Does Junior Inherit?

Refinancing and the Blocking Power of Second Mortgages

ABSTRACT

In most US states, mortgage seniority follows time priority: older mortgages are paid first. This impedes the refinancing of senior mortgages, because replacement mortgages are junior unless the existing junior lienholders sign subordination agreements. We identify the resulting impact on refinancing by contrasting states that do and do not require this consent. We find a significant negative impact of time priority on smaller mortgages. Among larger mortgages, the significant impact is driven by the conforming loan limit. We exploit legal variation to instrument for a borrower's ability to refinance, and show that successful refinancing reduces future mortgage delinquency.

JEL: D12, G18, H73, K11

1. Introduction

Mortgage debt represents the bulk of household indebtedness.[6] Homeowners' access to better mortgage terms therefore has significant implications for 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] Furthermore, since the collapse of the housing market in 2007, vigorous policy efforts have targeted refinancing, with one stated goal being to reduce default rates and hence stabilize the housing market.[8]

The steep fall in mortgage rates since 2007 holds the potential to deliver these benefits, but realizing the full potential has proved difficult. In the aftermath of the post-2006 decline in house prices, there has been considerable concern, in particular, that legal and institutional impediments lock borrowers into their old high rates. In this paper, we contribute to the policy debate by quantifying both some of the impediments to, and the benefits from, refinancing.

An important impediment to refinancing, one that has caught the attention of both policy makers and the popular press, is the presence of a second mortgage.[9] A homeowner with a second mortgage (17.5% of homeowners with a first mortgage as of September 2014, and 36% as of December 2008[10]) may experience difficulty in refinancing his first mortgage, particularly if he is unable or unwilling to refinance or pay off the second as well. The impediment in this situation is

[6] Source: Federal Reserve Survey of Consumer Finances (2012)
[7] Speech by William C. Dudley, January 6, 2012.
[8] Speech by President Barrack 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] 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).
[10] Federal Reserve Bank of New York/Equifax Consumer Credit Panel.

that, in most U.S. states, the mortgagor needs the second mortgagee's permission to do this. This is because most states 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 lienholder becomes senior when the first is refinanced, and therefore that the refinancing lender needs the second lienholder 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 most states, second mortgagees can block refinancing of the first, either actively or passively, by not granting this permission. This can occur, most notably, if the borrower is unable to easily roll both loans into a new mortgage, i.e., if the combined loan-to-value ratio is moderately high.

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 2.3 percentage points, or approximately 15 percent of the average refinancing rate of 15 percent, with the hardest impact on smaller mortgages. These same legal differences also serve as instruments for a borrower's ability to refinance, and thus allow us to gauge the effect of refinancing on future delinquency. Our empirical analysis suggests that successful refinancing causally reduces future mortgage delinquency, but has no effect on auto loan or credit card default rates.

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*.[11] In general, this principle holds that a debt inherits the claim of the debt it extinguishes. As implemented by a subset of states, 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] 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. 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 his lenders. However, the mortgage market appears far from frictionless. In particular, the popular press has pointed to the fact that second mortgage lenders who are concerned about the risk of their loans (for instance because the value of the house has fallen), 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 subrogation 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 them instead.[12]

Empirically, we find the hardest impact of time priority to be on smaller mortgages. This is suggestive of a fixed per-mortgage cost that must be overcome by borrowers and lenders, rather than of costs more likely to grow with mortgage size, such as those arising from aggressive bargaining over surplus.

Our 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

[12] 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

features of the laws governing time priority, i.e. that they should only affect 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 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 plunge in mortgage rates illustrated in Figure 1.[13]

Is the reduction in ex-post refinancing of first mortgages priced at origination? That is, does a lender extending a first mortgage charge less in a time-priority state, in expectation of less rate-

[13] 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.

refinancing in the future? This would offset some of the cost of time priority to borrowers. We test for this effect in mortgage rates, and find a small but statistically significant effect, so the net welfare effect includes both this small upfront unconditional benefit, along with the more substantial cost later, conditional on meeting the conditions for blocking power.

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.[14] We find a large negative impact on refinancing: borrowers with balances above the CLL are much less likely to refinance than other borrowers, and of those that succeed in refinancing, about 40% do so with a new loan exactly equal to the CLL, implying some amount of cash injection to close the deal.[15] We also find a positive impact of the Economic Stimulus Act (ESA) of 2008, which temporarily raised the CLL in certain high-cost counties: indeed, we find that it is this county-specific limit, rather than the nationwide limit of $417,000, that affects refinancing rates in these affected counties.

Furthermore, 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.

Policy interest in refinancing focuses on its implications for the financial health of the household. However, isolating these implications is difficult, because unobserved factors affecting financial health likely contribute to both refinancing and subsequent default risk. The legal

[14] See Krainer (2009), for example.
[15] See also Adelino et al (2014) and Fuster and Vickery (2014) for analyses of how the CLL affects, respectively, house prices and the incidence of fixed-rate mortgages.

variations we exploit to gauge the effect of time priority and the CLL on refinancing are also well-suited to gauge the implications of refinancing, because they deliver variation in refinancing that is exogenous to forces that could directly affect default risk. Accordingly, we run a bivariate probit model that jointly estimates both refinancing and subsequent delinquency, and we find that refinancing significantly reduces delinquency rates on mortgages (by one third), but not on credit cards or auto loans.[16] The theoretical literature has identified two channels through which lowering mortgage payments can reduce default rates. The first is that lower payments make paying the mortgage in order to retain the home more attractive,[17] and the second is that lower monthly payments improve liquidity for constrained households.[18] Our results thus suggest that the first channel is the more significant: the lower mortgage rates succeed in improving performance and fending off foreclosure and all its ramifications, but the effect of the mortgage interest savings on other payments is too small to detect.

2. The principles of time priority and equitable subrogation

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

> "The first mortgage on a property, being the first recorded, has first priority. All later recorded mortgages applying to a single property are called "junior" mortgages. The basic rule of mortgage priority is that it is set by the time of recording. Earlier recording grants earlier priority. This can only be changed when a mortgagee who has earlier recorded agrees to subordinate her interest."[19]

The problem arising from this principle is that it ties a potentially deal-breaking wealth transfer to a run-of-the-mill refinancing. If a borrower refinances the senior of two mortgages, the replacement

[16] We also show that a naïve univariate empirical model grossly overstates the impact of refinancing on default.
[17] This is important in option-theoretic models of default: see Kau and Kenenan (1995).
[18] E.g., Campbell and Cocco (2014).
[19] Schmudde (2004), p. 113.

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 discharge the obligation and the mortgage, they are preserved and the mortgage retains its priority in the hands of the subrogee.[20]

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 subordination 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

[20] American Law Institute (1997), p. 508.

> 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.*
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> 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.[21]

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.[22] 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

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

[22] We show below that the results do not change if one drops those states for which the law is uncertain.

states as "not easy."[23] 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 shows low correlation of easy/not-easy with the three legal-environment variables in 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,[24] 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.

[23] We include the District of Columbia as an easy subrogation state, but our results are robust to this coding.
[24] 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 9.

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.

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.[25] 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.[26] 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

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

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.[27] 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 data are available in every quarter).[28] After these restrictions, our sample contains 255,097 borrowers. Table 3 summarizes the matched database along a number of dimensions. It also provides the same statistics for a random sample of mortgages from the LPS data that were not matched to the FRBNY/Equifax data, to help gauge whether the matching procedure biases the sample in any way.

The comparison between mortgage refinancings in states with easy versus not-easy subrogation law drives identification in the empirical tests. To document how the mortgages themselves compare, Table 4 separates 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.

[27] 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.

[28] 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.

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.[29]

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

[29] 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.

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.[30]

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

[30] One should also consider a third alternative, namely that of a lender refinancing just the first mortgage without obtaining a subordination 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.

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 5, 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:

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

States vary in many dimensions other than subrogation law, and 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).[31]

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,

[31] 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 $\gamma_{Easy\times CLTV,H}$.

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 counties, we include two jumbo indicators---one using the nationwide limit of $417,000, and another using the county limit, if higher. [32]

The results of this probit estimation are in Column A of Table 6. 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 C of Table 6 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

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

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 ranges 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 effects 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.

