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FAILURE TO REFINANCE

Benjamin J. Keys
Devin G. Pope
Jaren C. Pope

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ABSTRACT

Households that fail to refinance their mortgage when interest rates decline can lose out on substantial savings. Based on a large random sample of outstanding U.S. mortgages in December of 2010, we estimate that approximately 20% of households for whom refinancing would be optimal and who appeared unconstrained to do so, had not taken advantage of the lower rates. We estimate the present-discounted cost to the median household who fails to refinance to be approximately \$11,500, making this a particularly large consumer financial mistake. To shed light on possible mechanisms and corroborate our main findings, we also provide results from a mail campaign targeted at a sample of homeowners that could benefit from refinancing.

Benjamin J. Keys
The Harris School
University of Chicago
1155 E. 60th Street
Suite 161
Chicago, IL 60637
benkeys@uchicago.edu

Jaren C. Pope
Department of Economics
130 Faculty Office Building
Brigham Young University
Provo, UT 84602
jaren_pope@byu.edu

Devin G. Pope
Booth School of Business
University of Chicago
5807 South Woodlawn Avenue
Chicago, IL 60637
and NBER
devin.pope@chicagobooth.edu

1. Introduction

Buying and financing a house is one of the most important financial decisions a household makes. Housing decisions can have substantial long-term consequences for household wealth accumulation in the U.S., where housing wealth makes up almost two thirds of the median household's total wealth (Iacoviello, 2011). Given the importance of housing wealth, public policies have been crafted to encourage home ownership and help households finance and refinance home mortgages. However, the effectiveness of these policies hinges on the ability of households to make wise housing decisions.

One housing decision in particular that can have large financial implications is the choice to refinance a home mortgage. Households that fail to refinance when interest rates decline can lose out on tens of thousands of dollars in savings. For example, a household with a 30-year fixed-rate mortgage of \$200,000 at an interest rate of 6.5% who refinances when rates fall to 4.5% (approximately the average rate decrease between 2008 and 2010 in the U.S.) will save over \$80,000 in interest payments over the life of the loan, even after accounting for refinance transaction costs. Further, when mortgage rates reached all-time lows in late 2012, with rates of roughly 3.35% prevailing for three straight months (Freddie Mac PMMS), this household with a contract rate of 6.5% would save roughly \$130,000 over the life of the loan by refinancing.

Despite the large stakes, anecdotal evidence suggests that many households may fail to refinance when they otherwise should. Failing to refinance is puzzling due to the large financial incentives involved. However, certain features of the refinance decision make failing to refinance consistent with recent work in behavioral economics. For example, calculating the financial benefit to refinancing is complex and households have very limited experience with transactions of this type. Furthermore, the benefits of refinancing are not immediate, but rather accrue over time. Finally, there are a number of up-front costs, both financial and non-financial, that households must pay in order to complete a refinance, including a re-evaluation of their financial

position and the value of their home. All of these features provide a psychological basis for why some households may fail to take up large savings.

In this paper, we move beyond anecdotes and provide empirical evidence regarding how many households in the U.S. appear to be suffering from a failure to refinance and approximate the magnitude of their mistakes. Our analysis utilizes a unique, nationally-representative sample of approximately one million single-family residential mortgages that were active in December 2010. These data include information about the origination characteristics of each loan, the current balance, second liens, the payment history, and the interest rate being paid. Given these data, we can calculate how many households would save money over the life of the loan if they were to refinance their mortgages at the prevailing interest rate.

Of course, there are many reasons why a household may very sensibly not refinance their house, even when it appears they could save money by doing so. Perhaps the most obvious reason – and one that is especially important after the recent housing bust – is that they are unable to qualify for a new loan due to bad credit or because of decreasing housing values (leading to high loan-to-value ratios). Another example of a reason why a household may choose not to refinance is if they plan to move in the near future. For these reasons, it would be naïve to argue that any household who appears as if they could save money by refinancing is acting sub-optimally when they fail to do so.

The dataset that we use contains information that allows us to reasonably identify homeowners who may be unable to refinance from those who sub-optimally fail to do so. For example, we can restrict the sample to homeowners who have not missed any previous loan payments and whose loan-to-value ratios are below a certain threshold (including information on second liens). Additionally, we can take into account reasonable assumptions about the probability of moving and the present-discounted, tax-adjusted benefits of refinancing relative to up-front costs.

Based on a conservative set of assumptions, we estimate that approximately 20% of households in December 2010 had not refinanced their house when it appeared profitable to do so given the interest rate environment at the time. We calculate that the median household that is holding on to a mortgage with too high an interest rate would have saved approximately \$160 per month, or \$45,000 (unadjusted) over the remaining life of the loan by refinancing, or approximately \$11,500 when adjusting for the probability of moving, tax incentives, up-front costs, and discounting over time. In addition, our data allow us to see whether these loans continue to be active in December 2012 when interest rates reached historic lows. We find that approximately 40% of the households that we identified as those who could have benefited from refinancing in December 2010 had not moved from their homes and still had not refinanced their mortgage – despite interest rates dropping even more between 2010 and 2012.

To be clear, refinancing behavior requires a lender willing to take on the risk of a new mortgage. Over the period 2010-2012, lenders were especially reluctant to lend to borrowers whose credit, income, or home values deteriorated substantially following the financial crisis. Although we use updated LTV measures at the time of refinancing, we do not observe updated credit scores or income for mortgage-holding households in our data. To explore whether income drops may be a primary driver of the failure to refinance, we stratified our data based on county-level unemployment rates, and find limited variation in the failure to refinance among creditworthy households (FICO>680, current LTV<90%, never missed a payment). This lack of geographic variation supports the view that failure to refinance during this period was a widespread phenomenon and not simply a function of revised underwriting standards in the wake of the crisis.

These results suggest that the size and scope of the problem of failing to refinance is large. While much of the savings a household can receive by refinancing represents a transfer of wealth from investors to households (as opposed to a welfare loss), the foregone savings is clearly significant for each individual household. Furthermore, we find some evidence that less

financially savvy households (e.g. those that are less educated and less wealthy) are systematically more likely to fail to refinance and thus disproportionately lose out on savings when interest rates decline.

As a complement to our results using a nationally-representative sample, we also analyze data from a nonprofit lender in one major city. In an attempt to help households refinance, this nonprofit lender participated in several waves of offers to their clients that would allow them to refinance. By working directly with the lender, we were able to identify in the data which households were eligible (preapproved) to refinance. Consistent with the results from the nationally-representative data, we find that a large fraction of the households who received an offer to refinance did not take up this offer despite large savings, no out-of-pocket costs, and being eligible to do so with certainty. We estimate factors that correlate with failure to take up and provide survey evidence from households who chose not to refinance in order to better understand the behavioral mechanisms at play.

