the holder of the second mortgage. These states thus present a contrast to time priority, and it is through this contrast that we identify the impact of the blocking power.

It is worth stressing that the legal principle of time priority does not necessarily lead to fewer refinancings. In particular, many borrowers obtain resubordination agreements from their junior lienholders, thereby undoing the impact of time priority. Indeed, in the frictionless setting of Coase (1960), the principle of time priority would not affect the incidence of refinancing, but instead would just affect the division of surplus among the borrower and her lenders. However, the mortgage market appears far from frictionless. In particular, the popular press highlights the possibility that second mortgage lenders, concerned about the risk of their loans (for instance because of declining home values), might refuse to resubordinate in the hope that they will be paid off. Other frictions that have been mentioned include the difficulty of contacting the second lender, fees for executing resubordination agreements, lengthy processing times (necessitating longer rate locks for those with second mortgages) and rigid rules for approving these agreements, as well as attempts by the second lienholder to hold up the homeowner by insisting the first mortgage be refinanced with him instead.[13]

Empirically, we find the hardest impact of time priority to be on smaller mortgages. This suggests a fixed cost per mortgage that must be overcome by borrowers and lenders, rather than a variable cost growing with mortgage size, such as might arise from aggressive bargaining over surplus.

[13] See "Some Borrowers Hit New Snag In Refinancing: Home-Equity Lenders Get Tougher on People Switching To Cheaper First Mortgages", Wall Street Journal, March 6, 2008, and "Home equity lenders may block refinance", February 26, 2009, http://www.bankrate.com/finance/home-equity/home-equity-lenders-may-block-refinance-1.aspx

Our findings shed light on the slow start of refinancing under HARP. Those with multiple liens refinancing under HARP need to secure resubordination agreements, and our work suggests that obtaining such agreements may be costly. This accords with anecdotal evidence that the cost of resubordination reduced the effectiveness of HARP,[14] and supports governmental efforts to reduce the cost.[15]

The measurement of the impact of time priority needs to be robust to other cross-state variation relevant to refinancing. So to tighten the identification we focus on the distinguishing features of the laws governing time priority, i.e. that they should affect only those who actually have second mortgages, and should *not* affect those with combined loan-to-value ratios (CLTVs) low enough to enable refinancing of the second mortgage along with the first. Moreover, they should also not affect borrowers with high CLTVs, as they are unlikely to be able to refinance regardless of the law. Accordingly, the identification includes state-level fixed effects to control for state differences, and then asks whether borrowers who have both second mortgages and intermediate CLTVs are less likely to refinance if they live in time-priority states. Thus, the identification is through a three-way interaction.

The database for this test pulls together multiple sources. One crucial step is to merge a database with detailed information on first mortgages with credit bureau files showing the borrowers' other mortgages, so as to see any second mortgages, and also to learn whether the end of a first mortgage was truly a refinancing, as opposed to a relocation or foreclosure. Another crucial step is to determine the cross section of state law. For this purpose we have a state-by-state database of relevant legislation and case law which indicates whether equitable subrogation prevails in the state. Because this database is current as of September 2008, we focus on refinancing in

[14] http://www.keaneloans.com/2010/03/22/harp-loans-with-a-second-mortgage-not-if-your-second-mortgage-is-with-key-bank/
[15] http://blogs.wsj.com/developments/2011/10/23/twelve-questions-on-obamas-refi-plan/

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. Despite the general distress, 2009 also saw frequent refinancing, likely encouraged by the low mortgage rates illustrated in Figure 1.[16]

This database allows us to address not only the effect of the legal environment of second mortgages on refinancing, but also the effect of that environment on acquiring a second mortgage in the first place. The effect could in principle go either way: time priority can encourage lenders to offer second mortgages by strengthening their rights at refinancing time, and it can discourage lenders through its negative effect on successful rate refinancing and the benefit such refinancing brings to seconds. What we find is that time priority increases the likelihood of taking out a second mortgage after the first, indicating that the former effect outweighs the latter.

Another important friction in the mortgage market is the conforming loan limit (CLL). Since the financial crisis, jumbo mortgages, i.e. mortgages that cannot be guaranteed by the Government Sponsored Enterprises (GSEs), Fannie and Freddie Mac, because their balances exceed the CLL, have been particularly difficult to obtain.[17] We find a large negative impact on refinancing: borrowers with balances above the CLL are much less likely to refinance than other borrowers. And we find a positive impact of the Economic Stimulus Act (ESA) of 2008, which temporarily raised the CLL in certain high-cost counties: it is this county-specific limit, rather than the nationwide limit of $417,000, that affects refinancing rates in these counties. We also find that those borrowers with balances above the CLL who succeed in refinancing tend to do so with a new loan right at this higher county-specific CLL, which is further evidence that the ESA succeeded in facilitating refinancing.

[16] 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.
[17] See Krainer (2009), for example.

Finally, we find that the time-priority and CLL frictions interact. In particular, a borrower with a first mortgage balance below the limit *and* a second mortgage that puts the *combined* balance above the limit benefits relatively more from refinancing just the first, and so is particularly exposed to the blocking power of the second lienholder. And indeed, we find that refinancing by borrowers in this predicament is especially reduced by time priority.

2. The principles of time priority and equitable subrogation

The principle of time priority 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."[18]

The difficulty caused by 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 - for example, by lowering the first mortgage's coupon.

Countervailing the time-priority principle is the principle of equitable subrogation. It is articulated in §7.6(a) of American Law Institute (1997), a document generally referred to as the *Restatement*, an abbreviation of its title:

> 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

[18] Schmudde (2004), p. 113.

> discharge the obligation and the mortgage, they are preserved and the mortgage retains its priority in the hands of the subrogee.[19]

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

The principle of equitable subrogation is not automatically incorporated into the laws of individual states. State legislatures and judiciaries choose whether to incorporate this and other elements of the Restatement. An example of a state that chooses not to adopt this principle 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.[20]

[19] American Law Institute (1997), p. 508.
[20] 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 principle 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 other states.[21] As a shorthand representation of the hypothesis that refinancing the first of several mortgages is easier in a Restatement state, we denote the Restatement states as "easy", and the other states as "not easy."[22] The geographic distribution of these states is presented in Figure 2, which shows them to be widely dispersed across the country. Note that when a state precludes the application of equitable subrogation in the case of actual knowledge of an existing lien, but not when there was constructive knowledge, we code this state as "not easy". The reason is that since it is routine today for lenders to perform a title search prior to a refinancing, "actual" versus "constructive" knowledge appears to be a distinction without a significant difference.

Although our three-way identification strategy is designed to rule out other sources of cross-state variation, it is useful to note that cross sectional correlation between these other sources and variation between easy and not-easy subrogation law is low. This is apparent in Figure 3, which

[21] We show below that the results do not change if one drops those states for which the law is uncertain.
[22] We include the District of Columbia as an easy subrogation state, but our results are robust to this coding.

shows low correlation of easy/not-easy with the three legal-environment variables in Pence (2006) and Ghent and Kudlyak (2011), i.e. recourse to the borrower for deficiency judgments, judicial versus non-judicial foreclosure, and the optimal foreclosure timeline recommended by the government-sponsored enterprises (see that paper for details). It also shows low correlation with state-level average mortgage rates in December 2008 (from the LPS data described below), which reflect, among other things, the competitiveness of the local mortgage market,[23] and also low correlation with home-price appreciation since mortgage origination (from our dataset, described below). Thus, the variation of time-priority regimes is a largely independent source of variation in the refinancing environment.

3. Data Description

The dataset consists of mortgages originated between 2003 and 2007, taken 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. We matched this dataset 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 two-fold: It provides information on the other (second) mortgages held by the same borrower, because these mortgages appear in bureau records, and it also allows us to identify refinancings. Definitions of variables used in the hypothesis tests are collected in Table 2.

[23] See Scharfstein and Sunderam (2013), who show that increases in banking-sector concentration reduce refinancing activity. We discuss the correlation between interest rates and subrogation law further in Section 6.

From the LPS data, we obtain first-mortgage characteristics such as origination FICO score, interest rate, LTV ratio, etc. From the consumer credit bureau data, we obtain the borrower's updated Equifax risk score and information about second mortgage balances.[24] We calculate updated CLTVs as of December 2008 with the most current mortgage balances in the numerator and the home price at origination, updated with the Corelogic zip-code level house-price index, in the denominator. The second mortgages include both closed-end seconds and revolving home-equity lines.

The following procedure is used to identify refinancings.[25] We begin by identifying the first mortgages that terminate in the LPS data; these make up approximately 55% of the sample. We then use the bureau data to identify which terminations are refinancings. A terminated mortgage is identified as a refinancing if it meets two conditions: (i) the borrower did not move in a one-year window spanning the mortgage termination date (based on the address in credit bureau records), and (ii) a new mortgage account appears in the bureau data with an opening date that is within three months of the mortgage termination date.[26] For our final sample, approximately 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 $25,000, and to "primary" Equifax panel members (for whom

[24] We include all second mortgages reported to the credit bureau.
[25] Haughwout et al (2011) use a similar procedure to identify refinancings.
[26] 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 our 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.

data are available in every quarter).[27] After these restrictions, our sample contains 255,097 borrowers. Columns A and B of Table 3 summarize 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 states with easy versus not-easy subrogation law drives identification in the empirical tests. To document how the mortgages themselves compare, Columns C and D of Table 3 separate the dataset into easy versus not-easy states and reports borrower and mortgage characteristics, and local conditions, in each. The columns show some small differences, with different and potentially offsetting implications for the likelihood of refinance. The easy states show slightly more fixed-rate, fewer jumbo and fewer second mortgages, which all support more refinancing, as does the lower unemployment rate, but they also show newer mortgages, higher CLTV and lower scores, which support less refinancing. Note that the average rate of refinancing in the set of easy states (12.8%) is lower than the average rate of refinancing in the set of not-easy states (15.8%). This difference (almost entirely attributable to Florida, which was severely affected by the collapse of the housing market in 2008) highlights the need to control in our empirical analysis for state-level differences, along with individual characteristics.[28]

[27] We also restrict attention to borrowers with credit scores of 660 or higher, and drop interest-only first mortgages and firsts with prepayment penalties. See Lee and van der Klaauw (2010) for further detail on the FRBNY/Equifax Consumer Credit Panel.

[28] We also re-estimated the baseline specification of the paper while dropping Florida (since this state – with easy subrogation law – was especially hard-hit by the collapse of the housing market); this did not appreciably change the results.

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 a 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_iR_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 is a random variable. Furthermore, assume that the homeowner's valuation is and will be identical to the market valuation, which implies that the home goes into foreclosure on the future date if the combined repayment exceeds the market valuation. Assume finally that if a home 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 at a lower rate, provided he at least breaks even in expectation. As we show in the Appendix, 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 (assuming the second mortgagee allows it), but an expected loss from refinancing both mortgages at their collective current rate $(F_1R_1+F_2R_2)/(F_1+F_2)$. In this region, the only gains from trade come from refinancing just the first mortgage, with the second mortgagee's cooperation.[29]

[29] One should also consider a third alternative, namely that of a lender refinancing just the first mortgage without obtaining a resubordination agreement, and consequently accepting a junior position on the new loan. It is relatively straightforward to show that if refinancing the first mortgage is possible with subordination of the second mortgage, and refinancing of both mortgages is unprofitable, then this third alternative is also unprofitable---provided that we are in the empirically relevant case of the second mortgage having a lower face value ($F_2<F_1$) and less attractive interest rate terms ($R_2>R_1$) than the first.

Figure 4 presents the solution to this model, where we assume for illustration that (F_1, R_1, R_2, V_0, c) = (80, 1.10, 1.12, 150, 10), and that ε follows a normal distribution with a mean of 0 and standard deviation of 50. On the horizontal axis, F_2 ranges from 10 to 80 to capture the effect of rising CLTV, while the vertical axis shows the lender's maximum possible expected return, i.e. the expected return from refinancing the existing mortgages at their current rates, thereby leaving the borrower indifferent to refinancing. When CLTV is low, we see that refinancing either the first mortgage or both mortgages 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 mortgagee'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 lower and upper bounds of CLTV where subrogation laws would matter, 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. Such 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%, although for a robustness check we also consider other bounds.

5. Empirical analysis: The effects of subrogation law on refinancing

To motivate our analysis, we begin by presenting the incidence of refinancing in 2009 across state legal regimes in Table 4, sorted by the presence of a second mortgage and by CLTV range. The three CLTV buckets are defined as: CLTV≤75, 75<CLTV≤95, 95<CLTV≤150, although we also consider finer breakdowns below. 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. (Recall that an easy state is one that has adopted the principle of equitable subrogation, as opposed to time-priority.)

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 0.32 percentage point higher probability of refinancing in the not-easy states and 0.19 percentage point higher in the easy states. Similarly, in the high CLTV range, it associates with a 1.5 percentage point increase in the refinancing probability in not-easy states and a 2.68 percentage point increase in the easy states. By contrast, in the middle CLTV range, the impact of a second mortgage on refinancing is slightly positive (+0.43%) in easy states, whereas in the not-easy states it is strongly negative (-3.25%).