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 only feasible for borrowers with a low CLTV. This feasibility motivates the hypothesis that time priority has little effect on low CLTV borrowers. Consistent with the hypothesis, Panel A of Table 7 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.[33] Accordingly, we re-run the test with interactions with an indicator for portfolio loans, so securitized loans are the baseline. The results, in Panel B of 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 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 loomed especially large in 2009, because jumbos fell to just 5 percent of originations that year (down from 21 percent in 2005).[34] This implies a potentially significant interaction with time priority. 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 he tap the conforming rather than jumbo market. Were the combined balance instead below the CLL, he could roll both mortgages into one new conforming mortgage. Thus he 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. (We discuss the direct effect of the CLL on refinancing, as opposed to the indirect effect through subrogation law, in Section 6 below.)

[33] 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.

[34] Source: Mortgage Market Statistical Annual.

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 D of Table 6. 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 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 C of Table 6 is 2.2%. For the benchmark probit model, the analogous marginal change is 2.3%.[35] By way of comparison, this increase in refinancing probability is equal to the increase from raising the borrower's origination FICO score by 61 points, or raising his original mortgage's coupon by 32 basis points (see Table 6,

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

column B). It is also worth noting that both estimates are close to the marginal effect implied by the sample averages of Table 5, since (16.12-16.09) - (14.58-17.13) = 2.58%.[36]

These effects of subrogation law are for the affected subset of the population, those with multiple liens and intermediate CLTVs, who comprise 8.3% of our sample. Subrogation law should not affect other borrowers, and our empirical results indicate that it does not. Thus, a shift in subrogation law affects *aggregate* refinancing by approximately 2.2% times 8.3%, i.e. 18 basis points, and has the same estimated effect as a change in mortgage rates of 3 basis points. This may appear small, but it is in the range of other policy interventions. For example, Krishnamurthy and Vissing-Jorgensen (2011) estimate the effect of QE2 on mortgage rates as approximately 10 basis points (see their Table 5). Relative to QE2, changing subrogation law is likely to attract much less political controversy, since among other things, it targets borrowers who are somewhat struggling (in that they have difficulties refinancing to a lower rate) and, as we show below, the benefits are greater for those that are likely less wealthy (in that they have smaller mortgages), while quantitative easing has been criticized for disproportionately benefiting the wealthy.[37]

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 10 by replicating the main probit specification (column A of Table 6), with finer partitions. The first set of results uses five

[36] In this 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%.

[37] See "How Quantitative Easing Contributed to the Nation's Inequality Problem," New York Times, October 22, 2014.

partitions, while the second uses nine. These alternate partitions yield the same result: as 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 6 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 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 column A of Table 9, 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.[38] The result, in column B of Table 9, is still significant. Finally, to address robustness with respect to the coding of legal regimes, Column C of Table 9 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.

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

Identification

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. Column D of Table 9 reports the 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

Hypothesis 1 merely requires 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.) Column E of Table 9 displays the results of this estimation, which are again consistent with Hypotheses 1 and 2.

6. Other determinants of refinancing

A: Basic determinants

Table 6 also sheds light on other influences on the propensity to refinance.[39] 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

[39] 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.

As discussed above, following the collapse of the private securitization market in 2008, one of the few remaining avenues for refinancing mortgages was through a loan securitized by the GSEs. In response, the Economic Stimulus Act of 2008 temporarily increased CLLs in certain high-cost housing markets, thereby introducing county-level variation in the CLL.[40] Fuster and Vickery (2013) show that the raised limits sharply increased the share of fixed-rate mortgages, as it freed lenders to originate these loans without retaining their elevated interest-rate risk. However, this new "super-conforming" market was not the same as the regular, sub-$417K conforming market: Vickery and Wright (2013) show, for instance, that their interest rates were higher than for sub-$417K mortgages during this time period.[41] In addition, the GSEs imposed higher underwriting standards for these loans.[42] Thus it is an open question whether these new limits completely superseded the old ones, or whether there remained a significant benefit to having a principal balance below $417K when the CLL was higher.

To address this question, we build on the result in Table 6 that first mortgages with December, 2008 balances above the CLL are indeed less likely to be refinanced in 2009, whether

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

the limit in the county in question was $417K or higher. In Column E of Table 6 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.[43] 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 succeeded in improving borrowers' access to refinancing, but furthermore when the CLL was increased, there was no remaining significance, at least with respect to successfully 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 test for this behavior in Table 13. We restrict the sample to borrowers who successfully refinance in 2009, and then we compare the new loan's balance with that of the old (refinanced) loan.[44] The comparison finds a strong tendency among borrowers with old loans above the CLL to shrink their new borrowing to the CLL. This is also visible in Figure 5, which plots the old and new balances relative to the CLL. Fully 42% of those with old balances above the CLL refinance to a new balance *exactly* equal to the CLL. This share is negligible when the old balance is below the CLL.

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

[43] 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.
[44] We further restrict to old principal balances in a window of $50,000 around the conforming loan limit.

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 frictions that have been mentioned in the popular press and were discussed in the introduction 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 (similarly, Maturana, 2014, finds evidence that servicers' capacity constraints interfered with beneficial mortgage modifications). The fixed cost could be explicit: at least some lienholders have been reported to simply charge a fixed amount to resubordinate. 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. A distinct alternative is that, for some fraction of mortgages, subordination 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 going directly to the relative 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, $\delta_M = \delta_H = 0$.

We interpret support for this hypothesis as indicating that time priority affects refinancing because there exist fixed-cost frictions, while frictions that are proportional to mortgage size are less important. Support for Hypothesis 4 would further suggest that all frictions are finite and thus surmountable. Conversely, rejection of Hypothesis 4 (together with support for Hypotheses 1 and 2, discussed above) would indicate that proportional 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 Table 8, and support Hypothesis 4. For small mortgages (Column A) we find that δ_M is positive and statistically different from 0, while δ_H is statistically indistinguishable from 0. In contrast, for big mortgages (Column B), neither δ_M nor δ_H is statistically distinguishable from 0.[45]

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

[45] Moreover, additional results (available upon request) support Hypothesis 4 even under the weaker identifying assumptions of equation (3) above.

mortgage interest rate of 32 basis points.[46] 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. Quantifying the economic benefits of refinancing

So far, we have focused on the determinants of refinancing activity. We next turn to the economic benefits of refinancing — and in particular, quantifying the consequences for a borrower's future ability to service his debt.

As discussed earlier, the consequences of mortgage refinance for household financial health are an important policy consideration. For example, the Home Affordable Refinancing Program (HARP) aims to help those borrowers who are unable to refinance to lower interest rates because their LTVs are too high, and a stated goal of this program is to reduce these borrowers' default risk. However, relatively little is known about how large an effect such refinancing would have, either on the mortgage market, or on the broader economy.

Estimating the causal effect of refinancing presents a significant econometric challenge, because refinancing is itself a choice variable. The econometrician would ideally like to offer refinancing to a random subsample of borrowers, and compare outcomes relative to a control group. However, there are many unobservable factors that affect both refinancing and default. For instance, we do not observe a borrower's income or employment status, while potential lenders do. Furthermore, some salient factors may even be unobservable to the lender. For example,

[46] Moreover, one would obtain a substantially larger estimate if one calculated this interest-rate equivalent using the subsample of smaller loans.

homeowners planning to default on their mortgages would be unlikely to expend the time and cost needed to refinance. So for a precise estimate of the causal impact of refinancing, an exogenous source of variation is useful.

In this respect, state-variation in subrogation law represents an attractive natural experiment, because it provides this exogenous variation in access to refinance: as we have shown, borrowers in states that follow the principle of time priority have less ability to refinance than otherwise identical borrowers in states with easy subrogation law. Accordingly, we use subrogation law as an instrument for a borrower's refinancing decision. We also use county-level variation in the CLL since, as shown earlier, during this period it was substantially more difficult to refinance a jumbo loan, and the county limit proved to be the binding one.

To implement this instrumented test we estimate a bivariate probit model. One dependent variable is an indicator variable for whether a borrower refinances in 2009, exactly as in the empirical analysis reported above. The other dependent variable is an indicator variable for whether a borrower is 30 or more days delinquent at any point in 2010. We further restrict attention to borrowers whose mortgages were in good standing at the end of 2009.

Given the magnitude of the interest savings involved, refinancing could potentially have a positive impact not just on mortgage outcomes, but also the homeowner's broader balance sheet. To test this we also consider the impact of refinancing on the homeowner's other credit instruments. Specifically, we consider a delinquency of 30 days or more on a borrower's first mortgage; the borrower's credit cards; or the borrower's auto loan. In each case we restrict attention to the subsample in which these accounts are in good standing at the end of 2009. We find that while refinancing reduces the incidence of mortgage default, it has no significant effect on either credit card or auto loan outcomes. As we discuss below, this differential impact is consistent with the fact

that refinancing a mortgage affects not just the borrower's overall cash flow, but in particular, lowers the interest rate that he is paying on the mortgage itself.