Our work builds on two recent papers that explore households' refinancing choices. Agarwal, Rosen, and Yao (2012) empirically investigate the time-varying option value of refinancing and find that over half of borrowers who refinance do so at a sub-optimal time, though more experienced refinancers make smaller mistakes. Agarwal, Driscoll, and Laibson (2013) provide the first optimal closed-form solution to the household's refinancing problem under a plausible set of parameters. In our paper we use this closed-form solution to calculate the fraction of households who suboptimally fail to refinance in our data, but unlike Agarwal, Rosen, and Yao (2012) we focus solely on the failure to refinance rather than the optimal timing for those who do choose to refinance.

Prior research in real estate and finance has documented the existence of a subset of households who fail to refinance despite the benefits from refinancing being large. The most closely related papers are those by Green and LaCour-Little (1999), Campbell (2006), Schwartz (2006), and Deng and Quigley (2013). Each of these papers provides varying degrees of

evidence on anomalous behavior on the part of homeowners with regards to optimal refinancing decisions during earlier time periods. Key contributions of our paper relative to these include the representativeness, accuracy, and immediacy of our loan-level data to better estimate the current magnitude of the failure to refinance in the U.S. and, importantly, our ability to restrict our focus to households whose payment histories and loan-to-value ratios (across all liens) are such that we can reasonably assume their ability to refinance. Our paper is also related to other evidence in the real estate market demonstrating that a lack of financial savvy may be costly to homeowners (see Bucks and Pence 2008). For example, Woodward and Hall (2012) argue that borrowers on average lose out on \$1,000 for failing to effectively shop for mortgage brokers and that the loss is heterogeneous across consumer types.

Our paper is also related to the literature that provides evidence of less than 100% take-up of social services (for a review, see Currie 2004). These papers – such as recent work on EITC take-up by Bhargava and Manoli (2013) – provide evidence that individual biases (inattention, status quo bias, self-control issues, etc.) can play an important role in the failure to take-up, along with lack of information, complexity, and potential stigma. Since there is not generally a stigma associated with refinancing a mortgage, our results complement the evidence in this literature on the importance of individual biases and lack of simple information as factors that can lead to surprisingly low take-up rates.

Finally, our paper contributes to a growing body of literature that documents important financial household mistakes, including mistakes associated with savings and investments (Madrian and Shea, 2001; Thaler and Bernartzi, 2004; Choi, Madrian, and Laibson, 2011), failure to smooth consumption (Stephens Jr. 2003; Shapiro, 2005), failure to accurately respond to taxation (Chetty, Looney, and Kroft, 2009; Finkelstein, 2009), mistakes associated with the purchase of durable goods (Conlin, O'Donoghue, and Vogelsang, 2007; Busse et al., 2012), and mistakes with credit cards and payday lending (Argarwal et al., 2008; Bertrand and Morse, 2011). DellaVigna (2009) provides a thorough review of the empirical literature at the

intersection of psychology and economics. Relative to the settings explored in this literature, the financial magnitude of failing to refinance is especially large.

The paper proceeds as follows. In section 2 we give some background on the mortgage market and refinancing in the United States. In section 3 we describe the unique loan-level dataset we use and document the size and magnitude of the failure to refinance in the U.S. during the recent decline in interest rates. In section 4 we describe our smaller, non-representative sample of loans and the attempts by a nonprofit to help their clients refinance. Finally, we provide a discussion of policy implications and conclude in section 5.

2. Background on Mortgage Markets and Refinancing

There are two primary mortgage loan instruments that are used in the U.S. and globally: an adjustable-rate mortgage (ARM) and a fixed-rate mortgage (FRM). A standard ARM has a floating nominal interest rate that is indexed to the general level of short-term interest rates. A standard FRM has a fixed interest rate over the life of the mortgage loan and thus eliminates any uncertainty about the required stream of payments even if interest rates increase substantially. If, however, interest rates move significantly downward, a household with a FRM may benefit by paying off the old mortgage (known as a prepayment) and taking out a new fixed-rate loan at the lower prevailing rate.

According to Campbell (2013), approximately 90% of the mortgages in the U.S. are 30-year nominal FRMs, with the remainder of mortgages either ARMs or shorter-duration FRMs. This dominance of 30-year FRMs in the U.S. is quite different than most other countries in the world and is likely an artifact of a relatively stable inflation history and a variety of public policies that promote this mortgage design (Green and Wachter, 2005). More importantly in the context of our paper, since most borrowers have FRMs, there are serious consequences for homeowners if they fail to take advantage of refinancing options when interest rates decline.

The decision to refinance is typically complicated and involves a large number of factors. These factors include the up-front costs associated with refinancing, the probability of moving within a short period of time, a discount factor on future savings, expectations about future interest rate changes, current mortgage balance, risk preferences, and current and future marginal tax rates.

Agarwal, Driscoll, and Laibson (2013) recently derived a closed-form optimal refinancing rule based on the difference between a household's contract rate and the current mortgage interest rate. Their solution requires the consideration of a large number of parameter values (a marginal tax rate, discount factor, probability of moving, etc.), as well as other more general assumptions (e.g. they assume that the nominal mortgage interest rate follows a continuous-time random walk). For a reasonable set of parameter values, they find that interest rates must fall by 100-200 basis points to make refinancing optimal. The optimal rate is particularly sensitive to up-front points and closing costs for the mortgage, as these costs are immediate and not discounted like the longer-term benefits of refinancing. When these costs fall, the refinancing threshold rate rises sharply, with \$1,000 in up-front costs associated with roughly 25 basis points movement in the threshold. As discussed below, we apply this closed-form solution, using a conservative set of parameter values, to a sample of recent mortgage loans active during a period of historically low interest rates.

3. Size and Magnitude of the Failure to Refinance

3.1 Description of Loan-Level Dataset

Our analysis is based on approximately one million observations of a nationally-representative sample of mortgage loans that were active in December 2010. The data comes from CoreLogic Solutions (henceforth "CoreLogic"), and is provided through a CoreLogic

Academic Research Council (CLARC) data grant.¹ Mortgage-level data is provided by most of the top 20 mortgage servicers in the nation, and the sample is drawn from mortgage records covering both the agency and non-agency segments of the mortgage market. In total, the CoreLogic database covers roughly 85% of the mortgage market.