For a formal hypothesis test, we specify a probit model. Each observation is a homeowner with a first mortgage and the dependent variable indicates whether the homeowner's first mortgage was refinanced in 2009. 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 $Easyj \cdot D_{ij} = 1$ if borrower i lives in an easy state and 0 otherwise. 2_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 $CLTV_{L,i}$ be a 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). Hence the probability of homeowner *i* refinancing satisfies $\Pr(refinance) = \Pr(z \leq Z_i)$, where *z* is normally distributed with mean 0 and variance 1, and:

$$\begin{aligned} \boldsymbol{Z_i} = \boldsymbol{X_i\beta_X} + \sum_j \boldsymbol{D_{ij}\gamma_j} + \boldsymbol{CLTV_{M,i}\gamma_{CLTV,M}} + \boldsymbol{CLTV_{H,i}\gamma_{CLTV,H}} + \boldsymbol{2_i \cdot \gamma_2} + \boldsymbol{2_i} \\ \cdot \left(\boldsymbol{CLTV_{M,i} \cdot \gamma_{2\times CLTV,M}} + \boldsymbol{CLTV_{H,i} \cdot \gamma_{2\times CLTV,H}}\right) \\ + \sum_j \left(\boldsymbol{CLTV_{M,i} \cdot \gamma_{Easy\times CLTV,M}} + \boldsymbol{CLTV_{H,i} \cdot \gamma_{Easy\times CLTV,H}}\right) \cdot \boldsymbol{Easy_j} \\ \cdot \boldsymbol{D_{ij}} + \sum_j \left(\boldsymbol{CLTV_{M,i} \cdot \delta_M} + \boldsymbol{CLTV_{H,i} \cdot \delta_H}\right) \cdot \boldsymbol{2_i} \cdot \boldsymbol{Easy_j} \cdot \boldsymbol{D_{ij}} \\ + \sum_j \boldsymbol{\gamma_{2\times Easy} 2_i} \cdot \boldsymbol{Easy_j} \cdot \boldsymbol{D_{ij}} \end{aligned} \quad (1)$$

States vary in many dimensions other than subrogation law; to control for these differences, the above specification includes state-level fixed effects. (Below, we allow also for state-specific coefficients on many of the explanatory variables.) One might also want to include a term $\gamma_{Easy} \cdot Easy_j \cdot D_{ij}$, so that the coefficient γ_{Easy} would measure how easy subrogation law affects borrowers in the omitted category in the above specification of Z_i, namely those with a single lien and low CLTV. However, an identification assumption is needed to identify both γ_{Easy} and the state fixed effects. Fortunately, the following economic argument provides a very natural

identification assumption. There is no reason for subrogation law — which governs seniority in the case of multiple liens — to have any effect on refinancing by borrowers with a single lien, especially for low-CLTV borrowers from whom a lender is almost certain to obtain repayment. In our formal notation, this statement is precisely $\gamma_{Easy} = 0$, which we impose as the required identifying assumption, and is already incorporated into (1). However, readers uncomfortable with even this mild identification assumption should instead interpret the estimates of $\gamma_{Easy \times CLTV,M}$ and $\gamma_{Easy \times CLTV,H}$ as measuring the effect of easy subrogation law on borrowers with a single lien and medium and high CLTV *relative* to those with low CLTV.

Our model generates the following hypotheses:

Hypothesis 1: $\delta_M > 0$.

Hypothesis 2: $\delta_H = 0$.

Hypothesis 3: $\gamma_{2 \times Easy} = 0$ *and* $\gamma_{Easy \times CLTV,M} = \gamma_{Easy \times CLTV,H} = 0$.

Hypothesis 1 is the central prediction of the model, and says that subrogation law should have a greater effect on borrowers with multiple liens and an intermediate CLTV than on borrowers with multiple liens and low CLTV.

Hypothesis 2 complements Hypothesis 1 by predicting no impact of subrogation law on borrowers with high CLTV (relative to those with low CLTV). As discussed, such borrowers are likely to have a hard time refinancing regardless of subrogation law.

Hypothesis 3 predicts no impact of subrogation law on either borrowers with low or high CLTV, or borrowers with a single lien (regardless of CLTV).[30]

Hypothesis 3 differs from Hypotheses 1 and 2 in two important ways. First, and as detailed below, Hypotheses 1 and 2 can be tested under considerably weaker identification assumptions about inter-state differences: viz., that only subrogation law *jointly* interacts with both CLTV and the presence of multiple liens. In this way, we address a potentially important concern, namely that several of the states with easy subrogation law were particularly affected by the housing crash of 2007, and it is conceivable that borrowers with high CLTV or multiple liens in such states were hit especially hard. Second, Hypothesis 3 contains predictions that are not specific to our model since, as we have discussed, subrogation law should not affect borrowers with a single lien, or borrowers with multiple liens but low CLTVs.

The other independent variables X_i 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 credit 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 the mortgage balance, as of December 2008, would have made it a jumbo loan. Because the Economic Stimulus Act of 2008 raised the conforming loan limit for a subset of

[30] The effects of easy subrogation law on borrowers with multiple liens and low and high CLTV are, respectively, given by $\gamma_{2\times Easy}$ and $\gamma_{2\times Easy} + \gamma_{Easy\times CLTV,H} + \delta_H$. So δ_H=0, $\gamma_{2\times Easy} = 0$ and $\gamma_{Easy\times CLTV,H} = 0$ then imply that these effects are both equal to 0. Similarly, the effects of easy subrogation law on a borrower with a single lien and medium and high CLTV are, respectively, given by $\gamma_{Easy\times CLTV,M}$ and $\gamma_{Easy\times CLTV,H}$.

counties, we include two jumbo indicators---one using the nationwide limit of $417,000, and another using the county limit, if higher. [31]

The results of this probit estimation are in Column A of Table 5. First, consider the estimates of the coefficients relating to subrogation law. Consistent with Hypothesis 1, the estimated value of δ_M is positive and statistically different from 0. The estimated value of δ_H is half that of δ_M, and statistically indistinguishable from 0 at the 5% level. This is consistent with Hypothesis 2. However, the estimated value of δ_H is statistically different from 0 at the 10% level, and in this sense, support for Hypothesis 2 is arguably weaker than for Hypothesis 1. Consistent with Hypothesis 3, the three remaining interactions with easy subrogation law are all statistically indistinguishable from 0. Column B of Table 5 reports the estimate of a linear probability model in place of a probit model, and confirms these results. Indeed, in the linear specification, δ_H is no longer significant at even the 10% level, strengthening support for Hypothesis 2. This linear model also gives us an alternative, and simpler, way to compute marginal effects for the interaction terms, as illustrated below.

To summarize: As hypothesized, the impact of time priority on borrowers with second mortgages is indeed concentrated on borrowers in the middle CLTV range with two mortgages, and there is no evidence that it affects either borrowers with low CLTV, or borrowers with a single lien. There is weak evidence that time priority affects borrowers with high CLTV, though this is sensitive to the regression specification. Looking ahead to the various robustness tests we perform, the estimate of δ_M is statistically significant at the 5% level in all regressions, while the estimate of δ_H is always much smaller than δ_M, and is statistically significant at the 10% level in some specifications but not others.

[31] For a breakdown of the loan limit by county and year, see http://www.fhfa.gov/DataTools/Downloads/Pages/Conforming-Loan-Limits.aspx

A borrower with both a first and second mortgage on the same property may be able to escape the consequences of the principle of time priority by refinancing both mortgages with the same lender. As illustrated by the model, this escape route is available only to borrowers with a low CLTV. This availability motivates the hypothesis that time priority has little effect on low CLTV borrowers. Consistent with the hypothesis, Table 6 shows that low CLTV borrowers with both first and second mortgages are indeed more likely to close their second mortgages if they refinance. (We note that this table should be viewed somewhat cautiously, since it shows the form of refinancing conditional on a borrower refinancing in the first place. As such, it is subject to selection bias.)

A somewhat different escape from time priority opens when both existing mortgages are from the same lender. In this case, the existing lender can refinance the first mortgage without suffering any net loss of seniority. Furthermore, in such a case the refinancing lender is unlikely to have difficulty in contacting the second lienholder, and the risk of bargaining breakdown seems minor. Unfortunately, our data do not let us directly identify whether both mortgages are from the same lender. However, we can roughly proxy for a common lender by using Agarwal et al (2011b)'s finding that common ownership of loans is much more frequent when the first loan is held in the bank's portfolio, rather than securitized.[32] Accordingly, we re-run the test including interactions with an indicator for portfolio loans, so securitized loans are the baseline. The results, in Table 7, show a significantly positive loading on *2*easy*mid*, indicating a significant impact of subrogation on the refinancing of securitized loans, but an offsetting loading on *2*easy*mid*portfolio*, such that the sum, reflecting the effect of subrogation on portfolio loans, is

[32] Specifically, for their sample (borrowers who are delinquent on their first mortgage and also have a second lien), when the first loan is held in a bank's portfolio, the bank is also the servicer of the second loan 60% of the time, while if the first mortgage is securitized the servicer of the first mortgage also services the second mortgage only 30-40% of the time.

not statistically different from zero (see the formal chi-square test statistics for the hypothesis *2*easy*mid + 2*easy*mid*portfolio* = 0 at the bottom of the table). This is consistent with joint ownership of the loans neutralizing the effect of subrogation.

Besides the legal barrier posed by time priority, there is also the institutional barrier posed by the CLL for U.S. homeowners to negotiate. This appears to have been a particularly high barrier in 2009, given that jumbos fell to just 5 percent of originations that year (down from 21 percent in 2005).[33] These two barriers can interact. When a first mortgage balance falls below the CLL, but the first plus second mortgage balance exceeds it, the borrower benefits especially from refinancing only the first, because only this way does she tap the conforming rather than jumbo market. Were the combined balance instead below the CLL, she could roll both mortgages into one new conforming mortgage. Thus she is especially exposed to the second lienholder's blocking power, so we modify the test to determine whether refinancing in this situation is especially affected by time priority.[34]

For each homeowner we create an indicator *span cll* for whether the first-mortgage balance is below the CLL, but the combined first and second mortgage balances exceed the CLL. This indicator uses the county-level conforming loan limit, which equals $417,000 in a majority of counties, but is higher in other counties (see discussion above). To implement the test we add *span cll* to the probit model, and interact it with the indicators for easy states. The results are displayed in Column C of Table 5. We find that a second mortgage spanning the CLL significantly decreases the propensity to refinance, but only in states that do not have easy subrogation laws. By contrast, in easy states the effect is insignificant. Thus, a second mortgage spanning the CLL impedes

[33] Source: Mortgage Market Statistical Annual.
[34] We discuss the direct effect of the CLL on refinancing, as opposed to the indirect effect through subrogation law, in Section 6 below.

refinancing, but not in the states that permit borrowers to circumvent time priority through equitable subrogation.

Magnitude of effect:

Besides providing the test statistics, the statistical models also indicate the magnitude of the effect of easy subrogation law on the probability of refinancing. The quantity of interest is the marginal change in refinancing probability associated with switching subrogation law from not-easy to easy for a borrower with two loans and an intermediate CLTV. For the linear probability model, this is simply $\gamma_{2\times Easy} + \gamma_{Easy\times CLTV,M} + \delta_M$, which from Column B of Table 5 is 2.2%. For the probit model of column E (discussed below), the analogous marginal change is also 2.2% (Column F).[35] It is worth noting that both estimates are close to the marginal effect implied by the sample averages of Table 4, since (16.12-16.09) - (14.58-17.13) = 2.58%.[36]

We can put this effect of subrogation law in perspective by comparing it to the effects of two other major determinants of a borrower's refinancing decision, namely the potential interest rate reduction, and the borrower's credit score.

Mortgage rates varied little over 2009, so the interest-rate environment of the refinancings in our sample was relatively stable. Therefore, a given borrower's potential coupon reduction is primarily determined by the coupon on her existing mortgage. Our data show this coupon but do not indicate whether the borrower paid points to get it. The data also do not indicate how the

[35] For the probit model, this marginal effect is computed by averaging the change in refinancing probability induced by changing the borrower's state from not easy to easy, across the subsample of borrowers residing in not-easy states, and with two loans and intermediate CLTV.

[36] In this latter calculation, the change in refinancing probability is calculated by comparing the refinancing probability of a borrower with intermediate CLTV and two mortgages across states with easy and not-easy subrogation law, i.e., 16.12%-16.09%, and then using the difference in refinancing probability for borrowers with low CLTV and one mortgage to sweep out state-level differences between states with easy and not-easy subrogation law, i.e., 14.58%-17.13%.

borrower acquired the mortgage, whether through a high- or low-priced broker, or through shopping around a little or a lot. These unobservable differences are potentially important and likely persistent over time. To circumvent the bias they can impart, we rerun our baseline model from Column A in Column E of Table 5 with the borrower's actual outstanding interest rate replaced by the market rate for a mortgage with the same term, taken out at the time of origination of the mortgage.[37] The result is an estimated coefficient on the interest rate which is about 25% higher than in Column A, and which equates the effect of subrogation law on refinancing to the effect of 26 basis points of interest-rate savings. That is, using these Column E estimates, the increase in refinancing probability associated with a change in subrogation law for a borrower with two mortgages and an intermediate CLTV is the same as that of a 26 basis point increase in the rate reduction from refinancing. [38]

Comparing the effect of subrogation law to the effect of the credit score requires a similar adjustment. This is because the baseline regression of Column A includes both the credit score at the origination of the original mortgage and the credit score from December 2008, and because the two are highly correlated. Accordingly, in Column E we also include only the December 2008 Equifax riskscore, and we find that the estimated coefficient is about 25% higher than the estimate from Column A, and that it equates the effect of subrogation law to the effect of 33 credit-score points. That is, the value of 0.022 reported at the bottom of Column F for the marginal effect on refinancing probability from a change in subrogation law for a borrower with two mortgages and an

[37] More precisely, in estimating this model we restrict attention to 15-year and 30-year FRM, and use the relevant market interest rate from the Freddie Mac Primary Mortgage Market Survey two months before the origination date of the mortgage (to reflect the time span between mortgage application and origination).