Recent papers by Fuster and Willen (2012), Keys et al (2014), and Zhu et al (2014) estimate the causal effects of payment reductions. In both Fuster and Willen (2012) and Keys et al (2014), the selection bias is avoided by considering only adjustable-rate mortgages, and using their automatic rate changes for exogenous variation.[47] Both papers find that a drop in mortgage payments leads to a reduction in mortgage default rates. In addition, Keys et al (2014) also find that this extra liquidity increases durable goods purchases, and that households also apply the payment savings to paying down credit card debts. Zhu et al (2014) estimate the effect of HARP refinancings, mitigating selection bias with a participation model, and also find that participating in a HARP refinancing leads to lower mortgage default rates.

Relative to Fuster and Willen (2012) and Keys et al (2014), one advantage of our approach is that we study the impact of refinancing directly. This may be important, since ARMs make up only a minority of mortgages, and these borrowers tend to be more credit-constrained than the overall population of homeowners (Johnson and Li, 2011). In addition, the impact of a decrease in the mortgage payment that extends over the entire life of the mortgage is different from that of a rate reset on a mortgage that could potentially adjust up in the future. In addition, although Zhu et al (2014) also find a positive benefit of refinancing on mortgage default rates, one concern is that their results could also reflect the circumstances behind the borrower's eligibility for, and choice to participate in, HARP. Finally, our test builds on Keys et al (2014)'s examination of the effects of

[47] Di Maggio et al (2014) use a similar strategy to estimate the effect of rate resets on homeowners' consumption and borrowing.

payment reductions on broader balance sheets by examining the impact of refinancing on default rates on other types of credit.

To obtain identification in our bivariate regression (without relying on the functional form), we impose the following exclusion restrictions. First, the triple-interaction of CLTV with subrogation law and possessing two mortgages does not enter the financial distress equation. Second, indicator variables for whether a borrower's principal balance at the end of 2008 exceeds $417,000, as well as the county-level conforming loan limit, also do not enter the financial distress equation. In both cases, these exclusion restrictions seem reasonable: it is hard to see why any of these variables would affect financial distress *except* through their effect on a borrower's ability to refinance.

Table 11 displays the results of this estimation. First, to motivate our IV strategy, columns A(i), B(i) and C(i) of Panel A display the results of estimating what one might term a "naïve" estimate of the effects of refinancing. In these columns, we estimate a probit model in which the dependent variable is financial distress in 2010 (measured, respectively, using mortgage delinquency, credit card delinquency and auto-loan delinquency), and in which we include an indicator for whether a borrower refinanced in 2009 as a control variable — but without any attempt to control for selection bias in this refinancing decision. In each case, the estimated coefficient on refinancing is negative (and very large in magnitude) and highly statistically significant. Consequently, if one took these regressions at face value, one would conclude that a borrower's ability to refinance plays a powerful role in preventing all forms future financial distress.

Columns A(ii), B(ii) and C(ii) of Panel A of Table 11 are the main results of this section, and display the estimates of the financial distress equation from the bivariate probit described above. Columns A-C of Panel B display the corresponding estimates of the jointly-estimated

refinancing equation.[48] Bearing out the risk of selection bias in the univariate distress models, the effects estimated with the bivariate models of refinancing and financial distress are very different. Refinancing in 2009 still has a beneficial effect on a borrower's probability of mortgage delinquency in 2010 (see column A(ii) of Panel A), but this effect is less than half as large as previously. Also, refinancing now has no significant effect on a borrower's probability of either credit-card delinquency or auto-loan delinquency. That this bivariate model is addressing selection bias is apparent in the estimated correlation between the two error terms, in that it is negative, with statistical significance when the outcome variable is either mortgage delinquency or credit card delinquency.

Finally, although these results highlight that care is needed in assessing the benefits of refinancing on borrower financial health, it is worth emphasizing that even after controlling for selection effects, the estimated coefficient of the effect of refinancing on mortgage delinquency is still large (column A(ii) of Panel A). Specifically, we calculate the marginal effect of refinancing on mortgage default to be 128 basis points, relative to an overall default rate of 364 basis points. By way of comparison, this is larger than the impact of moving a borrower from the middle to low CLTV region, which has a marginal effect of 90 basis points.

The contrast between the significant impact of refinancing on mortgage default, and the insignificant impact on other forms of credit is not surprising. The theoretical literature has identified two channels through which lowering mortgage payments can reduce mortgage default rates. The first, which plays an important role in option-theoretic models of default (see Kau and Keenan, 1995, for a summary) is that lower payments make paying the mortgage in order to retain

[48] The refinancing equation is simply the main regression from earlier in the paper. The estimates differ slightly across regressions, since the sample of borrowers changes. In particular, only a fraction of our sample actually has outstanding auto loans.

the home a more attractive investment. The second channel is that lower monthly payments relax the liquidity constraints faced by constrained households (see Campbell and Cocco, 2014, for example). Since we find that refinancing reduces only mortgage default, our results suggest that the first channel is the more important one.

9. Ex ante effects on interest rates

Our empirical findings above indicate that borrowers are more likely to refinance their loans when they live in states where subrogation law is easy, and that this enhanced access to refinancing reduces subsequent mortgage delinquency. These are boosts to borrower welfare in these states. However, they could be offset in equilibrium by increases in mortgages rates at origination. In particular, the principle of time priority acts in a similar way to a prepayment penalty, and, as Mayer, Piskorski, Tchistyi (2013) point out, such a penalty can be welfare-improving. Thus one might expect lenders to charge higher interest rates in states with easy subrogation law, because in these states this form of prepayment penalty is effectively waived. Thus, some or all of the borrower welfare gain from easier refinancing could be offset by higher financing costs in these states.

In Table 10, we empirically examine whether subrogation law affects interest rates at loan origination. To do so, we regress origination interest rates on a variety of controls, including an indicator for whether the state the borrower lives in has easy subrogation law. Note that the sample of loans used here is wider than our main sample, since we are not limited to the mortgages where we can identify refinancing. We look at originations of 30-year fixed-rate mortgages over the period 2005-2010.

Our estimates associate easy subrogation law with a statistically significant increase in the original interest rate, 1.4 basis points at the point estimate. Thus, borrowers do indeed pay upfront for the greater ex post refinancing flexibility in easy subrogation states.

One caveat to this finding is that the estimate is less well-identified than other estimates in our paper, since we are unable to include state-level fixed effects. Consequently, it is possible that the estimated effect of easy subrogation law in fact stems from other cross-state differences that are correlated with subrogation law.

To assess whether a change of 1.4 basis points in the origination interest rate is an economically sensible effect, consider next the following back-of-the-envelope calculation of the present value (PV) of interest payments received by a mortgage lender. We let *c* stand for the annual coupon rate, *r* for the lender's cost of funds, and *p* for the annual prepayment probability. For simplicity, we take all three quantities to be fixed over the life of the mortgage. Also for simplicity, we approximate the mortgage as having infinite maturity, i.e., as a consol bond. Hence the PV of the mortgage to the lender at origination is

$$\frac{c+p}{r+p}.$$

Differences in subrogation law affect the prepayment probability *p*. Hence a small change *dp* in the prepayment probability leaves the PV of the mortgage unchanged if it is accompanied by a change in the coupon payment of

$$dc = \frac{c-r}{r+p}\,dp.$$

Our estimate of the change in refinancing probability caused by easy subrogation law for a borrower with intermediate CLTV and two mortgages is 2.3%. At origination, there is considerable

uncertainty as to whether a borrower will take a second mortgage, and how house prices will evolve. Moreover, there is also considerable uncertainty as to whether interest rates will fall by enough for refinancing to be worthwhile. In the spirit of our back-of-the-envelope calculation, suppose that the probability at origination of house prices moving to put a borrower into the intermediate CLTV bucket, and interest rates falling by enough to make refinancing worthwhile, is $\frac{1}{3} \times \frac{1}{3} = \frac{1}{9}$. From our sample of the loans, the unconditional probability of taking a second loan is 25%. The unconditional refinancing probability in 2009 is 15%, which again must be adjusted to reflect that the fact that, at origination, the lender does not know interest rates will fall. Finally, in our loan sample the average coupon rate is c=5.95%, while we use r=3% for a lender's cost of funds. Substitution into the formula above then suggests that an increase in the origination interest rate of

$$dc \approx \frac{5.95\% - 3\%}{3\% + \frac{1}{3} \times 15\%} \times \frac{1}{9} \times 25\% \times 2.3\% = 0.024\%$$

would compensate the lender for the increase in prepayments stemming from easy subrogation law. Although this simple calculation entails considerable approximation, this output is the same order of magnitude as our empirical estimate of 0.014%.