To make our calculations of the financial benefit of refinancing as consistent across mortgage-holders as possible, the sample provided to us was randomly drawn from the overall sample of fixed-rate mortgages of single-family, owner-occupied homes that are not overseen by the FHA/VA program, are not manufactured or mobile homes, and are not in foreclosure proceedings as of December 2010. The sample was also restricted to loans with an outstanding balance of at least \$75,000 as of December 2010.

The data contain information about each mortgage including date of origination, credit score of borrower at origination, loan-to-value ratio at origination, unpaid balance (in December 2010), interest rate, time remaining on the loan, the zip code of the house location, and a full payment history (late payments, missed payments, etc.). In addition to these variables, we also have access to any additional liens for which the household is responsible. We also merge 2010 Census information that includes zip-code level variables such as median average income and education levels. We also merge zip-code level housing price data from Zillow. Using the loan-to-value ratio for each mortgage at origination and the date of origination, we are able to compute the loan-to-value ratio for each mortgage (including all liens) at subsequent dates.²

The CoreLogic data are unique for the amount of detail that is available for each mortgage. Although these data are likely the best available large-scale data source on

¹ More information on accessing the data can be found on the CLARC website at <http://www.corelogic.com/about-us/researchtrends/academic-research-council.aspx>.

² Due to the Zillow coverage, we are unable to compute December 2010 loan-to-value ratios for approximately 15% of the sample. Also, we have Zillow housing price data starting in 1997. For homes that had an origination date prior to 1997 (0.4% of our total sample), the loan-to-value ratios that we compute do not take into consideration any price movements that occurred prior to 1997. Since house prices were generally increasing through the 1990s, this is likely to result in loan-to-value ratios that are biased upward for these households. For robustness, we have also applied the CoreLogic proprietary valuation model to calculate updated LTV and CLTV values, and the results are similar (and available upon request).

refinancing, a number of limitations remain. First, we do not observe refinancing directly in the CoreLogic data, only the prepayment of a mortgage, which could be due to either refinancing or moving to a new home. Second, although we observe measures of borrower creditworthiness at the time the loan was originated, this information is not updated in the panel data. We do, however, have the full payment history for each loan. Lastly, we do not have any direct information regarding how long homeowners intend to remain in their home.³

Table 1 provides summary statistics for our sample. The first column in Table 1 indicates that a typical active loan in December of 2010 was paying an interest rate of 5.52%, had 23 years remaining and an unpaid balance of just over \$200,000. The average loan-to-value ratio at origination was approximately 70% and in 2010 was 74%. The additional columns in Table 1 provide the same summary statistics when we restrict our sample to loans with certain characteristics that we discuss in detail below.

Of particular importance for our research is the distribution of interest rates being paid across homeowners. Panel A of Figure 1 illustrates the distribution of interest rates for our full sample. While the average interest rate being paid is 5.52%, there is substantial variation with many households paying interest rates near the market rate in December 2010 (~4.3%) and other households paying interest rates well over 6%. The second panel in Figure 1 shows the distribution of interest rates being paid by households when we restrict the sample to households that appear as if they should be eligible to refinance (more discussion of these restrictions below). As expected, the distribution of interest rates for this latter sample is narrower, but there remains substantial heterogeneity in mortgage rates, with many homeowners continuing to make mortgage payments on rates well above the market rate of 4.3%, indicated by the solid black line.

³ An additional limitation is lack of information on the presence, duration, or size of prepayment penalties. These are unlikely to be an issue in 2010, as nearly all fixed-rate agency loans (Fannie Mae, Freddie Mac, and the FHA) do not carry prepayment penalties, and non-agency prepayment penalty periods had likely expired by this time, as frequent prepayment penalty durations are two or three years.

3.2 Estimating the scope of the failure to refinance

Using our loan-level dataset, Table 2 provides the main results regarding the failure to refinance. The first row results are based on the full sample, and thus the naïve assumption that all households could refinance in December 2010 at the prevailing rate of 4.3% if they chose to do so. For this full sample of mortgages, we first estimate the share of households that would experience positive savings if they were to refinance in December of 2010. The savings from refinancing are calculated by taking the difference between the total interest payments on the remaining term of the mortgage at the contract rate and the total interest payments on the remaining term at a counterfactual refinanced interest rate.⁴ These savings are then reduced by the upfront costs that are typically associated with refinancing a home (1% in points and \$2,000, see Agarwal, Driscoll, and Laibson 2013). Using this measure of savings, we estimate that 91.4% of households in our full sample could save money over the life of the loan by refinancing.

This simple measure of savings, however, does not include several obviously important factors. For example, it does not take into consideration the tax incentives associated with paying mortgage interest rates, the probability of moving, and the discounting of money over time. Thus, the 91.6% estimate is likely to dramatically overstate the percentage of households who would actually benefit from refinancing.

In order to obtain a more accurate measure of how many people should refinance (still assuming at this point that everyone is eligible to do so), we use the optimal refinancing formula found in Agarwal, Driscoll, and Laibson (2013). We also use the parameter values that they suggest in their baseline illustrative calibration. These parameter values include a discount rate of 5% per year, a 28% marginal tax rate, and a probability of moving each year of 10%. We think these parameter values are all quite conservative in that they suggest that people should only

⁴Using data from Freddie Mac PMMS series, the average interest rate for a 30-year, fixed-rate mortgage in November 2010 (immediately prior to our sample window) was 4.3%, so we use 4.3% as the baseline prevailing interest rate.

refinance when it is surely in their best interest to do so. With these parameter values, we use Agarwal, Driscoll, and Laibson's "square-root rule" and compute the change in interest rate required for a household to optimally decide to refinance their house.⁵ Based on this calculation, we report in the third column of Table 2 that 41.2% of households in our full sample were in a position where they should refinance.

Table 2 also gives a sense of the magnitude of the foregone savings. Conditional on refinancing being optimal for a household, we estimate that the median household would benefit from refinancing by \$184 per month, or approximately \$54,313 of unadjusted savings over the life of the loan. Using the same parameter values above (discount rate of 5% per year, 28% marginal tax rate, and a 10% probability of moving each year), we calculate the present-discounted value of refinancing once all considerations have been made to be approximately \$13,000.

The main factor that the calculation in the first row of Table 2 neglects is that many households in December 2010 may have wanted to refinance, but were unable to do so because of credit problems or because their loan-to-value ratio was too high. The subsequent rows in Table 2 impose increasingly restrictive requirements on mortgages in our sample in an attempt to limit the sample to households who likely would have been eligible in December 2010 to refinance their house had they chosen to do so. While these sample restrictions are not perfect, they allow us to better estimate how many households are actually failing to refinance due to non-optimal decision making as opposed to institutional features that cause them to be ineligible.⁶

⁵ The square root rule is straightforward to calculate on any calculator, and is a second-order Taylor series approximation to the authors' closed-form exact solution, which requires the use of Lambert's W-function. For details, see Agarwal, et al. (2013), page 601.