[38] The marginal effects for the Column E model, reported in Colum F, show that an increase in interest rate savings of 100 basis points raises the probability of refinancing in 2009 by 9.2 percentage points, which corresponds to an increase of 61% in the refinancing probability. This estimate is broadly consistent with estimates from the existing literature. For example, Bennett et al's (2001) results imply that if the market rate is 3.3% (the average ten-year treasury yield in 2009), then borrowers who took out a mortgage when ten year rates were 5.4% would refinance with a probability of $e^{2.5\times(1.28-1.14)} = 1.42$ times the refinancing probability of borrowers facing a market rate of 4.4% (the average ten year rate at the times the mortgages in our sample were originated).

intermediate CLTV is the same as the effect of a (0.022/0.067)(100) = 33 point increase in the borrower's December 2008 credit score.

Comparison to HARP and Quantitative Easing

The U.S. government intervened in the refinancing market with the Home Affordable Refinance Program, or HARP, which aims to bring the benefits of refinancing to homeowners who might otherwise be shut out. Because this intervention occurred during our 2009 sample period, we can use our sample to gauge its net effect and to compare this effect to that of subrogation law.

HARP brings improved access to refinancing to homeowners with mortgages satisfying certain bounds, so we can use these bounds to identify its effect. To be eligible, a loan needed to have been acquired or guaranteed by a GSE prior to June 2009; to have an LTV between 80% and 125%;[39] and to show zero delinquencies in the preceding six months and at most one delinquency in the six months prior to that. We first use the LTV criterion to form a rough difference-in-differences estimate of the causal impact of HARP on refinancing. Specifically, we compare the refinancing rates for GSE mortgages before and after the introduction of HARP (March 2009), and above (80% < LTV < 125%) and below (70% < LTV < 80%) the 80% cutoff for HARP eligibility.[40] This controls for the possibility that a mortgage refinanced under HARP would have otherwise refinanced through other channels (and indeed, FHA refinancings dropped following the introduction of HARP). For GSE mortgages with LTVs between 70 and 80%, the Q1 refinancing rate was 6.53% (Panel A of Table 8). If this trend had continued over Q2-Q4, it would have implied

[39] When HARP was first introduced, the maximum LTV was 105%. Within a few months this upper limit was raised to 125%. In 2012, HARP was substantially modified; the upper bound on LTV of 125% was removed and other criteria were relaxed.

[40] Note that all of the first mortgages in our sample were originated between 2003 and 2007. In addition, our restriction to prime mortgages, with credit scores of at least 660, and which are current as of December 2008, ensures that they also meet the other HARP criteria.

a refinancing rate of 19.59% over Q2-Q4. By contrast, the actual refinancing rate over Q2-Q4 was 13.74%, lower by 5.85%. For those mortgages with LTVs between 80 and 125%, the Q1 refinancing rate was 4.19% and the Q2-Q4 rate was 10.07%. So the actual refinancing rate in Q2-Q4 was lower than the extrapolated Q1 rate by 3×4.19-10.07=2.5%. Consequently, a rough estimate of the 2009 effect of HARP is that it raised the 2009 refinancing rate for eligible borrowers by 5.85-2.5 = 3.35 percentage points.[41]

The above analysis suggests that the increased refinancing HARP brings to the borrowers it affects is approximately 1.5 times the increase that subrogation law brings to those it affects. We can use this ratio to evaluate the alternate policy of expanding subrogation law from the easy states to the entire country. In our estimation sample, as of December 2008 there are 19,809 first mortgages that would be affected by such a policy (in not-easy states, have a second mortgage, and are either in the middle CLTV region or the second spans the conforming loan limit). In comparison, there are 77,733 loans in our sample that meet the HARP criteria. Hence HARP potentially affects roughly four times as many borrowers as would this alternative, and so (using the estimate above) HARP's effect on 2009 refinancing was roughly six times greater than that of expanding subrogation law.

Finally, to translate these estimates to a national scale, note that in our initial (pre-match) LPS dataset, at the end of 2008 there are approximately 5 million HARP eligible loans.[42] Consequently, our estimates above imply that instituting a nationwide subrogation law would affect approximately 1.25m loans. Similarly, our estimates imply that HARP led to 175,000 additional

[41] Our estimate is similar in magnitude to that obtained by Agarwal et al (2015) for the period 2009-2012. We can also further control for trends in refinancing by using the data in Panel B, on the refinancing rates for non-jumbo privately securitized mortgages (which were not HARP-eligible). Repeating the same procedure, we estimate a decrease in refinancing rates from Q1 to Q2-Q4 of 3×4.59-9.06=4.71% for mortgages with LTVs between 70 and 80%, and 2.67% for mortgages with LTVs between 80 and 125%. Thus the refinancing rate for high-LTV privately securitized mortgages falls by 2.04% less than low-LTV mortgages. Subtracting this from our estimate for GSE mortgages above, we obtain a (much smaller) estimate of the impact of HARP in 2009 of 3.35%-2.04% = 1.31 percentage points.

[42] This estimate is comparable to, though larger than, Goodman's (2012) estimate of 3.3 million eligible loans in 2012.

refinancings in 2009, while the hypothetical expansion of subrogation law would generate approximately a sixth of that, i.e. 29,000 additional refinancings.

Finally, from panel C, the number of HARP refinancings was roughly twice as high in 2010 and 2011 as in 2009. The program expanded eligibility in 2012 and 2013, and refinancings further rose to five times the 2009 level. It is unclear what fraction of these refinancings would have occurred even without HARP (a drawback of the difference-in-differences approach deployed above it that it can only be used to examine the impact of introducing the program). By 2014 the effect of the program seems to have waned.

A final, though necessarily more speculative, comparison is to the effects of quantitative easing (QE). While there is substantial debate about the magnitude of the effect of QE, Krishnamurthy and Vissing-Jorgensen (2011) estimate the effect of QE2 on mortgage rates as approximately 10 basis points (see their Table 5), which compares to the 26 basis point rate reduction that subrogation law equates to (as calculated above), for the subpopulation it applies to. So QE2 brought somewhat less refinancing relief per affected household, but to a wider population.[43]

Robustness

To gauge the sensitivity of the test result to our modeling choices, we re-run the test with different specifications. One important choice is the partitioning by CLTV to identify the borrowers ripe for equitable subrogation. We address this in Table 9 by replicating the main probit specification (column A of Table 5), with finer partitions. The first set of results uses five partitions, while the second uses nine. These alternate partitions yield the same result: as

[43] Note, moreover, that many of the households that benefitted from QE2 would have refinanced in its absence, and thus to a large extent it represented a transfer from lenders to borrowers.

Hypotheses 1 and 2 predict, time priority has its effect in the middle range. Indeed, these regressions represent our strongest evidence in support of Hypothesis 2, by documenting a clear hump-shaped pattern in the triple-interaction term between multiple liens, easy subrogation law and CLTV, with the estimated coefficients for both low and high CLTV being both small and statistically indistinguishable from 0.

Another choice in Table 5 is the variety of first mortgages to include. Our sample period is distinctive in its proliferation of mortgage products, many now dormant (e.g. 2/28s), and its high incidence of private securitization. To ensure the external validity of our results, it is worth re-running the test on mortgages more representative of the typical market, so we re-run the test on 30-year fixed-rate mortgages that were not privately securitized. The result, in Row *i* of Panel B, Table 10 (which, to conserve space, reports only the indicators and their interactions), is still significant. We also re-run the test on just the homeowners with only one first mortgage, thereby eliminating borrowers with multiple mortgaged properties, for whom the association of first and second mortgages could be problematic.[44] The result, in Row *ii*, is still significant. Finally, to address robustness with respect to the coding of legal regimes, the model in Row *iii* removes ten states (Colorado, Delaware, Hawaii, Michigan, Montana, Ohio, Rhode Island, South Dakota, Vermont and West Virginia) where the distinction between easy and not easy is cloudy because there is no case law, the law is unclear, or the cases are "conflicting" (see Table 1). The removal has little effect on the results.

Identification

[44] Furthermore, for the homeowners in this sample who also have a second mortgage, 95% of them have only a single such junior lien.

In both the probit and linear models, the implicit identification assumption is that although baseline refinancing rates may vary across states, all explanatory variables affect refinancing in the same way in all states. However, this restriction is not required to test Hypotheses 1-3, since the probit regression remains identified if Z_i is instead defined by:

$$\begin{aligned} Z_i = \sum_j (X_i\beta_{Xj} + \gamma_j)D_{ij} + CLTV_{M,i}\gamma_{CLTV,M} + CLTV_{H,i}\gamma_{CLTV,H} + 2_i \cdot \gamma_2 \\ + 2_i \cdot \left(CLTV_{M,i} \cdot \gamma_{2\times CLTV,M} + CLTV_{H,i} \cdot \gamma_{2\times CLTV,H}\right) \\ + \sum_j \left(CLTV_{M,i} \cdot \gamma_{Easy\times CLTV,M} + CLTV_{H,i} \cdot \gamma_{Easy\times CLTV,M}\right) \cdot Easy_j \cdot D_{ij} \\ + \sum_j \left(CLTV_{M,i} \cdot \delta_M + CLTV_{H,i} \cdot \delta_H\right) \cdot 2_i \cdot Easy_j \cdot D_{ij} \\ + \sum_j \gamma_{2\times Easy} 2_i \cdot Easy_j \cdot D_{ij} \end{aligned} \quad (2)$$

Here, all explanatory variables other than the CLTV indicator variables and the multiple lien indicator are allowed to have different effects in different states. Row *iv* of Panel B, Table 10, reports the key coefficients from this estimate, and confirms that they continue to support Hypotheses 1-3, i.e., that subrogation law only affects borrowers with an intermediate CLTV and multiple liens. Indeed, support for Hypothesis 2 is stronger here than in our baseline empirical specification (1).

Next, we consider further weakening the identification assumptions by also allowing the effects of CLTV and multiple liens to differ (individually) across states. In this way, we address a potentially important concern, namely that several of the states with easy subrogation law were particularly affected by the housing crash of 2007, and it is conceivable that borrowers with high CLTV or multiple liens in such states were especially affected. In doing so, we rely on the fact that

Hypotheses 1 and 2 merely require that subrogation law is the only cross-state difference that *jointly* interacts with CLTV and the presence of multiple liens. To this end, we estimate a probit in which Z_i is instead defined by:

$$Z_i = 2_i \cdot \left(CLTV_{M,i} \cdot \gamma_{2\times CLTV,M} + CLTV_{H,i} \cdot \gamma_{2\times CLTV,H}\right) + \sum_j \left[2_i \cdot \left(CLTV_{M,i} \cdot \delta_M + CLTV_{H,i} \cdot \delta_H\right)\right] \cdot Easy_j \cdot D_{ij} + \sum_j \left[X_i\beta_{X\times j} + \gamma_j + CLTV_{M,i}\gamma_{CLTV,M\times j} + CLTV_{H,i}\gamma_{CLTV,H\times j} + 2_i \cdot \gamma_{2,j}\right] \cdot D_{ij}. \quad (3)$$

In this estimation, which is fully identified, all independent variables — including the CLTV indicators and the multiple lien indicator — are allowed to affect refinancing differently in different states. Importantly, this empirical specification still allows us to test the model's central prediction, namely Hypotheses 1 and 2. (In contrast, Hypothesis 3 cannot be tested under the weaker identifying restrictions embodied in this last estimation.) Row *v* of Panel B, Table 10, displays the results of this estimation, which are again consistent with Hypotheses 1 and 2.

6. Other determinants of refinancing

A: Basic determinants

Table 5 also sheds light on other influences on the propensity to refinance.[45] Some of these are straightforward: higher coupons and balances on the first mortgage increase refinancing, as does a longer term, a higher credit score (at origination or in December 2008) and a lower LTV. Lower county-level unemployment rates are also associated with more refinancing. GSE-securitized

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

mortgages are also more likely to be refinanced, consistent with GSEs' higher standards at origination, and ARMs are also more likely to be refinanced, which may, as Moensch, Vickery and Aragon (2010) argue, reflect the relatively low rates on new fixed-rate-mortgages, compared to ARMs, that prevailed at that time.

B: Conforming loan limits

We find above that the CLL has an indirect effect on refinancing through subrogation law. Here, we consider the direct effect.

It is well-documented that home buyers strive to borrow in the conforming, rather than jumbo market, and that this effect was particularly pronounced when jumbo loans became harder to obtain following the onset of the financial crisis (Fuster and Vickery, 2015).

In response, the Economic Stimulus Act of 2008 temporarily increased CLLs in certain high-cost housing markets.[46] Evidence is mixed on whether these new limits entirely supplanted the default limit of $417K. Fuster and Vickery (2015) show that the raised limits sharply increased the share of fixed-rate mortgages, as they freed lenders to originate these loans without retaining their elevated interest-rate risk. However, Vickery and Wright (2013) argue that this new "super-conforming" market was not quite the same as the regular, sub-$417K conforming market, finding for instance that rates for above-$417K mortgages were higher than for sub-$417K mortgages.[47] In addition, the GSEs imposed higher underwriting standards for these loans.[48] Thus it is an open question whether there remained a significant benefit to having a principal balance at or below $417K when the CLL was higher.