Finally, note that in this discussion we have emphasized that easy subrogation law may hurt lenders, necessitating higher interest rates at origination — consistent with our empirical result. However, at least in principle easy subrogation may also help lenders through its effect in lowering default rates, as we have shown. Our finding of higher rates at origination suggests that the prepayment channel is the dominant one.

10. Summary and Conclusion

In this paper we investigate both mortgage borrowers' access to refinancing, and the effect of successful refinancing on a borrower's financial health. We provide evidence that the prevailing state-level law of allocating mortgage-seniority according to time-priority makes refinancing harder for homeowners with multiple liens. This is the case even though contracting parties can — and sometimes do — contract around time-priority by using subordination agreements. Time-priority especially affects the refinancing of relatively small mortgages, consistent with the presence of transactions costs that do not grow proportionately with mortgage size.

Policymakers have suggested that mortgage refinancing can play a role in stabilizing housing markets, and in improving household financial health more generally. Our findings show that successful refinancing predicts lower mortgage delinquency. We also provide evidence that the relation is not just predictive but causal, by using geographic variation in laws governing time priority and conforming loan limits to instrument for a borrower's ability to refinance. However, successful refinancing of a mortgage appears not to significantly improve the performance of a borrower's other debts, such as credit card and auto loan balances. Thus, the benefits of refinancing include stability of homeownership and the externalities arising from this stability, but do not appear to include significant externalities for other creditors.

Our findings also demonstrate that mortgage market frictions significantly impede borrowers and their lenders from implementing mutually beneficial changes to mortgage

modifications.[49] This is further evidence that laws affect financial outcomes (see, e.g., La Porta et al (1998), and others).

Eliminating the source of the impediment, the principle of time-priority, would not necessarily improve borrower welfare, because this principle reduces lenders' exposure to pre-payment, enabling them to offer lower interest rates at origination, and indeed we find that rates are slightly lower in states that follow time priority. Moreover, a rough calibration suggests that this difference in origination rates approximately compensates lenders for the difference in prepayment rates. Whether this leaves borrowers better or worse off in expectation is a promising area for future research.

[49] See Piskorski, Seru and Vig (2010), Adelino, Gerardi and Willen (2009), 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.

References

Adelino, Manuel, Kris Gerardi and Paul Willen, 2009, Why Don't Lenders Renegotiate More Home Mortgages? Redefaults, Self-Cures and Securitization, Federal Reserve Bank of Boston Public Policy Discussion paper 09-04.

Agarwal, Sumit, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, and Douglas Evanoff, 2011a, The Role of Securitization in Mortgage Renegotiation, *Journal of Financial Economics* 102(3), 559-578

Agarwal, Sumit, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, and Yan Zhang, 2011b, Second Liens and the Holdup Problem in First Mortgage Renegotiation. Working Paper, Federal Reserve Bank of Chicago, the Ohio State University, and the Office of the Comptroller of the Currency.

American Law Institute, 1997, Restatement of the Law Third. Property: Mortgages. American Law Institute Publishers, St. Paul, MN.

Been, Vicki; Jackson, Howell E.; and Willis, Mark A., 2012, Essay: Sticky Seconds -- The Problems Second Liens Pose to the Resolution of Distressed Mortgages. New York University Law and Economics Working Papers. Paper 302. http://lsr.nellco.org/nyu_lewp/302.

Bennett,Paul, Richard Peach, and Stavros Peristiani, 2001, Structural Change in the Mortgage Market and the Propensity to Refinance, *Journal of Money, Credit and Banking*, 33(4) 955-975.

Campbell, John and Joao Cocco, 2014, A Model of Mortgage Default. Mimeo.

Clapp, John M., Gerson M. Goldberg, John P. Harding, and Michael LaCour-Little, 2001, Movers and Shuckers: Interdependent Prepayment Decisions. *Real Estate Economics* 29(3), 411–450.

Cordell, Larry, Karen Dynan, Andreas Lehnert, Nellie Liang, and Eileen Mauskopf, 2011, The Incentives of Mortgage Servicers and Designing Loan Modifications to Address the Mortgage Crisis, in *Lessons from the Financial Crisis: Causes, Consequences, and Our Economic Future*, ed. Robert W. Kolb, Hoboken, NJ: John Wiley & Sons, Inc.

Di Maggio, Marco, Amir Kermani, and Rodney Ramcharan, Monetary Policy Pass-Through: Household Consumption and Voluntary Deleveraging, 2014, Columbia Business School Research Paper No. 14-24.

Elul, Ronel, Nicholas S. Souleles, Souphala Chomsisengphet, Dennis Glennon, and Bob Hunt, 2010, What 'Triggers' Mortgage Default, *American Economic Review* 100(2), 490-94.

Elul, Ronel, 2012, The Determinants of Mortgage Refinancing. Mimeo.

Fuster, Andreas and Paul S. Willen, 2012, Payment Size, Negative Equity, and Mortgage Default, Federal Reserve Bank of New York Staff Report no. 582.

Fuster, Andreas and James Vickery, 2013, Securitization and the Fixed-Rate Mortgage, Forthcoming, *Review of Financial Studies*.

Ghent, Andra and Marianna Kudlyak, 2011, Recourse and Residential Mortgage Default: Evidence from US States, *Review of Financial Studies* 24(9), 3139-3186.

Goodman, Laurie, 2011, Examining Lien-Position Conflicts. Mortgageorb.com, June 3, 2011.

Haughwout, Andrew, Donghoon Lee, Joseph Tracy, and Wilbert van der Klaauw, 2011, Real Estate Investors, the Leverage Cycle, and the Housing Market Crisis, Federal Reserve Bank of New York Staff Report no. 514.

Johnson, Kathleen, and Geng Li, 2011, Are Adjustable-Rate Mortgage Borrowers Borrowing Constrained? FEDS Working Paper No. 2011-21

Kau, James B, and Donald C. Keenan, 1995, An Overview of the Option-Theoretic Pricing of Mortgages, Journal of Housing Research, 6(2), 217-244.

Keys, Benjamin J., Tomasz Piskorski, Amit Seru, and Vincent Yao, 2014, Mortgage Rates, Household Balance Sheets, and the Real Economy, NBER Working Paper 20561.

Krainer, John, 2009, Recent Developments in Mortgage Finance, Federal Reserve Bank of San Francisco Fed Economic Letter, 2009-33.

Krishnamurthy, Arvind and Annette Vissing-Jorgensen, 2011, The Effects of Quantitative Easing on Interest Rates, *Brookings Papers on Economic Activity*, Fall 2011, 215-287.

Kroszner, Randall, 2008, Is It Better to Forgive than to Receive? An Empirical Analysis of the Impact of Debt Repudiation, Mimeo.

La Porta, Rafael, Florencio Lopez-de-Silanes, Andrei Shleifer, and Robert W. Vishny, 1998, Law and Finance, *Journal of Political Economy* 106(6), 1113-1155.

Lee, Donghoon and Wilbert van der Klaauw, 2010, An Introduction to the FRBNY Consumer Credit Panel, Federal Reserve Bank of New York Staff Report no. 479.

Maturana, Gonzalo, 2014, When are Modifications of Securitized Loans Beneficial to Investors? Mimeo.

Mayer, Christopher, Edward Morrison, and Tomasz Piskorski, 2009, A New Proposal for Loan Modifications. *Yale Journal on Regulation* 26(2), 417-429.

Mayer, Chris, and Tomasz Piskorski, and Alexei Tchistyi, 2013, The inefficiency of refinancing: Why prepayment penalties are good for risky borrowers. Journal of Financial Economics 107 , 694–714.

Moench, Emanuel, and James Vickery, and Diego Aragon, 2010, Why Is the Market Share of Adjustable-Rate Mortgages So Low? Federal Reserve Bank of New York Current Issues in Economics and Finance, 16.

Nelson, Grant S. and Dale A. Whitman, 2006, Adopting Restatement Mortgage Subrogation Principles: Saving Billions of Dollars for Refinancing Homeowners. *Brigham Young University Law Review* vol. 2006, 305-366.