⁶ Our sample restrictions may be imperfect in several different ways. For example, having good initial FICO scores and never missing a payment does not mean with certainty that the household has a high enough credit score to refinance. Thus, this restriction may not be restrictive enough. At the same time, it may be too restrictive; a household that had good initial FICO scores and simply was late on one house payment, may have a credit score that is high enough to refinance even though we categorize them as ineligible.

The second row in Table 2 restricts the sample to households with good credit scores at the time of origination ($FICO > 680$) and whose initial loan-to-value ratio was less than 90%.⁷ Imposing this sample restriction reduces the percentage of households who we estimate would see positive savings over the life of the loan from 91.4% to 89.0%, and the percentage of people who should optimally refinance according to the Agarwal, Driscoll, and Laibson (2013) formula from 41.2% to 31.1%. The reduction in the percentage of people who should optimally refinance that we observe when we restrict the sample to more creditworthy households with lower loan-to-value ratios could be a result of selecting households who were more likely to be eligible to refinance (and thus more of them do so) or a result of selecting on the types of households who are savvier and more likely to refinance when rates go down. We are unable to distinguish between these two explanations for the percentage decline that we observe and assume it is likely to be a combination of both factors.

While having good credit and a low loan-to-value ratio at origination helps us to restrict the sample to households who are more likely to be eligible to refinance in December 2010, many households may have had good initial credit, but then saw their credit score drop below usual mortgage underwriting standards. To help eliminate households whose credit rating declined after securing their initial loan, we further restrict the sample to households who have not missed a mortgage payment or even had one late payment (one of the clear signs of credit trouble). This sample restriction has a small effect on the percentage of people who should have optimally refinanced (now down to 27.5%).

Along with the possibility that households saw their credit scores decline after securing a loan, a household's loan-to-value ratio may have increased due to declining home prices. We, therefore limit the sample to households whose *current* LTV is less than 90% based on our zip-code adjusted LTV ratios described in the data section. This restriction reduces the sample by

⁷ These restrictions are intended to capture the stringent underwriting standards that prevailed in the aftermath of the housing crisis relative to the housing boom period. Sensitivity of our results to different sample restrictions are available upon request.

approximately 25% and is driven by the elimination of mortgages for homes that experienced a large amount of depreciation during the great recession. The percentage of people who should optimally refinance in this more restricted sample is 23.4%.

One reason why some households are unable to refinance is the existence of second liens that were taken out on the home. Our final sample restriction focuses on households whose current loan-to-value ratio on their *cumulative* loans for the house is less than 90%. In total, the sample restrictions that we impose in an attempt to focus in on homeowners who are likely eligible for a refinance reduces our sample from roughly 995,000 to 376,000 households.⁸ After imposing these restrictions, our final estimate is that approximately 20% of households in December of 2010 had not refinanced their house when it appears to have been both optimal and feasible to do so.

The average unadjusted savings available to the median household in this 20% of households was \$160 per month, or \$45,473 over the remaining life of the loan. When adjusting this using the parameter values discussed above, we find that the present-discounted value of forgone savings was equal to approximately \$11,500. This amount of savings masks a large degree of heterogeneity in the amount of savings possible. Figure 2 provides a simple histogram of the unadjusted savings for the 20% of households who we argue were failing to refinance.

An important unobserved dimension of refinancing eligibility is whether households would qualify for refinancing, especially during a period of financial contraction and tightening standards among lenders. Although we do not have microdata on households' income either at origination or at later dates, we can explore this dimension by stratifying our results based on county-level unemployment rates. For instance, comparing the top and bottom quartiles of counties in the unemployment distribution, we find extremely similar proportions of households who failed to refinance (after conditioning on FICO>680, current LTV<90%, and never missed a payment). In results not shown, among homeowners living in the quartile of counties with the

⁸ These creditworthy households are also least likely to face loan-level risk-based pricing adjustments, and thus the prevailing PMMS rate may be most reflective of their likely price of mortgage credit.

lowest unemployment rates in 2010 (less than 7.7 percent), 19% should have optimally refinanced but did not do so. Similarly, for homeowners in the top unemployment rate quartile (greater than 10.9 percent in 2010), 20.2% should have optimally refinanced but did not do so. The lack of a steep gradient in unemployment rates is suggestive evidence that among creditworthy households, there is consistent and widespread failure to refinance when it is optimal to do so.

If interest rates had increased sharply starting in December 2010, our estimates suggest that approximately 20% of households would have lost their chance to refinance even though it would have been optimal for them to do so. Interest rates, however, continued to decline through the end of 2012 and reached record lows of 3.35% for 30-year fixed-rate mortgages. This continued interest rate drop provided an opportunity for the 20% of households we estimate as failing to refinance in December 2010 to finally decide to refinance and to realize even greater savings because of the ever lower rates.

We obtained from CoreLogic an update for all loans in our December 2010 sample. Specifically, we know what fraction of these loans prepaid at some point between December 2010 and December 2012. Given that the even greater savings (due to historically low rates) and additional time, many of the 20% of households that had failed to refinance by December 2010 prepaid their mortgage in the subsequent two-year period.⁹ However, 40% of the households who we estimate should have refinanced in December 2010 are still living in their house by December 2012, continue to make full and on-time monthly payments, yet have not refinanced their house despite the further decline in interest rates.

Who are these households that fail to refinance despite the large financial stakes? Unfortunately, the CoreLogic data do not provide detailed demographic or socioeconomic variables for the households in our sample. However, it is possible to roughly cut the data in a few ways in order to better understand certain household characteristics that make people more

⁹ Again, our measure is a mortgage prepayment, so we cannot distinguish between refinances and moves.

at risk for failing to refinance. In Table 3, we replicate the results from the last row in Table 2, but do so separately for households with low and high credit scores at time of origination, low and high income based on zip-code level census data, and low and high education based on zip-code level census data.

This heterogeneity analysis suggests that the failure to refinance is widespread, but is more prevalent among households that have worse credit (but still have scores above 680), and slightly more prevalent in neighborhoods with lower education and income levels. For example, we find that the share of people who should optimally refinance that had above median credit scores at origination is only 14.5% compared to 25.1% for households who had below median credit scores at origination. The differences using the census data are smaller (possibly due to the large geographic units used to measure education and income levels). Nonetheless, we still find some small evidence for differences in suboptimal refinance behavior. For example, only 19.0% of households residing in zip-codes with above median education are suboptimally not refinancing while 20.9% of households residing in zip-codes with below median education are suboptimally not refinancing.