[46] Prior to 2008, the CLL was constant across the contiguous US.
[47] In part, because the super-conforming pools did not qualify for TBA trading.
[48] http://www.freddiemac.com/singlefamily/mortgages/docs/Updated_LTVs_superconforming.pdf

To address this question, we build on the result in Table 5 that first mortgages with December, 2008 balances above the CLL are less likely to be refinanced in 2009, whether the limit in the county in question was $417K or higher. In Column D of Table 5 we address the significance of $417K when the county limit is higher by restricting the sample to loans falling in counties with higher limits (about 35% of our sample), and then testing for the separate effects of the two limits.[49] We do this by including separate indicator variables for the first loan balance being above each of the limits, and then calculating p-values for their coefficients. The main result is that the higher, county-specific CLL comes in significantly, and $417K does not. Thus, not only did the policy of increasing CLLs succeed in improving borrowers' access to refinancing, but furthermore, when the CLL was increased, there was no remaining significance, with respect to successful refinancing, of the old limit.

Do borrowers adapt to the significance of the CLL when refinancing? In particular, do they scale back their new loans, if necessary, to conform to the CLL? We illustrate this behavior in Figure 5. We restrict the sample to borrowers with balances above the conforming loan limit who successfully refinance in 2009,[50] and plot the new loan's balance against that of the old (refinanced) loan. We do this for those borrowers located in a county where the conforming loan limit remained at $417,000, making up 56% of our sample, and for those in counties with the highest CLL, namely $729,750 (17% of our sample).[51] The comparison finds a strong tendency among borrowers with old loans above the CLL to shrink their new borrowing to the CLL.[52] This is the case both when the CLL is $417,000, as well as for those borrowers living in the high-cost counties with a CLL of

[49] To focus on the impact of the conforming loan limit, we further restrict attention to borrowers with first mortgage principal balances above $300,000 as of December 2008, and no second mortgage.
[50] And with no second mortgage.
[51] Each of the remaining CLL's was associated with only a small share of refinancers.
[52] This was also supported by a formal econometric analysis: results are available upon request.

$729,750.[53] Furthermore, for those borrowers in the high-cost counties the lower national limit of $417,000 appears to have little import.[54]

7. Why does blocking power matter?

How does time priority impede refinancing? In the frictionless Coasian setting, subrogation law would not impede refinancing, because the refinancings it addresses make both the borrower and the second lienholder better off. The goal of this section is to characterize the frictions responsible for the shortfall in refinancing. We are interested in particular in whether the frictions are best characterized as fixed across mortgages, or instead increasing with the mortgage balance. This is an important distinction because it sheds light on the variation, across borrowers, of the impact of time priority. That is, to the extent the cost is fixed, it impedes the refinancing of small mortgages more than of big mortgages, and thus concentrates the impact of time priority on homeowners with less-valuable homes.

Among the potential frictions are some that would likely be the same across mortgages, and others that would grow with the mortgage. The former category would include the borrower's time and effort to identify and contact the lienholder, and the lienholder's time and effort to do his diligence and execute the paperwork (along these lines, Maturana, 2014, finds evidence that servicers' capacity constraints interfered with beneficial mortgage modifications). The fixed cost

[53] Of those who do not reduce their new loan to the CLL, it is easy to see that the majority fall near the 45 degree line; i.e. the new loan's principal balance is roughly equal to that on the old loan.
[54] In addition, for those counties with the CLL equal to $729,750, there is also a modest share who refinance to $625,500; which was the FHA loan limit for high-cost areas in 2009.

could be explicit: many lienholders reportedly charge a fixed amount to resubordinate.[55] Among the costs that could increase with the mortgage balance, perhaps the most likely is failed bargaining over the surplus. That is, the lienholder might bargain more aggressively when there is more surplus, and this higher aggressiveness could result in more failures. Another cost that increases with the mortgage balance, and which has been reported in the popular press, is the need for a longer rate lock when refinancing a homeowner who has two mortgages.[56] A distinct alternative is that, for some fraction of mortgages, resubordination agreements are impossible to obtain (i.e., infinitely costly) because of the internal organization of the current junior lienholder; in this case, time priority will affect the refinancing of small and big mortgages equally.

We test for the fixed vs. variable character of the friction by comparing the impact on big and small mortgages. We categorize a first mortgage as being big if it is above the sample median of $160K, and small otherwise. We test:

Hypothesis 4: For small mortgages, $\delta_M > 0$ *and* $\delta_H = 0$*, while for big mortgages,* $\delta_M = \delta_H = 0$.

Support for this hypothesis is support for the fixed-cost view. It would further suggest that the cost is finite and thus surmountable. Conversely, rejection (together with support for Hypotheses 1 and 2, discussed above) would indicate that variable frictions are important.

To test Hypothesis 4, we re-estimate our basic probit model of refinancing on separate samples of borrowers with small and big first mortgages. The results are in Panel A of Table 10, and support Hypothesis 4. For small mortgages (row *i*) we find that δ_M is positive and statistically

[55] See Ilyce R. Glick and Samuel J. Temkin's article, in Real Estate Matters, in The Washington Post, on September 25, 2010.
[56] See Benny L. Kass's column, Housing Counsel, in the Washington Post, on June 16, 2007.

different from 0, while δ_H is statistically indistinguishable from 0. In contrast, for big mortgages (row *ii*), neither δ_M nor δ_H is statistically distinguishable from 0.[57]

Together, these results suggest that there is an important fixed cost component to the frictions that cause time priority to affect refinancing. As noted, one specific example of a fixed cost is simply that the second lienholder may charge an explicit subordination fee. However, the estimated magnitude of the effect of time priority suggests that other costs exist beyond explicit subordination fees. Recall that subrogation law has the same effect on refinancing as a change in the mortgage interest rate of 26 basis points.[58] On a loan with the median principal balance of $160,000, this translates to $500 annually, and thus to a present value in the thousands of dollars. By contrast, quoted subordination fees are typically one-time payments in the $200-$300 range.

8. Effects on the incidence of second liens

Our results thus far provide evidence that the principle of time priority impedes the refinancing of the first of two mortgages. This has both positive and negative effects on a second lender's ex ante expected payoff. On the positive side, the second lender may gain seniority if the borrower refinances the first loan without a resubordination agreement; receive a subordination fee in exchange for such an agreement; or gain an advantage in the competition to refinance the first loan. On the negative side, and as our results establish, time priority reduces the incidence of refinancing, which potentially hurts the second lender by increasing default risk. Overall, the dominant effect can only be determined empirically — although there is at least one significant theoretical argument suggesting that the positive effects should dominate, namely that the second

[57] Moreover, additional results (available upon request) support Hypothesis 4 even under the weaker identifying assumptions of equation (3) above.
[58] Moreover, one would obtain a substantially larger estimate if one calculated this interest-rate equivalent using the subsample of smaller loans.

lender can always take steps to facilitate resubordination in those cases in which he would especially benefit from payment-reducing refinancing of the first mortgage. Accordingly, we test:

Hypothesis 5: Ceteris paribus, under the principle of time priority a borrower with an existing first mortgage is more likely to obtain a second mortgage.[59]

We test Hypothesis 5 by examining whether time priority makes a borrower more likely to take out a second mortgage over the two years after taking out the first. In running this test we distinguish between loans taking out jointly with the first, i.e. "piggyback" seconds, and loans taken out separately from the first ("subsequent seconds"). In the test, we take the former to be seconds taken out within a month of the first, and the latter to be those taken out in the 23 subsequent months. Because the decision whether to take a piggyback loan is often determined simultaneously with the choice of the first mortgage balance, to keep the first-mortgage balance below the CLL, or to avoid the need for private mortgage insurance (Calhoun, 2005),[60] our interest is primarily in the subsequent seconds, but for completeness we present the results for both sets.

Table 11 displays the results of this probit analysis. The regression includes a number of controls, including the LTV and interest rate associated with the first loan, and the borrower's FICO score at the origination of the first loan. The piggyback seconds are on the left, and the non-piggyback, subsequent seconds that we focus on are on the right.

The hypothesis is that subsequent second mortgages are more likely in time priority, i.e. not-easy, states, and this is borne out by the significantly negative coefficient on *easy* in columns (C)

[59] A closely related hypothesis is that, ceteris paribus, the interest rate charged on second mortgages is lower under the principle of time priority. Unfortunately our dataset lacks information on the interest rate on second mortgages, and we are unable to use it to test this hypothesis.

[60] This is also confirmed by our results. For example, a first mortgage that is close to the conforming loan limit is associated with a high likelihood of having a piggyback mortgage, but not a subsequent second (Table 11).

and (D). Moreover, the magnitude of the effect is economically significant: time priority increases the probability of a second loan by approximately 1.3 percentage points, relative to the sample average of 18%. An alternative way to get a sense of the magnitude of the effect is to note that it is approximately equal to an increase of 20 points in a borrower's FICO score at the time of first-mortgage origination.

The rest of the coefficients in columns (C) and (D) show us the other determinants of second mortgages, and these are largely as one would expect. Borrowers with high first-mortgage LTVs are less likely to take a second, as are those with first-mortgage balances above the CLL. Similarly, riskier borrowers, such as those with low origination FICO scores, or loans that are privately securitized or held in portfolio, or borrowers whose first loans were "low-doc" are also less likely. Those that have enjoyed substantial house price appreciation are instead more likely to take a second, intuitively to extract this new equity.

Because subrogation law is determined at the state level, we are unable to include state-level fixed effects in this regression. However, in column (D), we include dummies for three other state-level laws that the literature [Pence (2006) and Ghent and Kudlyak (2011)] has suggested are important in mortgage-market outcomes: the ability of a lender to obtain deficiency judgments, i.e. recourse to the borrower's other assets in case of a mortgage default, the requirement for the mortgage lender to use a judicial foreclosure process , and the number of days in the typical foreclosure timeline for that state.[61] These additional controls have little effect on our estimates, and in particular, the coefficient on *easy* remains significantly negative.

[61] These variables are all taken from Table 1 of Ghent and Kudlyak (2011).

Among the other sources of interstate legal variation, it is unsurprising that the effect of requiring judicial foreclosure is negative, as this would intuitively make lending less attractive.[62] From this perspective it might seem at first surprising that the effect of prohibiting deficiency judgments is positive. However, this is consistent with the limitation of this prohibition, in most states, to purchase-money mortgages, which would not include second loans taken subsequent to first mortgages.[63] That the prohibitions would increase the demand for prohibition-exempt second loans concurs with the evidence in Pence (2006) that prohibitions on deficiency judgments reduce the size of the mortgages they apply to (the first), as this implies that the affected homeowners are relatively eager to borrow more (and do so by taking out subsequent seconds).

Finally, for completeness we include in columns (A) and (B) the analogous estimate for piggyback loans. These estimates confirm that piggyback second mortgages often serve to allow a first mortgage at the 80% LTV threshold required to avoid private mortgage insurance: specifically, the estimated coefficient on the first mortgage origination LTV being exactly 80% is large, positive, and strongly statistically significant, whereas in the subsequent second regressions of columns (C) and (D), the coefficient is instead negative and, smaller by an order of magnitude (and, more generally, higher first mortgage LTVs are negatively associated with the likelihood of a subsequent second). Similarly, the coefficient on the first mortgage balance at origination being within $1000 of the GSE conforming loan limit is again large, positive, and strongly statistically significant,

[62] This finding is broadly consistent with Pence (2006), who finds that laws mandating judicial approval of foreclosures reduce the size of purchase-mortgages, although they have little effect on equilibrium loan approval probabilities.
[63] The exact scope of deficiency-judgment prohibitions is determined by state-level law. For the case of California (a prominent example of a state with deficiency-judgment prohibitions), see http://www.southerncaliforniabankruptcylawblog.com/2012/10/02/the-treatment-of-a-second-mortgage-after-a-foreclosure-sale/, and in particular: "The second mortgage holder is still free to collect its shortfall from you if the second was a refinance. However, if the second was a loan you took out for the original purchase of the home, then it too is barred from going after you..."

whereas it is insignificant for subsequent seconds. It is consequently unsurprising that we find little evidence of subrogation law affecting the incidence of piggyback second mortgages.[64]

9. Summary and Conclusion

Interest rates on new mortgages have been at historic lows in recent years. As such, existing borrowers, and perhaps even society, would benefit greatly from refinancing, as this both increases their disposable income and reduces their foreclosure risk by easing their mortgage service (Agarwal et al, 2015, Fuster and Willen, 2015, and Zhu, 2015). However, and in spite of various government efforts to facilitate refinancing, the pace of refinancing has fallen short of many observers' hopes, especially among heavily indebted borrowers who would have especially benefited. Two common explanations for the lower-than-expected pace of refinancing are suboptimal borrower decisions, and frictions in the refinancing process. In this paper we document the importance of one widespread friction, the assignment of mortgage seniority by time priority. We show that this prevailing state-law practice makes refinancing harder for homeowners with multiple liens, who were particularly numerous during the crisis. Time priority had this effect even though the parties can contract around it at some expense through resubordination, and it had a bigger effect on smaller mortgages, indicating that this expense has a significant fixed component. Among homeowners with larger mortgages, the impact is felt particularly by those put in a bind by the CLL, with first mortgages below the limit but combined balances above. Their ability to refinance is significantly greater in the states that lower the time-priority barrier through the countervailing principle of equitable subrogation.

[64] Parallel to column (D), column (B) allows for other state level laws to affect the incidence of piggyback loans. Both judicial-foreclosure mandates and deficiency-judgment prohibitions reduce a borrower's propensity to take a second loan. Note that the negative sign on deficiency-judgment prohibitions contrasts with the positive estimate for subsequent second loans reported in column (D). However, if we subdivide the piggyback loan sample into purchase loans and refinancing loans, we find that deficiency-judgment prohibitions have a negative effect only for the purchase sample (unreported, available upon request). Both these findings are consistent with the fact discussed in the main text that deficiency-judgment prohibitions generally apply only to purchase-money mortgages.