Piskorski, Tomasz, Amit Seru, and Vikrant Vig, 2010, Securitization and Distressed Loan Renegotiation: Evidence from the Subprime Mortgage Crisis. *Journal of Financial Economics* 97 (3), 369-397.

David Scharfstein and Adi Sunderam, 2013, Concentration in Mortgage Lending, Refinancing Activity, and Mortgage Rates, Mimeo.

Schmudde, David A., 2004, A Practical Guide to Mortgages and Liens. American Law Institute – American Bar Association, Philadelphia, PA.

Vickery, James and Joshua Wright, 2013, TBA Trading and Liquidity in the Agency MBS Market, Federal Reserve Bank of New York Economic Policy Review.

Yoo, Sang Jun, 2011, A Uniform Test for the Equitable Subrogation of Mortgages. *Cardozo Law Review* 32, 2129-2158.

Zhu, Jun, Jared Janowiak, Lu Ji, Kadiri Karamon, and Douglas McManus, 2014, The Effect of Mortgage Payment Reduction on Default: Evidence from the Home Affordable Refinance Program, Mimeo.

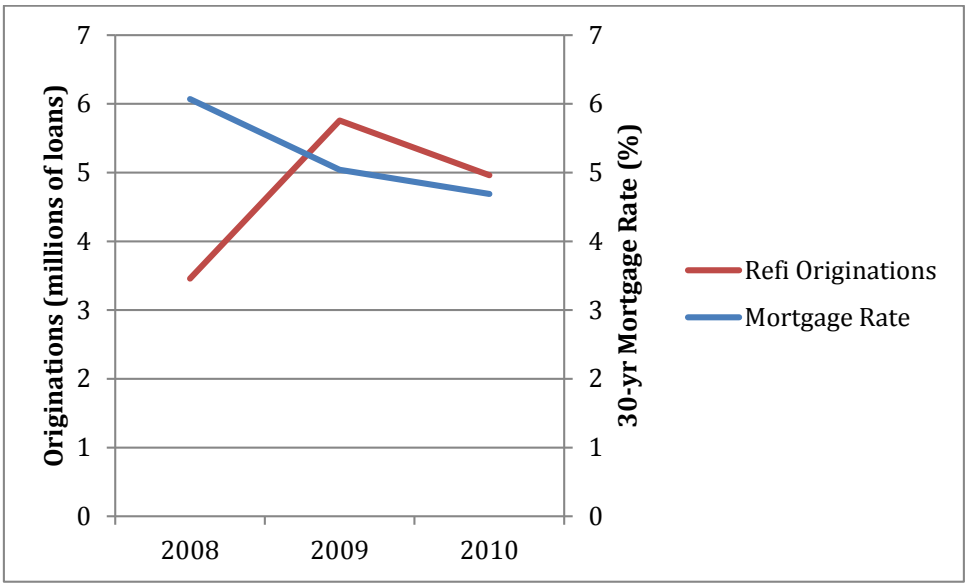

Figure 1. Mortgage rates and new refinancings, 2008-10. The refinancing originations are from the HMDA data, and the mortgage rates are the 30-year mortgage rates from the FHLMC primary mortgage market survey.

States With Easy Subrogation Laws

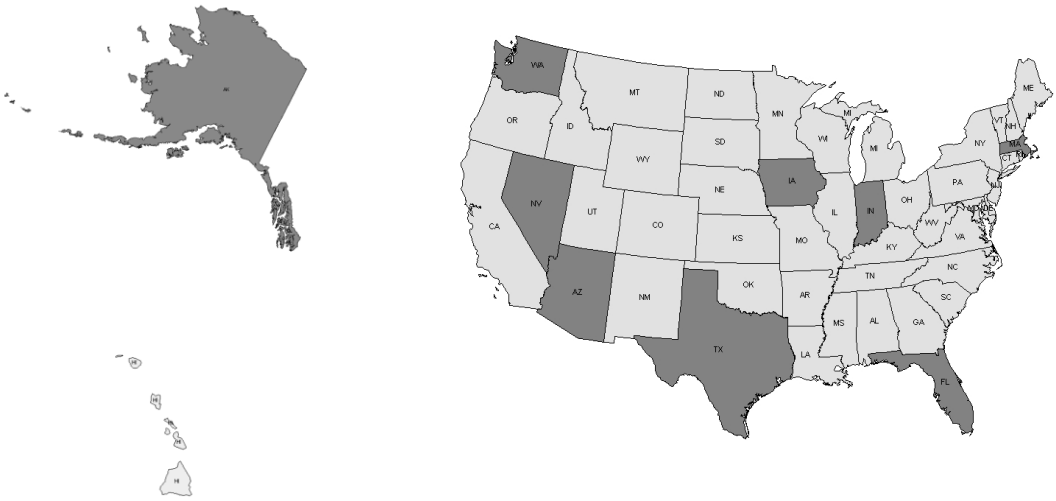

Figure 2. Geographic distribution of easy subrogation states. Easy Subrogation states are dark grey; Not-easy states are light gray.

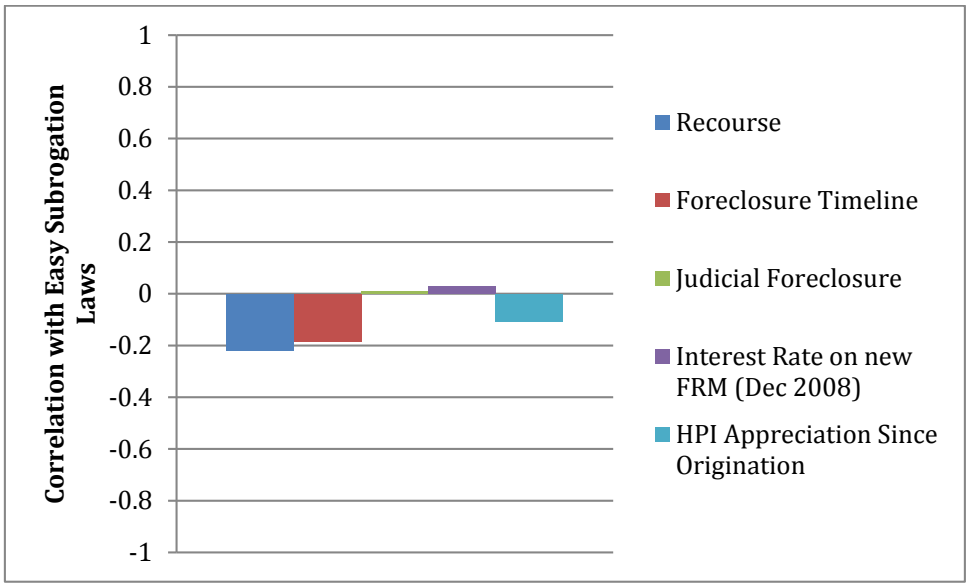

Figure 3. Correlation of easy subrogation laws with other state-level factors. The figure plots the correlation of easy subrogation laws with other state laws affecting mortgages, and also with state-level average interest rates and HPI appreciation. The state laws are from Ghent and Kudlyak (2011). 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.