4. Micro-Level Evidence

By using a large, random sample of households in the previous section, we were able to provide broad representative evidence regarding the failure to refinance in the U.S. While these data were ideal for producing general estimates, a more micro-level dataset could potentially provide even cleaner evidence of individual financial mistakes with regards to refinancing and on the behavioral mechanisms at play.

To this end, we partnered with a non-profit organization called Neighborhood Housing Services of Chicago, Inc. (NHS). Founded in 1975, NHS's stated mission is to create opportunities for individuals to live in affordable homes. Their efforts are primarily concentrated in lower-income communities in Chicago to provide services including, among others, education

programs for new homeowners, foreclosure prevention services, reclaiming vacant properties, and preserving and rehabilitating older homes. In addition to these various services, NHS's nonprofit lending affiliate, Neighborhood Lending Services (NLS) acts as a mortgage lender and servicer to homeowners in the Chicago area. Because they are a non-profit organization interested in helping homeowners – including those that they lend to – NHS and NLS educate their clients on the pros and cons of refinancing, and emphasizes the importance of considering long-term savings, short-term costs, and other factors. In some cases, NLS actively encourages their clients to refinance their mortgages when interest rates decrease to a level that is advantageous to their clients.

In July of 2011, NHS sent a letter to 446 households whose mortgages NHS services. The letter (see appendix figure 1) provided the details of an offer to refinance their current mortgage loan at a 4.7% interest rate. No money up front was required to refinance, as the appraisal fee and a loan origination fee of 1% of the loan amount could be rolled into the new loan. The letters were only sent to households who NHS had already determined were eligible to refinance their homes (screening included thresholds for current loan-to-value ratios and also required that the homeowners be current on their payments) and who would benefit from doing so (based on the unpaid balance and interest rate). The letter encouraged homeowners to call an NLS loan officer.

The data associated with this letter campaign that took place in the summer of 2011 is ideal for the purposes of this paper. The letter campaign isolated homeowners who were eligible and would benefit financially from refinancing, and allows us to measure exactly how many of them chose to take up the offer. Furthermore, these homeowners had a pre-existing relationship with NHS and NLS and had attended homeownership counseling in one of their offices, so this refinance offer was from a trusted source in the community. Additionally, because NLS is the servicer of these loans, we are able to calculate exactly how much savings each household would have received if they refinanced at a 4.7% interest rate.

The summary statistics from the letter campaign described above (which we refer to as “Wave 1”) are presented in the top panel of Table 4. 84% (375 of the 446) of the households who received the refinance offer did not respond to the pre-approved, no up-front-cost offer to refinance their mortgage. This is consistent with our findings in the previous section that a large portion of the population chooses not to refinance even when they are eligible to do so and substantial savings are at play. Using the same strategy discussed in the previous section, we calculate the forgone unadjusted savings over the life of the loan for each homeowner who received a letter in Wave 1 from NLS. We estimate that the 16% of homeowners that took up NLS’s first refinance offer would go on to pay \$85 less per month, or \$24,500 less in total interest payments over the life of the loan by lowering their rate.¹⁰ The median household of the 84% that did not respond to the offer to refinance saw forgone savings of \$17,700 over the life of the loan by failing to respond to the refinance offer. Thus, those households who took up the offer had a slightly larger financial benefit to do so, but not dramatically so.

Because rates continued to decrease, NLS decided to send a similar letter in July of 2012 with an offer to refinance their clients’ mortgages at a 3.99% interest rate. This letter was sent to 140 households (nearly all of whom had been non-responders in Wave 1) who continued to have loan-to-value ratios that NLS deemed low enough and whose loans were current. The results from this second wave of refinance offers are presented in the second panel of Table 5. Still, over 75% of households did not respond, resulting in a take-up rate of 24.3%. The median household for those that took up the refinance offer had a large savings opportunity of \$100 per month reduction in mortgage outlays (\$29,900 unadjusted savings over the life of the loan), but once again households that chose not to respond to the offer letter saw a large forgone unadjusted savings opportunity (\$24,700).

¹⁰ The savings available to NLS borrowers is smaller relative to the estimated savings for the national average household because the rate reductions were not as dramatic and mortgage balances were smaller relative to the mortgage holders in the CoreLogic data.

In May of 2013, NLS once again decided to conduct a mail campaign to encourage their clients to refinance their mortgages. 193 households were deemed eligible and preapproved by NLS to refinance. Each of these households once again received an offer to refinance their house at a 4% interest rate. During this mail campaign, we worked with NLS to divide letter recipients into three treatment groups. Each group received a different letter with a different treatment. For example, one letter provided more direct information about the amount of savings that homeowners could receive both over the life of the loan and on a month-to-month basis if they were to refinance. The results from this third wave of refinance offers are presented in the final panel of Table 5. Only 13.0% of households took up the offer to refinance. As in the previous two waves, we find that higher potential savings significantly predicts a higher take up of the refinance offer. However, once again, those that did not take up passed on a large amount of money (in this case, an savings opportunity of \$94 per month, or \$26,400 on average over the life of the loan). We found no differences in take-up across the treatment groups, but due to the very small sample sizes (fewer than 10 households refinanced in each group), we are unable to reject economically meaningful differences across the randomized groups.

In an attempt to shed light on why households chose not to refinance, we (in conjunction with NHS and NLS) designed and conducted a short survey after the expiration of the 3rd mail offer. Eligible households that did not refinance were contacted by phone and asked to answer a few simple questions about the refinance process. Of the non-refinancing households, 32 were reached by phone and were willing to answer the survey questions. The survey results suggest that up to 1/4th of the households did not open the letter that they received from NLS. Of those that did open the letter, just over 1/3rd indicated that they planned to call the loan officer, but did not get around to it or were simply too busy to make the phone call. Another 1/3rd indicated that they did not call the loan officer because they didn't think the savings were significant enough. At the end of the survey, 12 out of the 32 households said they would be happy to have a loan officer call them to discuss the possibility of refinancing their home. These survey results are

consistent with both behavioral explanations such as procrastination and inattention, as well as lack of information as possible reasons why households fail to respond to offers that appear to be in their financial best interest.

The results from letter campaigns of a non-profit mortgage lender further establish that many households in the U.S. choose not to refinance despite being eligible to do so and despite a large amount of savings potential.