Because both the homeowner and the holder of her second mortgage benefit when the homeowner refinances her first mortgage to a lower rate, as opposed to not refinancing at all, the failures to refinance that we document represent ex-post deadweight losses from their perspective.[65] This is further evidence of the practical significance of the legal environment, and the cost of contracting around it (see, e.g., La Porta et al (1998)). The scale of the effect of time priority raises the question of whether all states should adopt equitable subrogation. Our estimates put the effect of such an adoption, on the affected population, at the level of an additional 26 basis points of interest-rate savings, or an increase of 33 points in the homeowner's credit score. Our estimates also put the effect of equitable subrogation on those it affects in the neighborhood of the effect of HARP on those that HARP affects. Thus, a countrywide adoption would bring significant new access to refinancing.

Whether this makes adoption a good idea depends on whether the ex post benefits described above outweigh the ex ante costs. The time priority rule serves as a form of refinancing penalty, and thus could benefit the holders of the first mortgage, and some of these benefits could be passed to homeowners in the form of lower interest rates.[66] In addition, second-mortgage lenders may also value and pay ex ante for the bargaining power imparted ex post by time priority. There is at least some evidence for this latter channel, in that time priority increases the incidence of second mortgages.[67] Assessing the net costs and benefits of time priority is thus an important question for future research.

[65] See Piskorski, Seru and Vig (2010), Adelino, Gerardi and Willen (2013), and Agarwal, et al. (2011a) for more on securitization and the efficiency of mortgage modifications. See also Kroszner (2008) for evidence on the existence of mutually beneficial loan modifications in a different context.
[66] See Mayer et al (2013) for a theoretical model in which refinancing penalties can be welfare-improving.
[67] Our data do not show the coupons on these second mortgages, so we leave that dimension of the effect to future research.

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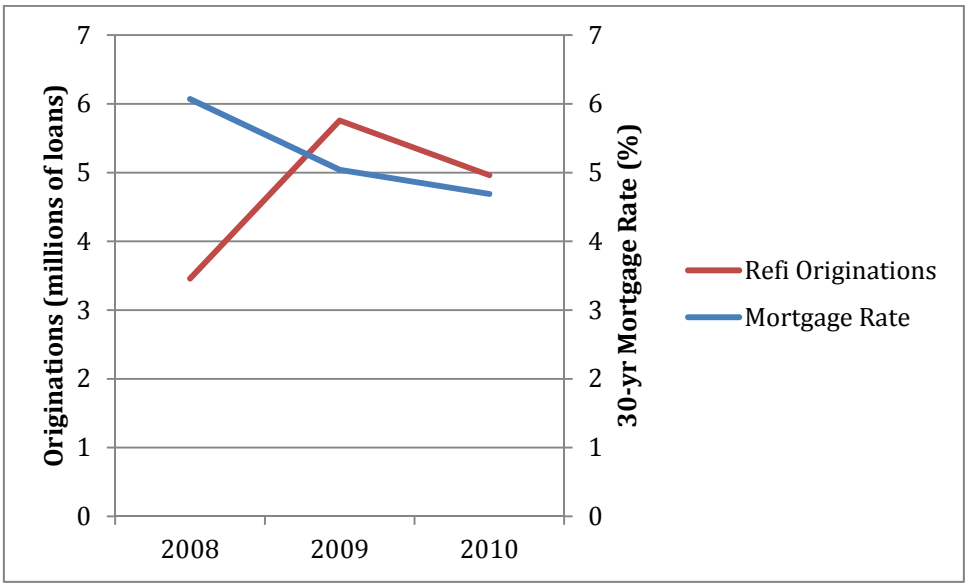

Figure 1. Mortgage rates and new refinancings, 2008-10. The refinancing originations are from the HMDA data, and the mortgage rates are the 30-year mortgage rates from the FHLMC primary mortgage market survey.

States With Easy Subrogation Laws

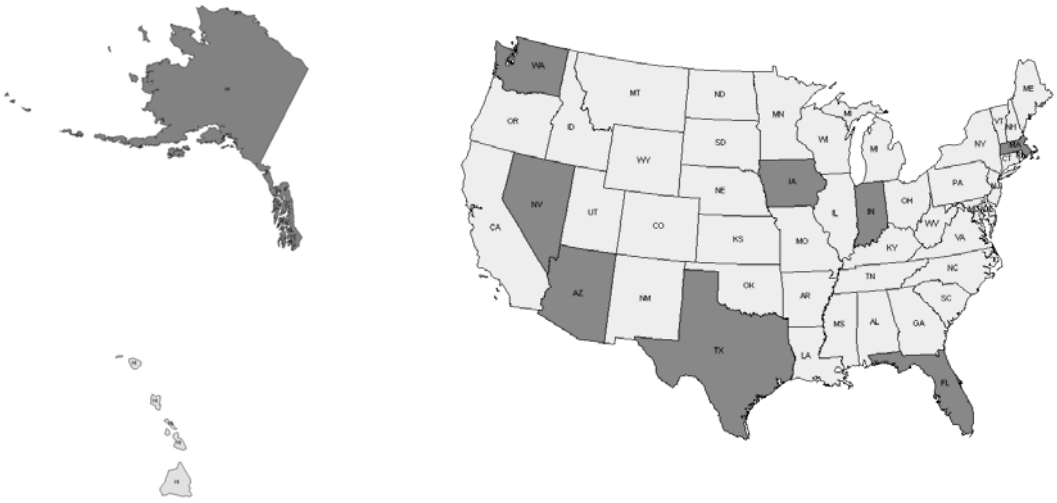

Figure 2. Geographic distribution of easy subrogation states. Easy Subrogation states are dark grey; Not-easy states are light gray.

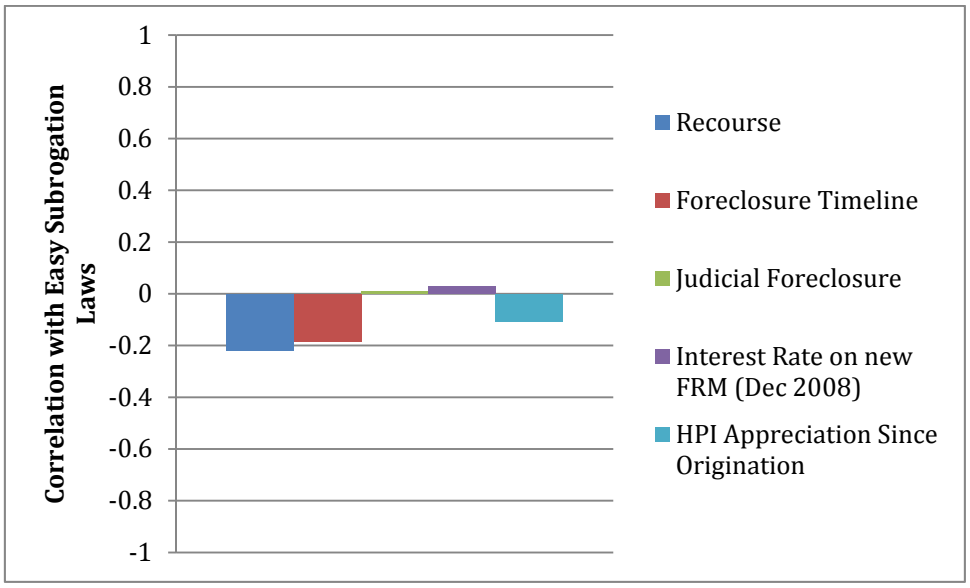

Figure 3. Correlation of easy subrogation laws with other state-level factors. The figure plots the correlation of easy subrogation laws with other state laws affecting mortgages, and also with state-level average interest rates and HPI appreciation. The state laws are from Ghent and Kudlyak (2011). The interest rates are for fixed-rate mortgages originated in the LPS dataset in December 2008. The HPI appreciation is for mortgages in our dataset.

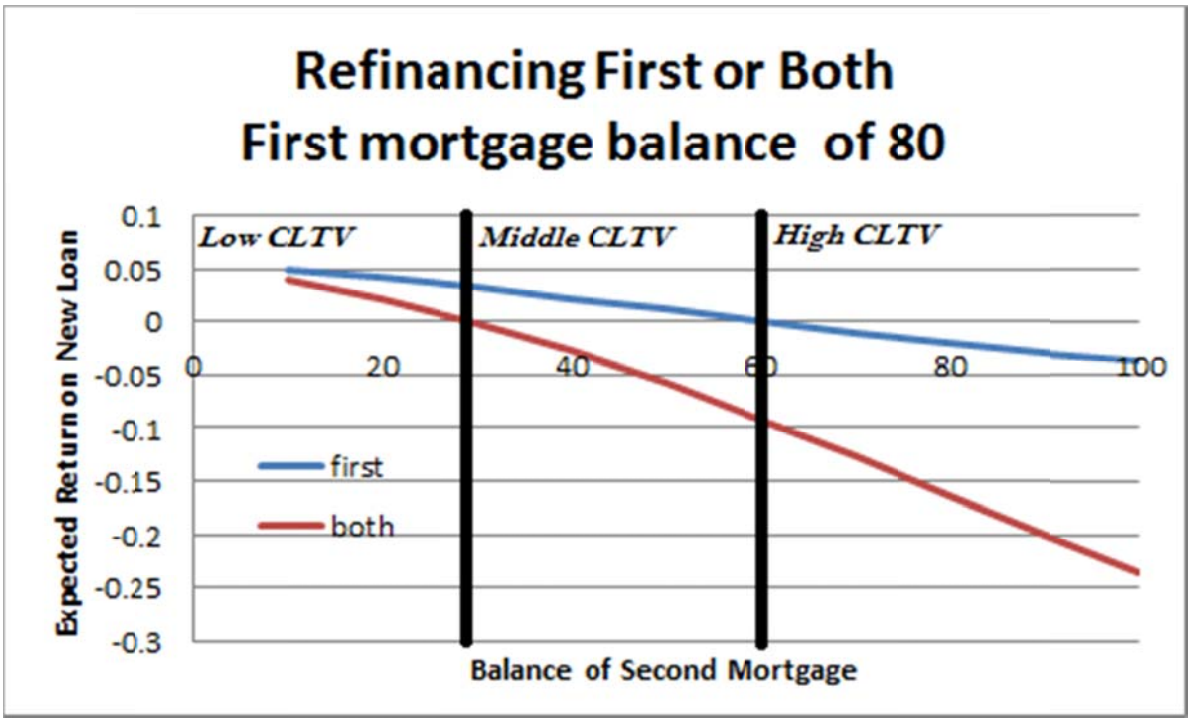

Figure 4. Model of mortgage refinancing: Numerical example. The figure assumes a first mortgage with interest rate 10% and balance 80, a second mortgage with an interest rate of 12% and the balance indicated on the horizontal axis, a home whose future value has a mean of 150 and a standard deviation of 50, and a cost of foreclosure, as experienced by any current lender, of 10.

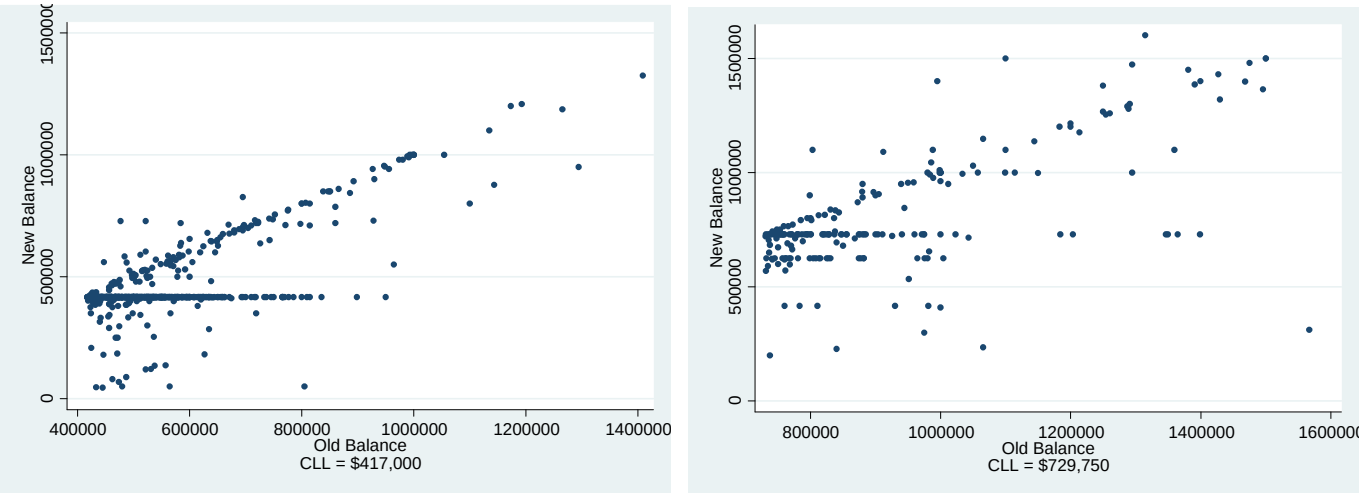

Figure 5: We plot the new balance against the old balance, for those borrowers with a principal balance at the end of 2008 above the county-level conforming loan limit, and with no second mortgage, who successfully refinanced in 2009. We do this for counties with a limit equal to $417,000 (left panel), and for those with a limit of $729,750 (right). The sample is a subset of that of the baseline regression in Table 6.