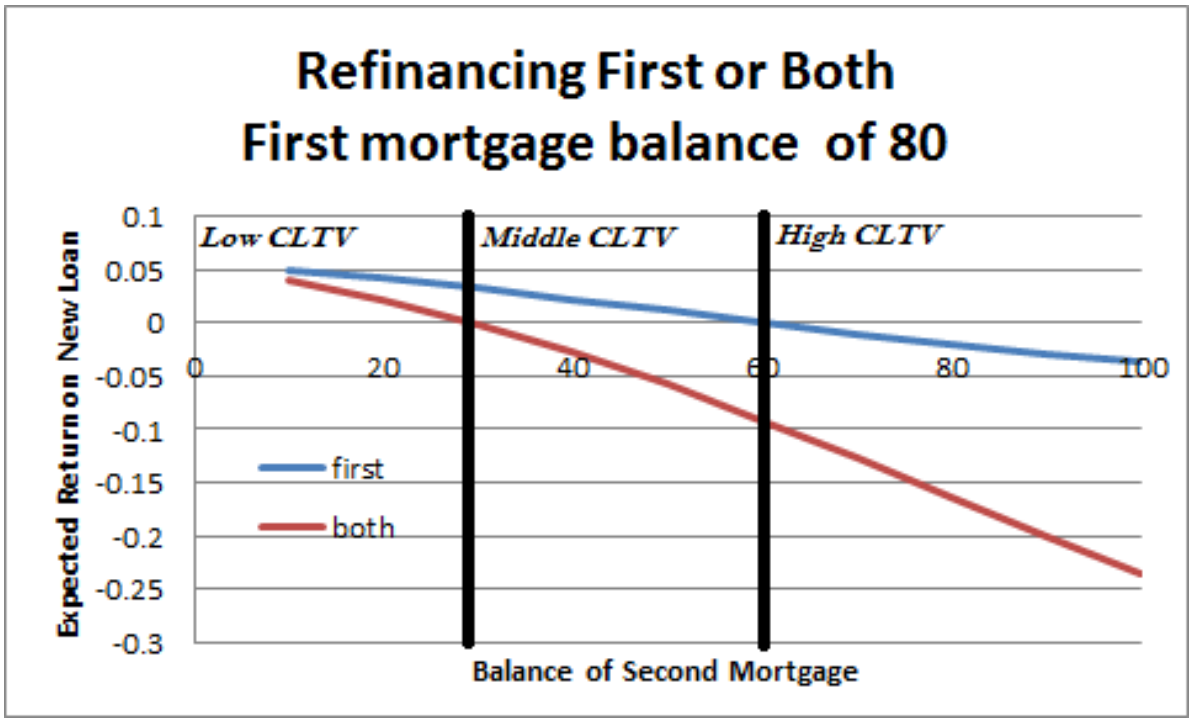

Figure 4. Model of mortgage refinancing: Numerical example. The figure assumes a first mortgage with interest rate 10% and balance 80, a second mortgage with an interest rate of 12% and the balance indicated on the horizontal axis, a home whose future value has a mean of 150 and a standard deviation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

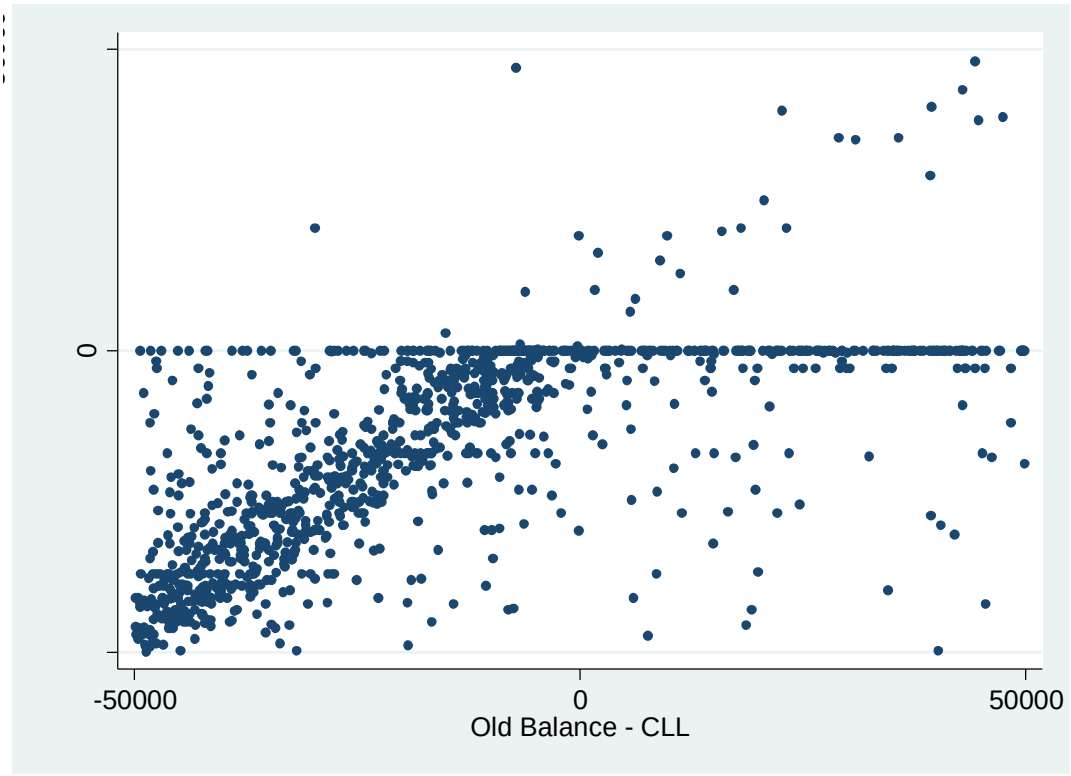

Figure 5: We plot the difference between the balance and the county-level conforming loan limit, for the new balance following the refinancing, against this difference prior to refinancing. The sample is as in Table 13, with observations larger/smaller than ±$50,000 truncated.

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	loan-to-value as of origination date, in percent
bal [d]	first-mortgage balance as of date *d*
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
Data Description and Comparison with Unmatched Sample

The column labeled "Matched Sample Mean" characterizes the mortgages in the sample resulting from the match of LPS data with FRBNY/Equifax data, and used to estimate the baseline model in Table 6. The column labeled "Unmatched Sample Mean" characterizes a random sample of mortgages drawn from the LPS dataset (with the same sample restrictions), but not matched to the FRBNY/Equifax data.

Variable	Matched	Unmatched
refinanced in 2009	0.150	
easy	0.245	0.255
FICO orig	744	741
bal orig	$212,343	$211,252
ltv orig	67.4	69.0
orig 2003	0.139	0.164
orig 2004	0.140	0.177
orig 2005	0.223	0.226
orig 2006	0.198	0.188
orig 2007	0.300	0.245
fixed-rate	0.940	
first 6	0.000	0.000
first 12	0.003	0.004
first 60	0.033	0.045
first 84	0.014	0.018
first 120	0.010	0.011
10yr	0.016	0.013
15yr	0.162	0.154
20yr	0.041	0.035
30yr	0.780	0.798
option arm	0.009	0.010
condo	0.086	0.113
lowdoc	0.137	0.146
gse	0.855	0.846
private	0.106	0.114
portfolio	0.038	0.040
second	0.276	
second bal	$48,477	
CLTV dec08	0.744	
unemp dec08	6.949	7.033
coupon dec08	5.951	5.921
escore dec08	774	
jumbo 417	0.063	0.056
jumbo cll	0.013	0.012
# observations	255097	641998

Table 4
Mortgage Statistics: Easy versus Not-Easy States

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. The sample is restricted to the subset of mortgages used in estimating the refinancing models in Table 6.

Variable	not easy	easy
refinanced in 2009	0.158	0.128
FICO orig	744	743
bal orig	$217,757	$195,682
ltv orig	67.0	68.7
orig 2003	0.145	0.122
orig 2004	0.144	0.128
orig 2005	0.223	0.220
orig 2006	0.193	0.215
orig 2007	0.294	0.316
fixed-rate	0.937	0.948
first 6	0.000	0.000
first 12	0.003	0.002
first 60	0.035	0.028
first 84	0.014	0.013
first 120	0.011	0.009
10yr	0.017	0.015
15yr	0.162	0.162
20yr	0.043	0.036
30yr	0.778	0.787
option arm	0.009	0.008
condo	0.091	0.091
lowdoc	0.149	0.130
gse	0.851	0.868
private	0.113	0.087
portfolio	0.036	0.045
second	0.281	0.260
second bal	$49,713	$44,361
low	49.1	43.2
mid	29.5	29.3
hi	21.5	27.5
unemp dec08	6.98	6.85
coupon dec08	5.94	6.00
escore dec08	775	771
jumbo 417	0.069	0.043
jumbo cll	0.014	0.012
# observations	192535	62562

Table 5
Refinancing Rate by CLTV, State Law, and Second Mortgage (2009)