5. Discussion and Conclusion

This paper analyzes an important behavioral anomaly—the failure of households to refinance their mortgage when interest rates decline, despite substantial monetary benefits from doing so. We analyze a detailed loan-level dataset containing a large random sample of U.S. mortgages and demonstrate that approximately 20% of households who appeared unconstrained to refinance failed to do so at a point during the recent decline in interest rates. The median household would have saved \$160 per month over the remaining life of the loan, and the total present-discounted value of the forgone savings for these 20% of households was approximately \$11,500. Given that this 20% of households represents roughly 400,000 mortgages from the full sample in the CoreLogic database, which represents 85% of the mortgages in the U.S., our estimates conservatively suggest that the total forgone savings of U.S. households over this period was approximately 5.4 billion dollars. Thus it appears that the size and scope of the failure to refinance is substantial and that this is a particularly large household financial mistake.

One obvious parallel with our research is the current effort by the U.S. federal government to encourage refinancing. In March of 2009, the Federal Housing Finance Agency (FHFA) and the Treasury announced a refinance program entitled “Home Affordable Refinance Program” (HARP). This program was designed to help borrowers with federally guaranteed loans to refinance even if they had little or no equity in their homes. Homeowners that were current on their mortgage payments and met the other conditions of the loan (including having

less than 125% loan-to-value on their mortgage) could refinance to a lower interest rate. When HARP was announced, FHFA and the Treasury estimated that 4 to 5 million borrowers whose mortgages were backed by Fannie Mae and Freddie Mac could take advantage of the refinancing program. By September 2011, however, less than a million borrowers had actually refinanced their mortgages under HARP, remarkably similar in scope to the failure to refinance we find in our loan-level analysis. Although modifications to the program have resulted in more households taking up refinance offers, the overall take-up rate remains low.

Our results suggest the presence of information barriers regarding the potential benefits and costs of refinancing. Expanding and developing partnerships with certified housing counseling agencies to offer more targeted and in-depth workshops and counseling surrounding the refinancing decision is a potential direction for policy to alleviate these barriers for the population most in need of financial education.

In addition, the magnitude of the financial mistakes that households make suggest that psychological factors such as procrastination, trust, and the inability to understand complex decisions are likely barriers to refinancing. One policy that has been suggested to overcome the need for active household participation would require mortgages to have fixed interest rates that adjust downward automatically when rates decline (Campbell 2013). To the extent that it is undesirable to reward only those households that are able to overcome the computational and behavioral barriers of the refinance process, policies such as an automatically-refinancing mortgage may be beneficial. Although an automatically-refinancing mortgage contract would be more expensive up-front for all borrowers in equilibrium, it would remove the cross-subsidization in the current mortgage finance system, where savvier homeowners who use their refinancing option when rates decline are subsidized by those households who fail to do so.