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. The rightmost column indicates how the laws were coded for our analysis: An easy subrogation state is indicated by "E" and a not-easy state by "NE".

State	Legal position	Controlling case	Notes and comments	Our Coding
Alabama (AL)	Yes if constructive notice, no if actual knowledge.	In re Hubbard, 89 B.R. 920 (Bankr.N.D.Ala.1988)		NE
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.	E
Arizona (AZ)	Restatement	Lamb Excavation, Inc. v. Chase Manhattan Mortgage Corp., 95 P.3d 542 (Ariz.App.2004)		E
Arkansas (AR)	Yes if constructive notice, no if actual knowledge.	United States v. Hughes, 499 F.2d 322 (8th Cir.1974)		NE
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)		NE
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	NE
Connecticut (CT)	No if actual or constructive notice	Independence One Mortg. Corp. v. Katsaros, 43 Conn.App. 71, 681 A.2d 1005 (1996)		NE
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)		NE
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.	E
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.	E

Georgia (GA)	Not if actual or constructive notice	McCollum v. Lark, 187 Ga. 292, 200 S.E. 276 Ga. 1938		NE
Hawaii (HI)	Unclear; court's analysis is too cursory.	Strouss v. Simmons, 66 Haw. 32, 657 P.2d 1004 (Hawaii,1982)		NE
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)		NE
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."	NE
Indiana (IN)	Restatement	Bank of New York v. Nally, 820 N.E.2d 644 (Ind.2005)		E
Iowa (IA)	Restatement	Klotz v. Klotz, 440 N.W.2d 406 (Iowa App.1989)		E
Kansas (KS)	No if actual or constructive notice	National City Mortg. Co. v. Ross, 117 P.3d 880 (Kan.App.2005)		NE
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)		NE
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.	NE
Maine (ME)	Yes if constructive notice, no if actual knowledge.	United Carolina Bank v. Beesley, 663 A.2d 574 (Me.1995)		NE
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)		NE
Massachusetts (MA)	Restatement	East Boston Sav. Bank v. Ogan, 428 Mass. 327, 701 N.E.2d 331 (1998)		E
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.	NE
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.)		NE
Mississippi (MS)	Yes if constructive notice, no if actual knowledge.	Home Owners' Loan Corporation v. Moore, 185 So. 253 (Miss.1939)		NE
Missouri (MO)	No if actual or constructive notice	184 Miss. 283, 185 So. 253		NE
Montana (MT)	No case law	Miss. 1939.		NE

Nebraska (NE)		American National Bank v. Clark, 660 N.W.2d 530 (Neb.App.2003)	Ostensibly based on "conventional subrogation."	NE
Nevada (NV)	Restatement	Houston v. Bank of America, 78 P.3d 71 (Nev.2003)		E
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.	NE
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)		NE
New Mexico (NM)	Yes if constructive notice, no if actual knowledge.	In re Beltramo, 367 B.R. 825, 2007 WL 1307917 (Bkrtcy.D.N.M.2007)	A bankruptcy court predicting NM law.	NE
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)		NE
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)		NE
North Dakota (ND)				NE
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.	NE
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.	NE
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.	NE
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."	NE
Rhode Island (RI)	No case law			NE
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)		NE
South Dakota (SD)				NE
Tennessee (TN)	Apparently no subrog.in absence of fraud or mistake by the lender being subordinated	Bankers Trust Co. v. Collins, 124 S.W.3d 576 (Tenn.Ct.App.2003)		NE

Texas (TX)	Restatement	Farm Credit Bank v. Ogden, 886 S.W.2d 305 (Tex.App.1994)	There are several earlier Texas cases taking the same view as early as 1969.	E
Utah (UT)	No if actual or constructive notice	Richards v. Security Pacific Nat. Bank, 849 P.2d 606 (Utah App.1993)		NE
Vermont (VT)	Unclear	No modern cases		NE
Virginia (VA)	No if actual or constructive notice	Centreville Car Care, Inc. v. North American Mortg. Co., 559 S.E.2d 870 (Va.2002)		NE
Washington (WA)	Restatement	Bank of America v. Prestance Corp., 2007 WL 1631420 (Wash. 2007)		E
West Virginia (WV)	No case law			NE
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)	The *Pierner* 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.	NE
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)		NE

Table 2
Variable Definitions

In these definitions, *dec08* refers to December 31, 2008, and *orig* refers to the date of origination of the first mortgage.

Variable	Definition
2	1 if borrower has 2nd mortgage as of 12/08
CLTV [d]	Balance of all mortgages on property, divided by property value, as of date *d*, in percent
low	1 if *CLTV dec08* $\leq$ 75 ($CLTV_L$ in the text)
mid	1 if 75< *CLTV dec08* $\leq$ 95 ($CLTV_M$ in the text)
hi	1 if 95 < *CLTV dec08* $\leq$ 150 ($CLTV_H$ in the text)
first [n]	1 if coupon fixed for first *n* months
private	1 if privately-securitized mortgage
portfolio	1 if mortgage held in lender's portfolio
gse	1 if mortgage securitized by FNMA or FHLMC
FICO orig	FICO score as of origination
ltv orig *ltv orig =80* *ltv orig >80*	loan-to-value of the first mortgage as of origination date, in percent *ltv orig* = 80 *ltv orig* > 80
bal [d] *vclose orig*	first-mortgage balance as of date *d* *bal orig* $\in$ [$416,000,$417,000]
orig [y]	1 if first mortgage originated in year *y*
[n]yr	1 if mortgage term at origination is *n* years
opt arm	1 if option-ARM style mortgage
jumbo 417	1 if first mortgage balance as of 12/08 in excess of $417K
cll	county conforming loan limit as of 12/08
jumbo cll	1 if first mortgage balance as of 12/08 in excess of *cll,* and *cll* > $417
condo	1 if mortgaged property is a condominium
low doc	1 if low-doc or no-doc mortgage
coupon [d]	mortgage coupon as of date *d*, in percent
second bal	Balance of second mortgage, if it exists, as of 12/08. Undefined if no second.
unemp dec08	county unemployment rate as of 12/08
escore dec08	Equifax risk score as of 12/08
easy	1 if residence is in a state permitting easy subrogation
*span cll*not easy*	1 if *bal dec08<cll and bal dec08* +balance of second mortgage as of 12/08 > *cll*, and *easy=0*
*span cll*not easy*	1 if *bal dec08<cll and bal dec08* +balance of second mortgage as of 12/08 > *cll*, and *easy=1*
*marginal effect of easy on 2*mid*	Effect on probability of refinancing of moving mid-*CLTV* borrower with 2 mortgages to easy state

Table 3
Sample Comparisons

The column labeled "Matched" characterizes the mortgages in the sample resulting from the match of LPS data with FRBNY/Equifax data, and used to estimate the baseline model in Table 5. The column labeled "Unmatched" characterizes a random sample of mortgages drawn from the LPS dataset (with the same sample restrictions), but not matched to the FRBNY/Equifax data. The column "not easy" reports the average for the portion of our dataset representing mortgages on properties in not-easy states, as defined in the text. The column "easy" addresses the easy states.

Variable	Matched	Unmatched	Not Easy	Easy
refinanced in 2009	0.15		0.158	0.128
easy	0.245	0.255	0	1
fico Orig	744	741	744	743
bal orig	$212,343	$211,252	$217,757	$195,682
ltv orig	67.4	69	67	68.7
orig 2003	0.139	0.164	0.145	0.122
	0.14	0.177	0.144	0.128
orig 2005	0.223	0.226	0.223	0.22
orig 2006	0.198	0.188	0.193	0.215
orig 2007	0.3	0.245	0.294	0.316
fixed-rate	0.94		0.937	0.948
first 6	0	0	0	0
first 12	0.003	0.004	0.003	0.002
first 60	0.033	0.045	0.035	0.028
first 84	0.014	0.018	0.014	0.013
first 120	0.01	0.011	0.011	0.009
10yr	0.016	0.013	0.017	0.015
15yr	0.162	0.154	0.162	0.162
20yr	0.041	0.035	0.043	0.036
30yr	0.78	0.798	0.778	0.787
option arm	0.009	0.01	0.009	0.008
condo	0.086	0.113	0.091	0.091
lowdoc	0.137	0.146	0.149	0.13
GSE	0.855	0.846	0.851	0.868
private	0.106	0.114	0.113	0.087
portfolio	0.038	0.04	0.036	0.045
second	0.276		0.281	0.26
second bal	$48,477		$49,713	$44,361
CLTV dec08	0.744		0.733	0.779
unemp dec08	6.949	7.033	6.98	6.85
coupon dec08	5.951	5.921	5.94	6.00
escore dec08	774		775	771
jumbo 417	0.063	0.056	0.069	0.043
jumbo cll	0.013	0.012	0.014	0.012
lo	0.477		0.491	0.432
mid	0.294		0.295	0.293
hi	0.229		0.215	0..275
# observations	255097	641998	192535	62562

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

This table reports the 2009 refinancing rate for first mortgages in the sample used for estimating the models in Table 5. The CLTV includes balances on all mortgages in the borrower's credit bureau file as of December 2008, and the house price is updated using the Corelogic ZIP-code-level house price index, as described above. We split the sample by whether the borrower has a second mortgage in his credit bureau file as of December 2008, and the states are grouped (Easy versus Not Easy) by whether or not they permit equitable subrogation, i.e. they have adopted the Restatement.

Low CLTV Range (CLTV≤75)		
	Not Easy	*Easy*
No Second	17.13%	14.58%
Second	17.45%	14.77%
Second-No Second	0.32%	0.19%
Middle CLTV Range (75<CLTV≤95)		
	Not Easy	*Easy*
No Second	19.35%	15.69%
Second	16.09%	16.12%
Second-No Second	-3.25%	0.43%
High CLTV Range (95<CLTV≤150)		
	Not Easy	*Easy*
No Second	8.20%	5.73%
Second	9.70%	8.41%
Second-No Second	1.50%	2.68%

Table 5
Models of Refinancing in 2009

This table reports a probit model and a linear probability model, where observations are borrowers with non-delinquent mortgages as of 12/08, and the dependent variable indicates a successful refinancing of the first mortgage in 2009. The basic probit model is in column A, and one expanded to test for the effect of spanning the conforming loan limit, i.e. having a first mortgage balance below the limit and a combined balance above, is in column C. Column B reports a linear probability model for the model in Column A. Column D limits the sample to the borrowers with no second mortgage, and located in counties where the conforming loan limit exceeds $417K. Column E reruns the baseline model for 15 and 30-year FRM, but with a single credit score, and substituting the market interest rate at origination for the coupon. Column F reports marginal effects for the model in Column E. Statistical significance is indicated with "**" for the 5% level and "*" for 10%. Standard errors clustered at the county level. State fixed effects are included but not reported. Variables are defined in Table 2. Coefficients on controls for origination year, term and fixed term of fixed/floating mortgages are not reported; complete results are reported in the online appendix.

Expl. Var.	A	*se*	B	*se*	C	*se*	D	*se*	E	***se***	**F**
2	0.111**	*0.014*	0.020**	*0.003*	0.121**	*0.014*			0.102**	*0.016*	0.022
Mid	-0.218**	*0.014*	-0.049**	*0.004*	-0.216**	*0.014*	-0.205**	*0.045*	-0.209**	*0.014*	-0.049
Hi	-0.760**	*0.026*	-0.159**	*0.005*	-0.758**	*0.026*	-0.945**	*0.071*	-0.700**	*0.027*	-0.132
*easy*mid*	-0.028	*0.027*	-0.010*	*0.006*	-0.029	*0.027*	0.021	*0.061*	-0.038	*0.027*	
*easy*hi*	-0.014	*0.054*	0.009	*0.008*	-0.015	*0.054*	0.330**	*0.097*	-0.024	*0.055*	
*2*mid*	-0.073**	*0.019*	-0.015**	*0.005*	-0.070**	*0.019*			-0.074**	*0.021*	
*2*hi*	0.068**	*0.025*	0.014**	*0.005*	0.075**	*0.025*			0.057**	*0.026*	
*2*easy*	-0.020	*0.034*	-0.004	*0.007*	-0.028	*0.034*			-0.005	*0.036*	
*2*easy*mid*	0.144**	*0.043*	0.036**	*0.009*	0.143**	*0.043*			0.136**	*0.047*	
*2*easy*hi*	0.088*	*0.051*	0.010	*0.009*	0.084*	*0.051*			0.077	*0.052*	
private securit.	-0.146**	*0.015*	-0.027**	*0.003*	-0.137**	*0.016*	-0.043	*0.041*	-0.072**	*0.018*	-0.015
Portfolio	-0.284**	*0.020*	-0.053**	*0.004*	-0.281**	*0.020*	-0.172**	*0.049*	-0.286**	*0.022*	-0.053
FICO orig / 100	0.182**	*0.009*	0.040**	*0.002*	0.182**	*0.009*	0.282**	*0.033*			
ltv orig / 100	-0.135**	*0.034*	-0.028**	*0.007*	-0.145**	*0.034*	-0.643**	*0.115*	-0.176**	*0.033*	-0.037
opt arm	-0.254**	*0.049*	-0.050**	*0.009*	-0.252**	*0.049*	-0.386**	*0.113*			
jumbo 417	-0.398**	*0.038*	-0.088**	*0.009*	-0.412**	*0.038*	-0.035	*0.040*	-0.372**	*0.036*	-0.067
jumbo cll	-0.456**	*0.050*	-0.094**	*0.010*	-0.466**	*0.050*	-0.437**	*0.052*	-0.432**	*0.051*	-0.074
condo	-0.221**	*0.018*	-0.042**	*0.004*	-0.222**	*0.018*	-0.148**	*0.049*	-0.216**	*0.018*	-0.042
low doc	-0.053**	*0.011*	-0.012**	*0.002*	-0.054**	*0.011*	-0.067*	*0.040*	-0.062**	*0.012*	-0.013
cll ($MM)	-0.154*	*0.087*	-0.044**	*0.018*	-0.146*	*0.088*	-0.082	*0.191*	-0.136	*0.091*	-0.029
coupon dec08	0.346**	*0.010*	0.065**	*0.002*	0.347**	*0.010*	0.232**	*0.031*			
market rate (orig.)									0.437**	*0.018*	0.092
log(bal dec08)	0.487**	*0.009*	0.100**	*0.002*	0.495**	*0.009*	-0.113	*0.081*	0.421**	*0.009*	0.089
unemp dec08	-0.022**	*0.004*	-0.004**	*0.001*	-0.022**	*0.004*	-0.046**	*0.012*	-0.022**	*0.004*	-0.005
escore dec08 / 100	0.260**	*0.010*	0.054**	*0.002*	0.259**	*0.010*	0.424**	*0.037*	0.317**	*0.010*	0.067
*span cll*not easy*					-0.178**	*0.031*					
*span cll*easy*					-0.057	*0.056*					
*marginal effect of easy on 2*mid*											0.022
#obs	255097		255097		255097		18778		224007		