This table reports the 2009 refinancing rate for first mortgages in the sample used for estimating the models in Table 6. 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 6
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 D. Column B reports marginal effects from the model in Column A, and Column C reports the linear probability model. Column E limits the sample to the borrowers with no second mortgage, and located in counties where the conforming loan limit exceeds $417K. 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	C	*se*	D	*se*	E	*se*
2	0.111**	*0.014*	0.024	0.020**	*0.003*	0.121**	*0.014*		
mid	-0.218**	*0.014*	-0.051	-0.049**	*0.004*	-0.216**	*0.014*	-0.205**	*0.045*
Hi	-0.760**	*0.026*	-0.140	-0.159**	*0.005*	-0.758**	*0.026*	-0.945**	*0.071*
*easy*mid*	-0.028	*0.027*		-0.010*	*0.006*	-0.029	*0.027*	0.021	*0.061*
*easy*hi*	-0.014	*0.054*		0.009	*0.008*	-0.015	*0.054*	0.330**	*0.097*
*2*mid*	-0.073**	*0.019*		-0.015**	*0.005*	-0.070**	*0.019*		
*2*hi*	0.068**	*0.025*		0.014**	*0.005*	0.075**	*0.025*		
*2*easy*	-0.020	*0.034*		-0.004	*0.007*	-0.028	*0.034*		
*2*easy*mid*	0.144**	*0.043*		0.036**	*0.009*	0.143**	*0.043*		
*2*easy*hi*	0.088*	*0.051*		0.010	*0.009*	0.084*	*0.051*		
first 6	0.440*	*0.246*	0.109	0.092**	*0.047*	0.434*	*0.247*	-0.042	*0.622*
first 12	0.241**	*0.063*	0.055	0.046**	*0.014*	0.240**	*0.063*	0.356**	*0.144*
first 60	0.408**	*0.024*	0.100	0.080**	*0.006*	0.411**	*0.024*	0.396**	*0.050*
first 84	0.420**	*0.026*	0.103	0.086**	*0.007*	0.420**	*0.026*	0.286**	*0.078*
first 120	0.408**	*0.029*	0.100	0.092**	*0.008*	0.412**	*0.029*	0.327**	*0.067*
private	-0.146**	*0.015*	-0.029	-0.027**	*0.003*	-0.137**	*0.016*	-0.043	*0.041*
portfolio	-0.284**	*0.020*	-0.053	-0.053**	*0.004*	-0.281**	*0.020*	-0.172**	*0.049*
FICO orig / 100	0.182**	*0.009*	0.038	0.040**	*0.002*	0.182**	*0.009*	0.282**	*0.033*
ltv orig / 100	-0.135**	*0.034*	-0.028	-0.028**	*0.007*	-0.145**	*0.034*	-0.643**	*0.115*
orig 2004	0.124**	*0.016*	0.022	0.020**	*0.003*	0.122**	*0.016*	0.036	*0.063*
orig 2005	0.137**	*0.014*	0.024	0.024**	*0.003*	0.133**	*0.014*	0.034	*0.052*
orig 2006	0.352**	*0.019*	0.070	0.078**	*0.004*	0.348**	*0.019*	0.255**	*0.060*
orig 2007	0.361**	*0.017*	0.072	0.079**	*0.004*	0.358**	*0.017*	0.327**	*0.058*
15yr	0.085**	*0.039*	0.017	0.002	*0.005*	0.082**	*0.039*	0.646	*0.563*
20yr	0.141**	*0.042*	0.029	0.008	*0.006*	0.137**	*0.042*	0.797	*0.576*
30yr	0.103**	*0.039*	0.021	0.004	*0.005*	0.099**	*0.039*	0.828	*0.560*
opt arm	-0.254**	*0.049*	-0.047	-0.050**	*0.009*	-0.252**	*0.049*	-0.386**	*0.113*
jumbo 417	-0.398**	*0.038*	-0.071	-0.088**	*0.009*	-0.412**	*0.038*	-0.035	*0.040*
jumbo cll	-0.456**	*0.050*	-0.077	-0.094**	*0.010*	-0.466**	*0.050*	-0.437**	*0.052*
condo	-0.221**	*0.018*	-0.043	-0.042**	*0.004*	-0.222**	*0.018*	-0.148**	*0.049*
low doc	-0.053**	*0.011*	-0.011	-0.012**	*0.002*	-0.054**	*0.011*	-0.067*	*0.040*
cll ($MM)	-0.154*	*0.087*	-0.032	-0.044**	*0.018*	-0.146*	*0.088*	-0.082	*0.191*
coupon dec08	0.346**	*0.010*	0.073	0.065**	*0.002*	0.347**	*0.010*	0.232***	*0.031*
log(bal dec08)	0.487**	*0.009*	0.102	0.100**	*0.002*	0.495**	*0.009*	-0.113	*0.081*
unemp dec08	-0.022**	*0.004*	-0.005	-0.004**	*0.001*	-0.022**	*0.004*	-0.046**	*0.012*
escore dec08 / 100	0.260**	*0.010*	0.055	0.054**	*0.002*	0.259**	*0.010*	0.424**	*0.037*
*span cll*not easy*						-0.178**	*0.031*		
*span cll*easy*						-0.057	*0.056*		
*marginal effect of easy on 2*mid*			0.023						
#obs	255097		255097	255097		255097		18778	

Table 7
Closing Second Mortgages and Effect of Portfolio Holding

Panel A 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. Panel B reports the results of an extension of the probit model in Column A of Table 6, in which an indicator for portfolio-held mortgages is interacted with *easy*, *2*, and *mid* and *hi*. To conserve space we report only the coefficients on these variables and their interactions. 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 clustered at the county level. State fixed effects are included. Variables are defined in Table 2.

Panel A

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

Panel B

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

Effect on Small vs. Big Mortgages

A probit model of successful refinancing in 2009 is repeated separately for borrowers with first mortgages below (Column A) and above (Column B) the median ($160K) for 12/08. Statistical significance is indicated with "**" for the 5% level and "*" for 10%. Standard errors clustered at county level. State fixed effects are included but not reported. Variables are defined in Table 2.

	A		B	
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	

Table 9
Models of Refinancing in 2009: Robustness

This table reports a probit 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. Model A limits the sample to fixed-rate, 30-year, first mortgages that are either GSE-securitized or held in bank portfolios, Model B limits the sample to borrowers with just one first mortgage, and Model C drops mortgages on residences in the states with unclear subrogation law: CO, DE, HI, MI, MT, OH, RI, SD, VT, and WV. Models D and E 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%.

	A		B		C		D		E	
Expl Var	*coef*	*se*	*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*	-0.063**	*0.021*
*2*hi*	0.097**	*0.029*	0.046*	*0.026*	0.046	*0.028*	0.075**	*0.025*	0.048*	*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*	0.128**	*0.044*
*2*easy*hi*	0.048	*0.060*	0.093*	*0.050*	0.108**	*0.052*	0.058	*0.051*	0.053	*0.049*
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		254633	

Table 10
Robustness to CLTV Bin Widths

The probit model of successful refinancing, from Column A of Table 6, 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 11
Models Predicting 2010 Defaults

This table reports the output from 2 types of probit models: univariate models, labeled "naïve", and bivariate models, labeled "bivar". The dependent variable is an indicator for a default, in 2010, in a type of consumer credit: mortgages ("mort"), credit cards ("cc") and auto loans ("auto"). Statistical significance is indicated with "**" for the 5% level and "*" for 10%, and variables are defined in Table 2. Standard errors clustered at county level. State fixed effects (and any interactions) are included but not reported. For the bivariate models, the other variable is a mortgage refinancing in 2009. The naïve and bivariate estimates of default are in Panel A, and the bivariate estimates of refinancing are in Panel B.