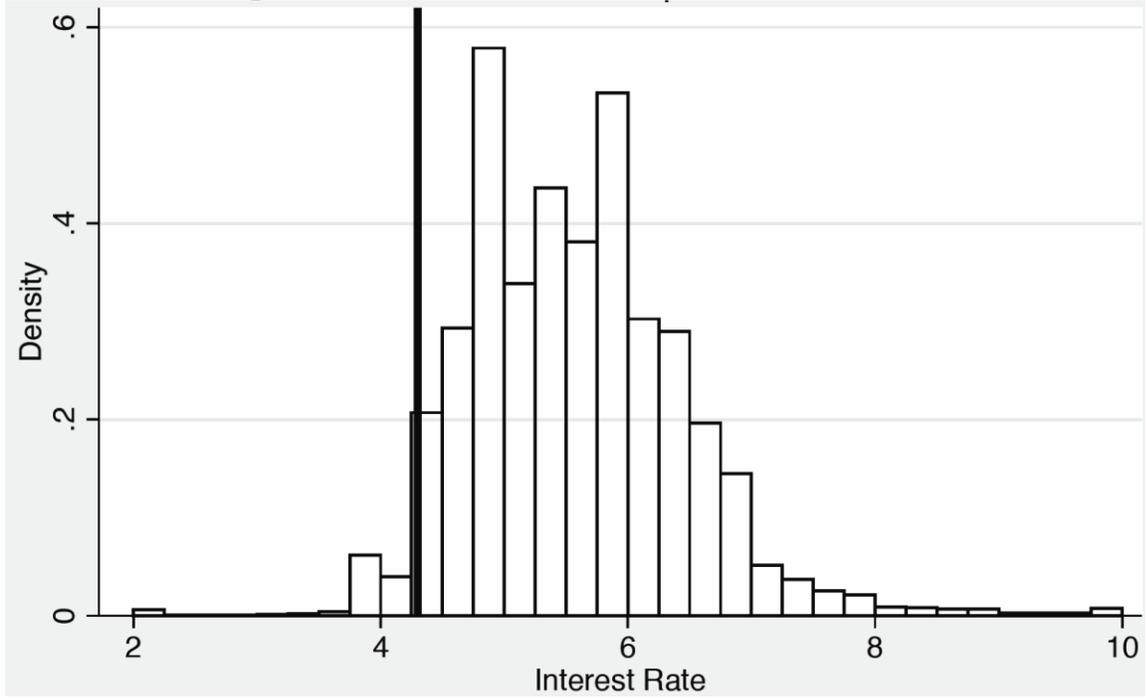
References

- Agarwal, S., Driscoll, J. C., Gabaix, X., & Laibson, D. (2008). Learning in the credit card market (No. w13822). *National Bureau of Economic Research*.
- Agarwal, Sumit, John C. Driscoll, and David I. Laibson (2013). "Optimal Mortgage Refinancing: A Closed-Form Solution." *Journal of Money, Credit and Banking*, 45(4): 591-622.
- Agarwal, Sumit, Richard J. Rosen, and Vincent Yao (2012). "Why Do Borrowers Make Mortgage Refinancing Mistakes?" working paper 2013-02, Federal Reserve Bank of Chicago.
- Bertrand, M., & Morse, A. (2011). Information disclosure, cognitive biases, and payday borrowing. *The Journal of Finance*, 66(6), 1865-1893.
- Bhargava, Saurabh., and Dayanand Manoli (2013). "Why are Benefits Left on the Table? Assessing the Role of Information, Complexity, and Stigma on Take-up with an IRS Field Experiment." mimeo.
- Bucks, Brian, and Karen Pence (2008). "Do Borrowers Know Their Mortgage Terms?" *Journal of Urban Economics*, 64(2), 218-233.
- Busse, M. R., Pope, D. G., Pope, J. C., & Silva-Risso, J. (2012). Projection Bias in the Car and Housing Markets (No. w18212). *National Bureau of Economic Research*.
- Campbell, John Y. (2006). "Household Finance." *The Journal of Finance*, Vol. LXI, No. 4: 1553-1604.
- Campbell, John Y. (forthcoming). "Mortgage Market Design." *Review of Finance*.
- Chetty, R., Looney, A., & Kroft, K. (2009). Salience and taxation: Theory and evidence. *American Economic Review*, 99(4), 1145-1177.
- Choi, J. J., Madrian, B., & Laibson, D. I. (2011). \$100 bills on the sidewalk: Suboptimal investment in 401(k) plans. *The Review of Economics and Statistics*, 93(3), 748-763.
- Conlin, M., O'Donoghue, T., & Vogelsang, T. J. (2007). Projection bias in catalog orders. *The American Economic Review*, 97(4), 1217-1249.
- Currie, Janet (2004). "The Take Up of Social Benefits." NBER Working Paper No. 10488.
- DellaVigna, S. (2009). Psychology and economics: Evidence from the field. *Journal of Economic Literature*, 47(2), 315-372.
- Deng, Yongheng and John M. Quigley (2013). "Woodhead behavior and the Pricing of Residential Mortgages." Working paper 2012-025, Institute of Real Estate Studies, National University of Singapore.

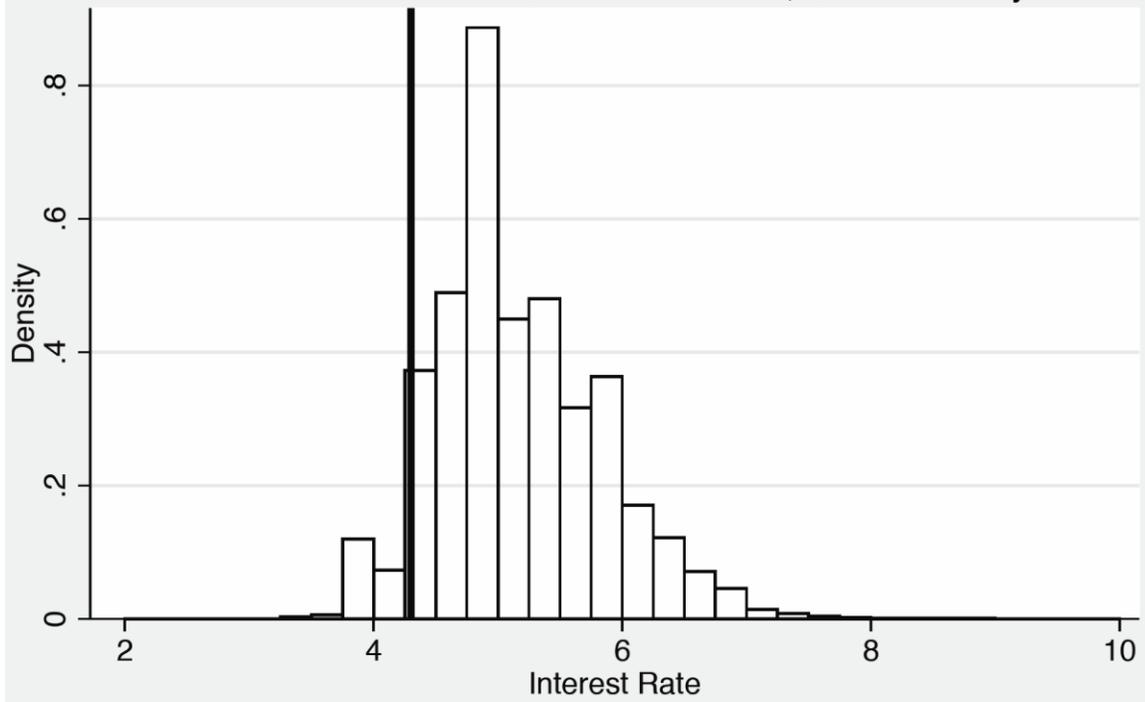
- Finkelstein, A. (2009). E-Z Tax: Tax salience and tax rates. *Quarterly Journal of Economics*, 124(3), 969-1010.
- Green, Richard K., and Micahel LaCour-Little (1999). “Some Truths about Ostriches: Who Doesn’t Prepay Their Mortgages and Why They Don’t.” *Journal of Housing Economics*, 8: 233-248.
- Green, Richard K., and Susan M. Wachter (2005). “The American Mortgage in Historical and International Context.” *Journal of Economic Perspectives*, 19(4), 93-114.
- Iacoviello, Matteo. (2011). “Housing Wealth and Consumption.” working paper 1027, International Finance Discussion Papers, Board of Governors of the Federal Reserve System.
- Madrian, B. C., & Shea, D. F. (2001). The power of suggestion: Inertia in 401 (k) participation and savings behavior. *The Quarterly Journal of Economics*, 116(4), 1149-1187.
- Schwartz, Allie. (2006). “Household refinancing behavior in fixed rate mortgages.” Unpublished paper, Harvard University.
- Shapiro, J. M. (2005). Is there a daily discount rate? Evidence from the food stamp nutrition cycle. *Journal of Public Economics*, 89(2), 303-325.
- Stephens Jr, M. (2003). '3rd of the Month': Do Social Security Recipients Smooth Consumption Between Checks? *The American Economic Review*, 93(1), 406-422.
- Thaler, Richard H., and Shlomo Benartzi (2004). “Save More Tomorrow: Using Behavioral Economics to Increase Employee Saving.” *Journal of Political Economy*, 112(1): 164-187.
- Woodward, Susan, and Robert Hall (2012). “Diagnosing Consumer Confusion and Sub-Optimal Shopping Effort: Theory and Mortgage-Market Evidence.” *American Economic Review*, 102(7): 3249-3276.