Table 6
Closing Second Mortgages

This table reports the probability of closing a mortgage in 2009 or 2010, for those with a second mortgage at the end of 2008, and who refinanced their first mortgage in 2009, broken down by CLTV. Variables are defined in Table 2.

range	*prob*
low	60.08%
mid	57.51%
hi	53.36%

Table 7
Subrogation: Effect of Portfolio Holding

This table reports the results of an extension of the probit model in Column A of Table 5, in which an indicator for portfolio-held mortgages is interacted with *easy*, *2*, and *mid* and *hi*. Only the coefficients on these variables and their interactions are reported; full results are in the online appendix. Statistical significance is indicated with "**" for the 5% level and "*" for 10%. Test statistics for the hypotheses that *2*easy + 2*easy*portfolio*=0, *2*easy*mid+2*easy*mid*portfolio*=0 and *2*easy*hi+2*easy*hi*portfolio*=0 are reported as χ^2(*low*), χ^2(*mid*) and χ^2(*hi*), respectively. Standard errors are clustered at the county level. State fixed effects are included. Variables are defined in Table 2.

Expl. Var.	*Coef*	*se*
portfolio	-0.132**	0.034
2	0.114**	0.015
mid	-0.212**	0.014
hi	-0.745**	0.026
*2*portfolio*	-0.128*	0.075
*mid*portfolio*	-0.170**	0.048
*hi*portfolio*	-0.267**	0.068
*easy*mid*	-0.029	0.027
*easy*hi*	-0.020	0.055
*easy*mid*portfolio*	0.079	0.075
*easy*hi*portfolio*	0.122	0.099
*2*mid*	-0.077**	0.020
*2*hi*	0.057**	0.026
*2*mid*portfolio*	0.134	0.107
*2*hi*portfolio*	0.156	0.125
*2*easy*	-0.021	0.035
*2*easy*portfolio*	0.103	0.150
*2*easy*mid*	0.149**	0.042
*2*easy*hi*	0.095*	0.051
*2*easy*mid*portfolio*	-0.222	0.242
*2*easy*hi*portfolio*	-0.159	0.237
χ^2(*low*)	0.30	0.587
χ^2(*mid*)	0.09	0.768
χ^2(*hi*)	0.07	0.787

Table 8
HARP Refinancings

Panel A reports the refinancing rates of GSE-guaranteed mortgages in 2009. Panel B reports the refinancing rates of non-jumbo privately securitized mortgages in 2009. Panel C reports HARP refinancings by year, in thousands, as reported in the Federal Housing Finance Agency Refinance Report, First Quarter 2015.

Panel A

	2009Q1	2009Q2-Q4
70<LTV≤80	6.53%	13.74%
80<LTV≤125	4.19%	10.07%

Panel B

	2009Q1	2009Q2-Q4
70<LTV≤80	4.59%	9.06%
80<LTV≤125	2.42%	4.59%

Panel C

year	*refis*
2009	197
2010	365
2011	438
2012	1066
2013	893
2014	212

Table 9
Robustness to CLTV Bin Widths

The probit model of successful refinancing, from Column A of Table 5, is repeated with finer partitions for CLTV; instead of three, there are five, and then nine. The model is otherwise identical. The variable *cltv_btw_x_y* is 1 if $x <$ *CLTV dec08* $\leq y$, and 0 otherwise. Standard errors are clustered at the county level. Statistical significance is indicated with "**" for the 5% level and "*" for 10%.

Bin	*coef*	*se*
*2*easy*	-0.021	0.034
*2*easy*cltv_btw_75_85*	0.132**	0.052
*2*easy*cltv_btw_85_95*	0.155**	0.055
*2*easy_cltv_btw_95_105*	0.139**	0.052
*2*easy*cltv_btw_105_150*	0.029	0.072
*2*easy*	-0.011	0.036
*2*easy*cltv_btw_70_75*	-0.056	0.074
*2*easy*cltv_btw_75_80*	0.067	0.077
*2*easy_cltv_btw_80_85*	0.172**	0.067
*2*easy*cltv_btw_85_90*	0.134*	0.072
*2*easy*cltv_btw_90_95*	0.160**	0.067
*2*easy*cltv_btw_95_100*	0.216**	0.067
*2*easy*cltv_btw_100_105*	0.011	0.083
*2*easy*cltv_btw_105_150*	0.019	0.073

Table 10
Variations on Baseline Probit Model

In this table, each pair of rows represents the output of a probit model, with standard errors below coefficients. Panel A: A model of successful refinancing in 2009 is repeated separately for borrowers with first mortgages below (row *i*) and above (row *ii*) the median ($160K) for 12/08. Panel B: Model *i* limits the sample to fixed-rate, 30-year, first mortgages that are either GSE-securitized or held in bank portfolios, Model *ii* limits the sample to borrowers with just one first mortgage, and Model *iii* drops mortgages on residences in the states with unclear subrogation law: CO, DE, HI, MI, MT, OH, RI, SD, VT, and WV. Models *iv* and *v* report the results from estimating equations (2) and (3), which interact the covariates with the state fixed effects. Variables are defined in Table 2. Standard errors clustered at county level. State fixed effects (and any interactions) are included but not reported. Statistical significance is indicated with "**" for the 5% level and "*" for 10%. Only the coefficients on the interacted variables are reported; full results are reported in the online appendix.

	2	***mid***	***hi***	***easy*mid***	***easy*hi***	***2*mid***	***2*hi***	***2*easy***	***2*easy* mid***	***2*easy* hi***
Panel A										
i(small)	0.207**	-0.172**	-0.602**	-0.106**	-0.029	-0.087**	0.01	-0.093**	0.247**	0.09
	0.02	*0.02*	*0.032*	*0.034*	*0.052*	*0.033*	*0.039*	*0.044*	*0.071*	*0.074*
ii(big)	0.002	-0.236**	-0.794**	0.015	0.019	-0.015	0.126**	0.04	0.064	0.066
	0.019	*0.018*	*0.035*	*0.034*	*0.069*	*0.026*	*0.034*	*0.045*	*0.054*	*0.07*
Panel B										
i	0.078**	-0.203**	-0.694**	-0.032	-0.029	-0.048*	0.097**	0.015	0.121**	0.048
	0.02	*0.015*	*0.026*	*0.031*	*0.053*	*0.026*	*0.029*	*0.045*	*0.053*	*0.06*
ii	0.138**	-0.188**	-0.759**	-0.038	-0.025	-0.116**	0.046*	-0.014	0.166**	0.093*
	0.015	*0.015*	*0.027*	*0.027*	*0.054*	*0.021*	*0.026*	*0.034*	*0.044*	*0.05*
iii	0.105**	-0.212**	-0.768**	-0.026	0.007	-0.083**	0.046	-0.017	0.152**	0.108**
	0.015	*0.015*	*0.029*	*0.027*	*0.055*	*0.021*	*0.028*	*0.035*	*0.043*	*0.052*
iv	0.094**	-0.227**	-0.751**	0.002	0.089*	-0.053**	0.075**	-0.029	0.138**	0.058
	0.015	*0.015*	*0.026*	*0.029*	*0.053*	*0.02*	*0.025*	*0.035*	*0.042*	*0.051*
v						-0.063**	0.048*		0.128**	0.053
						0.021	*0.025*		*0.044*	*0.049*

Table 11

Determinants of Second Mortgages

This table reports the results from estimating probit models where the dependent variable is 1 if a second mortgage is taken out, and 0 otherwise. The sample is that of the baseline model in Table 5, but without the requirement that the first mortgage be active and current at the end of 2008. In models A and B, the second mortgage is taken out within a month of the first mortgage (and thus the sample for these models includes only those mortgages that entered the sample within one month of origination). In models C and D, the second mortgage is taken out within 2 years of the first mortgage (but after one month), and before the first mortgage terminates. Standard errors are clustered at the county level. Statistical significance is indicated with "**" for the 5% level and "*" for 10%.

	A		***B***		***C***		***D***	
	coef	*stderr*	*coef*	*stderr*	*coef*	*stdeff*	*coef*	*stderr*
ltv orig =80	0.397**	0.009	0.396**	0.009	-0.019**	0.009	-0.012	0.009
ltv orig > 80	-0.911**	0.014	-0.915**	0.014	-0.239**	0.009	-0.230**	0.009
log(bal orig)	-0.058**	0.008	-0.052**	0.008	0.223**	0.007	0.212**	0.007
low doc	0.134**	0.010	0.133**	0.010	-0.042**	0.009	-0.039**	0.009
Refi	-0.472**	0.009	-0.469**	0.009	0.102**	0.007	0.095**	0.006
first 6	-0.185**	0.090	-0.185**	0.090	-0.282**	0.086	-0.283**	0.085
first 12	-0.151**	0.034	-0.150**	0.034	-0.049*	0.029	-0.043	0.029
first 60	0.133**	0.014	0.130**	0.014	0.032**	0.012	0.027**	0.012
first 84	0.122**	0.017	0.119**	0.017	0.050**	0.018	0.046**	0.018
first 120	0.162**	0.022	0.163**	0.022	0.018	0.022	0.013	0.022
opt arm	-0.243**	0.027	-0.237**	0.027	0.063**	0.027	0.052*	0.027
FICO orig/100	-0.122**	0.010	-0.123**	0.010	-0.221**	0.007	-0.225**	0.007
15 yr	-0.013	0.020	-0.014	0.020	-0.009	0.019	-0.007	0.019
20 yr	0.010	0.024	0.009	0.024	-0.011	0.023	-0.006	0.023
30 yr	0.199**	0.022	0.197**	0.022	0.015	0.019	0.016	0.019
jumbo	-0.063**	0.015	-0.062**	0.015	-0.031**	0.015	-0.036**	0.016
private	0.043**	0.013	0.044**	0.013	-0.053**	0.013	-0.051**	0.013
portfolio	0.102**	0.009	0.104**	0.009	-0.038**	0.009	-0.038**	0.009
orig 2004	0.235**	0.012	0.235**	0.012	-0.019**	0.008	-0.025**	0.008
orig 2005	0.324**	0.013	0.322**	0.012	-0.013	0.011	-0.024**	0.011
orig 2006	0.377**	0.011	0.375**	0.012	-0.225**	0.014	-0.242**	0.014
orig 2007	0.228**	0.011	0.225**	0.012	-0.541**	0.016	-0.557**	0.017
unemp orig	-0.015**	0.003	-0.015**	0.003	-0.008**	0.003	-0.013**	0.003
vclose orig	0.472**	0.024	0.472**	0.024	0.022	0.029	0.027	0.029
hpi 2yr					0.382**	0.026	0.355**	0.027
easy	-0.016	0.013	0.007	0.013	-0.052**	0.024	-0.043**	0.021
no defjudge			-0.068**	0.012			0.061**	0.011
no njforeclose			-0.075**	0.014			-0.038**	0.013
days			0.000*	0.000			0.000	0.000
# observations	421362		421362		346947		346947	

Appendix: An 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; otherwise the borrower will 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.

The first mortgagee's expected repayment, net of foreclosure costs, which we denote as E_1, is

$$E_1 = Pr(V \geq F_1R_1)F_1R_1 + Pr(V < F_1R_1)E(V \mid V < F_1R_1) - Pr(V < F_1R_1 + F_2R_2)c.$$

For specificity, assume now that ε follows a normal distribution with mean 0 and standard deviation σ. Under this assumption, E_1 can be written explicitly as:

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

where Φ and φ are the cdf and pdf, respectively, of the Standard Normal distribution. 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 as 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 lender's maximum possible expected returns from refinancing the first mortgage or refinancing both mortgages are E_1/F_1-1 or $E_B/(F_1+F_2)$-1, respectively. Thus 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 4 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.