Panel A

	mort naïve		mort bivar		cc naïve		cc bivar		auto naïve		auto bivar	
Expl Var	*coef*	*se*	*coef*	*se*	*coef*	*se*	*coef*	*se*	*coef*	*se*	*coef*	*se*
refi_2009	-0.528**	0.025	-0.185*	0.100	-0.255**	0.020	0.123	0.116	-0.271**	0.036	0.131	0.257
2	0.030	0.029	0.026	0.028	0.061**	0.023	0.056**	0.023	-0.159**	0.049	-0.162**	0.049
mid	0.142**	0.022	0.153**	0.022	0.099**	0.023	0.113**	0.023	-0.020	0.040	-0.009	0.040
hi	0.336**	0.029	0.374**	0.031	0.118**	0.026	0.163**	0.029	0.064	0.052	0.101*	0.056
*easy*mid*	0.020	0.036	0.019	0.036	-0.070*	0.036	-0.070*	0.037	0.047	0.071	0.048	0.071
*easy*hi*	0.110**	0.041	0.105**	0.042	-0.005	0.034	-0.010	0.035	0.063	0.064	0.061	0.065
*2*mid*	-0.040	0.032	-0.037	0.032	-0.039	0.031	-0.037	0.030	0.207**	0.061	0.208**	0.060
*2*hi*	-0.074**	0.032	-0.076**	0.032	0.021	0.029	0.016	0.029	0.089	0.063	0.085	0.063
*2*easy*	-0.003	0.031	-0.007	0.031	0.037	0.028	0.034	0.028	0.120**	0.054	0.116**	0.053
first 6	0.141	0.308	0.112	0.311	0.624**	0.239	0.591**	0.240	0.341	0.492	0.347	0.494
first 12	0.153	0.102	0.141	0.101	-0.054	0.121	-0.067	0.120	0.204	0.170	0.188	0.169
first 60	0.104**	0.036	0.083**	0.037	-0.005	0.035	-0.027	0.035	0.062	0.065	0.042	0.065
first 84	-0.038	0.050	-0.059	0.049	-0.094*	0.055	-0.116**	0.054	0.052	0.107	0.029	0.105
first 120	-0.113*	0.058	-0.133**	0.058	-0.041	0.064	-0.064	0.063	0.030	0.105	0.007	0.105
private	-0.029	0.019	-0.014	0.020	0.016	0.020	0.033*	0.020	0.022	0.035	0.040	0.036
portfolio	-0.024	0.025	-0.007	0.025	0.021	0.028	0.039	0.028	-0.060	0.055	-0.039	0.055
orig FICO / 100	-0.164**	0.016	-0.173**	0.016	-0.152**	0.015	-0.162**	0.015	-0.094**	0.026	-0.103**	0.027
ltv orig / 100	0.096	0.059	0.103*	0.059	-0.014	0.048	-0.007	0.048	-0.249**	0.099	-0.236**	0.099
orig 2004	0.010	0.026	0.005	0.026	0.016	0.025	0.009	0.025	0.022	0.045	0.015	0.045
orig 2005	0.015	0.022	0.008	0.022	0.035	0.022	0.027	0.022	-0.005	0.044	-0.012	0.044
orig 2006	-0.002	0.028	-0.020	0.028	-0.020	0.025	-0.041	0.026	-0.046	0.052	-0.067	0.052
orig 2007	-0.032	0.026	-0.050*	0.027	-0.040	0.026	-0.062**	0.026	-0.092*	0.048	-0.112**	0.049
15yr	0.035	0.069	0.034	0.069	-0.125**	0.052	-0.128**	0.052	-0.022	0.122	-0.025	0.121
20yr	-0.055	0.074	-0.058	0.074	-0.109*	0.058	-0.115**	0.058	-0.042	0.125	-0.046	0.124
30yr	0.023	0.070	0.020	0.069	-0.119**	0.051	-0.125**	0.051	-0.042	0.126	-0.046	0.126
opt arm	0.035	0.069	0.167**	0.041	0.113*	0.059	0.130**	0.059	0.061	0.119	0.075	0.120
condo	0.023	0.070	0.022	0.023	-0.104**	0.019	-0.093**	0.020	-0.092**	0.040	-0.079*	0.041
low doc	0.027*	0.014	0.028**	0.014	0.018	0.016	0.021	0.016	-0.026	0.028	-0.022	0.027
cll ($MM)	0.066	0.089	0.080	0.090	0.149	0.092	0.161*	0.094	0.420**	0.160	0.431**	0.160
coupon dec08	0.182**	0.014	0.165**	0.014	0.090**	0.014	0.072**	0.015	0.114**	0.027	0.097**	0.028
log(bal dec08)	-0.055	0.074	0.208**	0.014	0.078**	0.014	0.055**	0.015	0.099**	0.025	0.078**	0.027
unemp dec08	0.016**	0.004	0.018**	0.004	0.014**	0.004	0.015**	0.004	0.021**	0.007	0.022**	0.007
dec08 score / 100	-0.627	0.016	-0.636**	0.016	-0.863**	0.014	-0.872**	0.014	-0.794**	0.026	-0.806**	0.026
#obs	234115		234115		206858		206858		107127		107127	

Panel B	mort		cc		auto	
Expl. Var.	*coef*	*se*	*coef*	*se*	*coef*	*se*
2	0.105**	0.015	0.103**	0.015	0.112**	0.022
mid	-0.228**	0.015	-0.227**	0.016	-0.171**	0.020
hi	-0.757**	0.027	-0.778**	0.029	-0.698**	0.034
*easy*mid*	-0.029	0.028	-0.006	0.028	-0.052	0.034
*easy*hi*	-0.012	0.052	0.015	0.054	0.006	0.062
*2*mid*	-0.076**	0.021	-0.067**	0.021	-0.082**	0.031
*2*hi*	0.051**	0.025	0.087**	0.027	0.077**	0.035
*2*easy*	-0.034	0.036	-0.019	0.037	0.008	0.053
*2*easy*mid*	0.177**	0.044	0.132**	0.048	0.131**	0.065
*2*easy*hi*	0.115**	0.055	0.051	0.054	0.009	0.078
first 6	0.403*	0.243	0.376	0.276	-4.497**	0.147
first 12	0.236**	0.070	0.251**	0.069	0.283**	0.095
first 60	0.433**	0.025	0.420**	0.025	0.398**	0.037
first 84	0.431**	0.027	0.415**	0.028	0.423**	0.040
first 120	0.419**	0.030	0.420**	0.033	0.420**	0.048
private	-0.122**	0.016	-0.140**	0.017	-0.165**	0.025
portfolio	-0.272**	0.022	-0.274**	0.021	-0.337**	0.031
orig FICO / 100	0.187**	0.010	0.182**	0.010	0.157**	0.015
ltv orig / 100	-0.147**	0.036	-0.127**	0.037	-0.219**	0.046
orig 2004	0.128**	0.016	0.130**	0.017	0.128**	0.024
orig 2005	0.136**	0.015	0.140**	0.015	0.115**	0.023
orig 2006	0.357**	0.019	0.350**	0.020	0.332**	0.027
orig 2007	0.357**	0.018	0.361**	0.018	0.343**	0.024
15yr	0.073*	0.041	0.100**	0.042	0.081	0.059
20yr	0.128**	0.044	0.162**	0.047	0.095	0.065
30yr	0.103**	0.040	0.117**	0.042	0.059	0.060
opt arm	-0.264**	0.047	-0.247**	0.051	-0.268**	0.077
jumbo 417	-0.446**	0.038	-0.409**	0.036	-0.447**	0.040
jumbo cll	-0.494**	0.057	-0.450**	0.050	-0.430**	0.067
condo	-0.221**	0.019	-0.224**	0.018	-0.265**	0.025
low doc	-0.037**	0.011	-0.053**	0.011	-0.060**	0.014
cll ($MM)	-0.217**	0.087	-0.150*	0.086	-0.135	0.089
coupon dec08	0.365**	0.010	0.359**	0.011	0.347**	0.014
log(bal dec08)	0.513**	0.010	0.480**	0.010	0.447**	0.014
unemp dec08	-0.023**	0.004	-0.023**	0.004	-0.020**	0.005
dec08 score / 100	0.233**	0.010	0.234**	0.011	0.290**	0.014
#obs	234115		206858		107127	

Table 12

Determinants of Mortgage Coupon

The mortgage coupon (in percent) at origination is regressed on relevant variables, as measured at origination. The sample includes all fixed-rate first mortgage originations from 2005-2010 in the LPS dataset. Variables are as defined in Table 2, except *dti* = debt-to-income ratio, *cashout* = indicator for cash-out refinancing, *broker* = indicator for broker-originated mortgage, *correspondent* = indicator for correspondent-originated mortgage and *pmi* = indicator for mortgage taken out with private mortgage insurance. Standard errors are clustered at the county level. Statistical significance is indicated with "**" for the 5% level and "*" for 10%.

Expl. Var.	*coef*	*se*
dti/100	0.073**	0.006
FICO/100	-1.772**	0.048
(FICO/100)^2	0.111**	0.003
bal orig ($MM)	-1.100**	0.303
(bal orig ($MM))^2	0.972	0.646
unemp orig /100	0.611**	0.151
ltv/100	-0.646**	0.058
(ltv/100)^2	0.794**	0.053
cashout	0.057**	0.003
broker	0.021**	0.006
correspondent	-0.012**	0.004
condo	0.016**	0.004
easy	0.014**	0.007
gse	0.248**	0.013
pmi	0.060**	0.007
# obs	3.1m	

Table 13

Determinants of Mortgage Balance Change upon Refinancing

The observations in this table are refinancings of first mortgages in 2009, limited to borrowers with a single first mortgage and no second, where this first mortgage is within $50,000 of the conforming loan limit of the county of the residence. The dependent variable is the balance of the new first mortgage minus the balance of the old first mortgage. The explanatory variables are all observed as of December 2008. Standard errors are clustered at the county level. Statistical significance is indicated with "**" for the 5% level and "*" for 10%, and variables are defined in Table 2.

Expl. Var.	*coef*	*se*
jumbo cll	-15912**	7687
bal dec08	-1.042**	0.237
(bal dec08)^2/MM	0.765**	0.224
cll	0.027	0.119
constant	279856**	66693
# obs	1405	

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.