Online Appendix: All Explanatory Variables

Table 5: Models of Refinancing in 2009

This table, corresponding to Table 5 in the paper, reports a probit model and a linear probability model, where observations are borrowers with non-delinquent mortgages as of 12/08, and the dependent variable indicates a successful refinancing of the first mortgage in 2009. The basic probit model is in column A, and one expanded to test for the effect of spanning the conforming loan limit, i.e. having a first mortgage balance below the limit and a combined balance above, is in column C. Column B reports a linear probability model for the model in Column A. Column D limits the sample to the borrowers with no second mortgage, and located in counties where the conforming loan limit exceeds $417K. Column E reruns the baseline model for 15 and 30-year FRM, but with a single credit score, and substituting the market interest rate at origination for the coupon. Column F reports marginal effects for the model in Column E. Statistical significance is indicated with "**" for the 5% level and "*" for 10%. Standard errors clustered at the county level. State fixed effects are included but not reported. Variables are defined in Table 2.

Expl. Var.	A	*se*	B	*se*	C	*se*	D	*se*	E	*se*	*F*
2	0.111**	*0.014*	0.020**	*0.003*	0.121**	*0.014*			0.102**	*0.016*	0.022
Mid	-0.218**	*0.014*	-0.049**	*0.004*	-0.216**	*0.014*	-0.205**	*0.045*	-0.209**	*0.014*	-0.049
Hi	-0.760**	*0.026*	-0.159**	*0.005*	-0.758**	*0.026*	-0.945**	*0.071*	-0.700**	*0.027*	-0.132
*easy*mid*	-0.028	*0.027*	-0.010*	*0.006*	-0.029	*0.027*	0.021	*0.061*	-0.038	*0.027*	
*easy*hi*	-0.014	*0.054*	0.009	*0.008*	-0.015	*0.054*	0.330**	*0.097*	-0.024	*0.055*	
*2*mid*	-0.073**	*0.019*	-0.015**	*0.005*	-0.070**	*0.019*			-0.074**	*0.021*	
*2*hi*	0.068**	*0.025*	0.014**	*0.005*	0.075**	*0.025*			0.057**	*0.026*	
*2*easy*	-0.020	*0.034*	-0.004	*0.007*	-0.028	*0.034*			-0.005	*0.036*	
*2*easy*mid*	0.144**	*0.043*	0.036**	*0.009*	0.143**	*0.043*			0.136**	*0.047*	
*2*easy*hi*	0.088*	*0.051*	0.010	*0.009*	0.084*	*0.051*			0.077	*0.052*	
first 6	0.440	*0.246*	0.092	*0.047*	0.434*	*0.246*	-0.042	*0.622*			
first 12	0.241	*0.063*	0.046	*0.014*	0.240**	*0.063*	0.356**	*0.144*			
first 60	0.408	*0.024*	0.080	*0.006*	0.411**	*0.024*	0.396**	*0.050*			
first 84	0.420	*0.026*	0.086	*0.007*	0.420**	*0.026*	0.286**	*0.078*			
first 120	0.408	*0.029*	0.092	*0.008*	0.412**	*0.029*	0.327**	*0.067*			
private securit.	-0.146**	*0.015*	-0.027**	*0.003*	-0.137**	*0.016*	-0.043	*0.041*	-0.072**	*0.018*	-0.015
portfolio	-0.284**	*0.020*	-0.053**	*0.004*	-0.281**	*0.020*	-0.172**	*0.049*	-0.286**	*0.022*	-0.053
FICO orig / 100	0.182**	*0.009*	0.040**	*0.002*	0.182**	*0.009*	0.282**	*0.033*			
ltv orig / 100	-0.135**	*0.034*	-0.028**	*0.007*	-0.145**	*0.034*	-0.643**	*0.115*	-0.176**	*0.033*	-0.037
orig 2004	0.124**	*0.016*	0.020**	*0.003*	0.122**	*0.016*	0.036	*0.063*	0.112**	*0.017*	
orig 2005	0.137**	*0.014*	0.024**	*0.003*	0.133**	*0.014*	0.034	*0.052*	0.195**	*0.015*	
orig 2006	0.352**	*0.019*	0.078**	*0.004*	0.348**	*0.019*	0.255**	*0.060*	0.335**	*0.022*	
orig 2007	0.361**	*0.017*	0.079**	*0.004*	0.358**	*0.017*	0.327**	*0.058*	0.359**	*0.019*	
15yr	0.085**	*0.039*	0.002	*0.005*	0.082**	*0.039*	0.646	*0.563*			
20yr	0.141**	*0.042*	0.008	*0.006*	0.137**	*0.042*	0.797	*0.576*			
30yr	0.103**	*0.039*	0.004	*0.005*	0.099**	*0.039*	0.828	*0.560*			
opt arm	-0.254**	*0.049*	-0.050**	*0.009*	-0.252**	*0.049*	-0.386**	*0.113*			
jumbo 417	-0.398**	*0.038*	-0.088**	*0.009*	-0.412**	*0.038*	-0.035	*0.040*	-0.372**	*0.036*	-0.067
jumbo cll	-0.456**	*0.050*	-0.094**	*0.010*	-0.466**	*0.050*	-0.437**	*0.052*	-0.432**	*0.051*	-0.074
condo	-0.221**	*0.018*	-0.042**	*0.004*	-0.222**	*0.018*	-0.148**	*0.049*	-0.216**	*0.018*	-0.042
low doc	-0.053**	*0.011*	-0.012**	*0.002*	-0.054**	*0.011*	-0.067*	*0.040*	-0.062**	*0.012*	-0.013
cll ($MM)	-0.154*	*0.087*	-0.044**	*0.018*	-0.146*	*0.088*	-0.082	*0.191*	-0.136	*0.091*	-0.029
coupon dec08	0.346**	*0.010*	0.065**	*0.002*	0.347**	*0.010*	0.232**	*0.031*			
market rate (orig.)									0.437**	*0.018*	0.092
log(bal dec08)	0.487**	*0.009*	0.100**	*0.002*	0.495**	*0.009*	-0.113	*0.081*	0.421**	*0.009*	0.089
unemp dec08	-0.022**	*0.004*	-0.004**	*0.001*	-0.022**	*0.004*	-0.046**	*0.012*	-0.022**	*0.004*	-0.005
escore dec08 / 100	0.260**	*0.010*	0.054**	*0.002*	0.259**	*0.010*	0.424**	*0.037*	0.317**	*0.010*	0.067
*span cll*not easy*					-0.178**	*0.031*					
*span cll*easy*					-0.057	*0.056*					
*marginal effect of easy on 2*mid*											0.022
#obs	255097		255097		255097		18778		224007		

Table 10: Other Refinancing Models

In this table, each column corresponds to a row of Table 10 in the paper. Panel A: A model of successful refinancing in 2009 is repeated separately for borrowers with first mortgages below (column *i*) and above (column *ii*) the median ($160K) for 12/08. Panel B: Model *i* limits the sample to fixed-rate, 30-year, first mortgages that are either GSE-securitized or held in bank portfolios, Model *ii* limits the sample to borrowers with just one first mortgage, and Model *iii* drops mortgages on residences in the states with unclear subrogation law: CO, DE, HI, MI, MT, OH, RI, SD, VT, and WV. Models *iv* and *v* report the results from estimating equations (2) and (3), which interact the covariates with the state fixed effects. Variables are defined in Table 2. Standard errors clustered at county level. State fixed effects (and any interactions) are included but not reported. Statistical significance is indicated with "**" for the 5% level and "*" for 10%.

Panel A

	i(small)		*ii(big)*	
Expl Var	*coef*	*se*	*coef*	*se*
2	0.207**	*0.020*	0.002	*0.019*
mid	-0.172**	*0.020*	-0.236**	*0.018*
hi	-0.602**	*0.032*	-0.794**	*0.035*
*easy*mid*	-0.106**	*0.034*	0.015	*0.034*
*easy*hi*	-0.029	*0.052*	0.019	*0.069*
*2*mid*	-0.087**	*0.033*	-0.015	*0.026*
*2*hi*	0.010	*0.039*	0.126**	*0.034*
*2*easy*	-0.093**	*0.044*	0.040	*0.045*
*2*easy*mid*	0.247**	*0.071*	0.064	*0.054*
*2*easy*hi*	0.090	*0.074*	0.066	*0.070*
first 6	0.628	*0.399*	0.312	*0.264*
first 12	0.366**	*0.111*	0.174**	*0.078*
first 60	0.406**	*0.038*	0.409**	*0.028*
first 84	0.524**	*0.046*	0.375**	*0.033*
first 120	0.381**	*0.071*	0.409**	*0.032*
private	-0.166**	*0.027*	-0.132**	*0.020*
portfolio	-0.246**	*0.036*	-0.289**	*0.026*
FICO orig / 100	0.121**	*0.014*	0.236**	*0.013*
ltv orig / 100	-0.197**	*0.041*	-0.268**	*0.056*
orig 2004	0.108**	*0.020*	0.123**	*0.023*
orig 2005	0.150**	*0.019*	0.098**	*0.018*
orig 2006	0.330**	*0.022*	0.335**	*0.025*
orig 2007	0.309**	*0.022*	0.367**	*0.023*
15yr	0.019	*0.041*	0.236**	*0.117*
20yr	0.018	*0.046*	0.338**	*0.123*
30yr	-0.014	*0.040*	0.264**	*0.119*
opt arm	-0.116	*0.087*	-0.256**	*0.053*
jumbo 417			-0.301**	*0.037*
jumbo cll			-0.399**	*0.047*
Condo	-0.218**	*0.024*	-0.220**	*0.022*
low doc	-0.038**	*0.015*	-0.072**	*0.014*
cll ($MM)	-0.428**	*0.107*	-0.034	*0.104*
coupon dec08	0.370**	*0.013*	0.337**	*0.015*
log(bal dec08)	0.592**	*0.017*	0.317**	*0.019*
unemp dec08	-0.007	*0.004*	-0.038**	*0.005*
escore dec08 / 100	0.155**	*0.014*	0.351**	*0.012*
#obs	126335		128762	

Panel B

	i		*ii*		*iii*		*iv*	
Expl Var	*coef*	*se*	*coef*	*se*	*coef*	se	*coef*	*se*
2	0.078**	*0.020*	0.138**	*0.015*	0.105**	*0.015*	0.094**	*0.015*
mid	-0.203**	*0.015*	-0.188**	*0.015*	-0.212**	*0.015*	-0.227**	*0.015*
hi	-0.694**	*0.026*	-0.759**	*0.027*	-0.768**	*0.029*	-0.751**	*0.026*
*easy*mid*	-0.032	*0.031*	-0.038	*0.027*	-0.026	*0.027*	0.002	*0.029*
*easy*hi*	-0.029	*0.053*	-0.025	*0.054*	0.007	*0.055*	0.089*	*0.053*
*2*mid*	-0.048*	*0.026*	-0.116**	*0.021*	-0.083**	*0.021*	-0.053**	*0.020*
*2*hi*	0.097**	*0.029*	0.046*	*0.026*	0.046	*0.028*	0.075**	*0.025*
*2*easy*	0.015	*0.045*	-0.014	*0.034*	-0.017	*0.035*	-0.029	*0.035*
*2*easy*mid*	0.121**	*0.053*	0.166**	*0.044*	0.152**	*0.043*	0.138**	*0.042*
*2*easy*hi*	0.048	*0.060*	0.093*	*0.050*	0.108**	*0.052*	0.058	*0.051*
first 6			0.410	*0.296*	0.608**	*0.237*		
first 12			0.308**	*0.073*	0.259**	*0.066*		
first 60			0.444**	*0.025*	0.416**	*0.025*		
first 84			0.462**	*0.027*	0.431**	*0.027*		
first 120			0.404**	*0.036*	0.432**	*0.030*		
private			-0.159**	*0.016*	-0.129**	*0.015*		
portfolio	-0.309**	*0.028*	-0.294**	*0.022*	-0.268**	*0.020*		
FICO orig / 100	0.217**	*0.011*	0.179**	*0.010*	0.173**	*0.010*		
ltv orig / 100	-0.435**	*0.039*	-0.167**	*0.036*	-0.157**	*0.036*		
orig 2004	0.107**	*0.022*	0.136**	*0.018*	0.126**	*0.017*		
orig 2005	0.126**	*0.019*	0.144**	*0.015*	0.137**	*0.015*		
orig 2006	0.338**	*0.022*	0.361**	*0.020*	0.352**	*0.021*		
orig 2007	0.324**	*0.021*	0.368**	*0.018*	0.361**	*0.019*		
15yr			0.071*	*0.042*	0.067	*0.042*		
20yr			0.120**	*0.045*	0.112**	*0.045*		
30yr			0.084**	*0.041*	0.089**	*0.042*		
opt arm	-1.324**	*0.431*	-0.246**	*0.053*	-0.269**	*0.050*		
jumbo 417	-0.519**	*0.087*	-0.399**	*0.043*	-0.379**	*0.038*		
jumbo cll	-0.650**	*0.141*	-0.489**	*0.052*	-0.477**	*0.049*		
condo	-0.231**	*0.020*	-0.214**	*0.019*	-0.212**	*0.020*		
low doc	-0.089**	*0.013*	-0.049**	*0.011*	-0.047**	*0.012*		
cll ($MM)	-0.320**	*0.095*	-0.180**	*0.091*	-0.194**	*0.086*		
coupon dec08	0.450**	*0.012*	0.382**	*0.011*	0.335**	*0.011*		
log(bal dec08)	0.541**	*0.011*	0.524**	*0.010*	0.480**	*0.010*		
unemp dec08	-0.027**	*0.004*	-0.022**	*0.004*	-0.024**	*0.004*		
escore dec08/ 100	0.273**	*0.011*	0.253**	*0.010*	0.259**	*0.010*		
#obs	163481		212521		227837		254633	