Figure 1. Distribution of Interest Rates in December 2010

Panel A. Full Sample

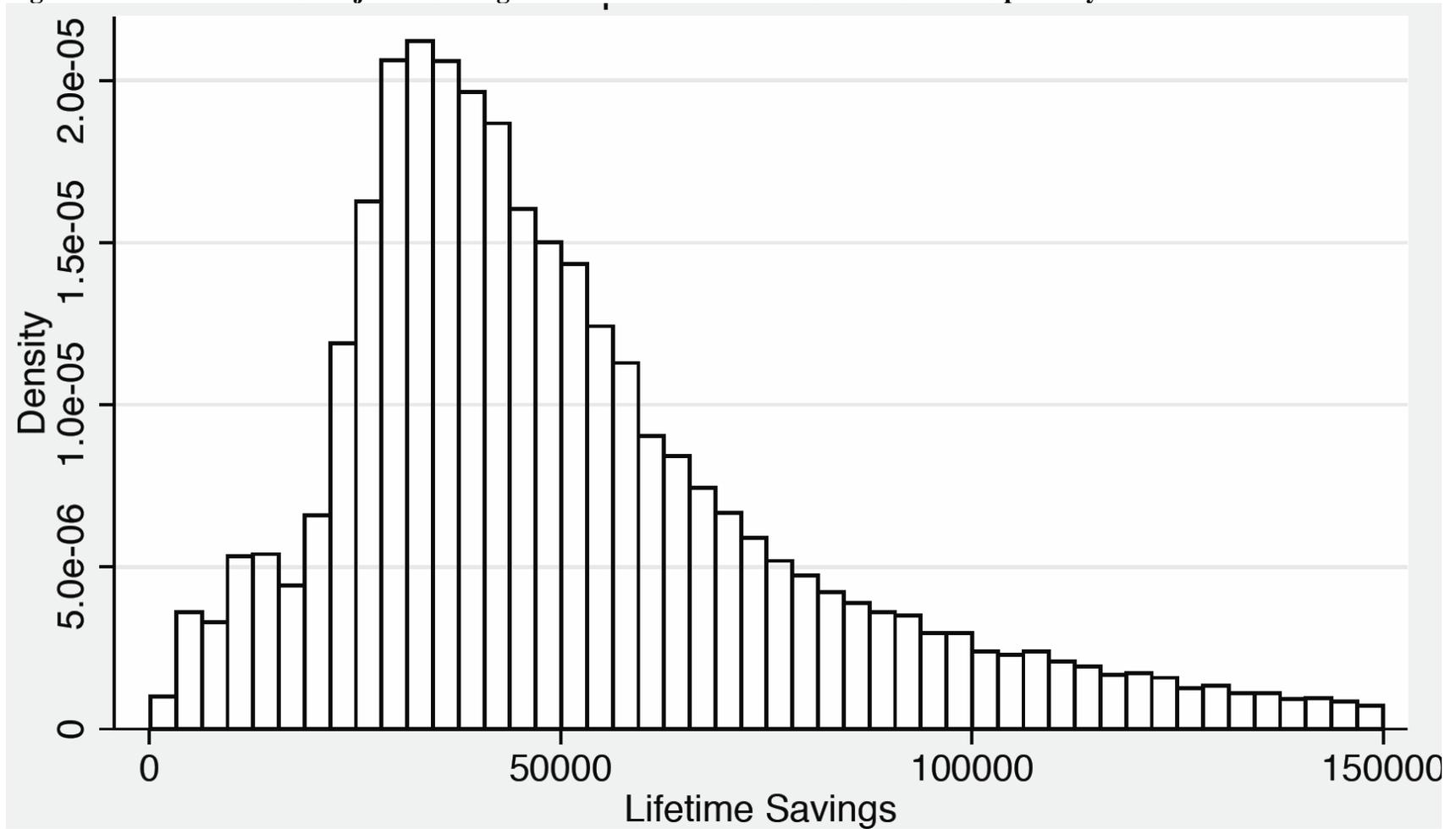


Panel B. Loans with Initial FICO >680, Current CLTV < 90, and Never Missed a Payment



Source: Calculations from CoreLogic Data. Sample of loans originated prior to November 2010 and active in December 2010. See text for detailed description of sample selection criteria.

Figure 2. Distribution of Unadjusted Savings for the 20% of Households who Should Optimally Refinance in Dec. 2010



Source: Calculations from CoreLogic Data. Sample of loans originated prior to November 2010 and active in December 2010. See text for detailed description of sample selection criteria.

Table 1. CoreLogic Data Summary Statistics

Variables of Interest						
Interest Rate		5.52	5.29	5.22	5.22	5.1
Years Remaining		23.4	23.3	23.3	22.9	22.9
Unpaid Balance		\$205,218	\$215,481	\$215,248	\$216,296	\$212,102
Monthly Payment		\$1,370	\$1,421	\$1,414	\$1,420	\$1,395
FICO Score at Origination		737	758	761	761	765
LTV at Origination		70.7	66.4	65.9	64.6	62.7
Computed LTV in December 2010		74.2	68.5	67.1	62.4	60.2
Sample Restrictions						
FICO>680 & LTV < 90			X	X	X	X
Never missed a payment				X	X	X
Current LTV < 90					X	X
Current CLTV < 90						X
Observations		994,188	650,490	573,973	477,601	376,036
Source: Calculations from CoreLogic Data. Sample of loans originated prior to November 2010 and active in December 2010. See text for detailed description of sample selection criteria.						

Table 2. Percentage Failing to Refinance

Sample	Observations	% with positive unadjusted savings	% optimal in Dec. 2010	Median unadjusted savings if optimal	Median adjusted savings if optimal
Full Sample	994,188	91.4%	41.2%	\$54,313	\$13,260
Initial FICO > 680 and initial LTV < 90	650,490	89.0%	31.1%	\$53,831	\$13,218
Initial FICO > 680 and initial LTV < 90, never missed a payment	573,973	88.2%	27.5%	\$52,075	\$12,815
Initial FICO > 680 and <i>current</i> LTV < 90, never missed a payment	477,601	87.2%	23.4%	\$48,344	\$12,174
Initial FICO > 680 and <i>current</i> CLTV < 90, never missed a payment	376,036	85.7%	20.0%	\$45,473	\$11,568

Source: Calculations from CoreLogic Data. Sample of loans originated prior to November 2010 and active in December 2010. See text for detailed description of sample selection criteria. All savings calculations include transaction costs of point point (one percent of the unpaid balance) plus \$2000. Optimal threshold calculated using Agarwal et al. (2013) formula. See text for details.

Table 3. Heterogeneity of Failure to Refinance

Sample: Initial FICO > 680, current CLTV < 90, and never missed a payment							
	All	Above FICO median	Below FICO median	Above Median Income	Below Median Income	Above Median Ed (BA)	Below Median Ed (BA)
Number of records	376,036	181,606	194,430	187,986	188,050	186,707	189,329
% with positive unadjusted savings	85.7%	82.7%	88.6%	85.8%	85.6%	85.5%	85.9%
% optimal in Dec. 2010	20.0%	14.5%	25.1%	19.7%	20.3%	19.0%	20.9%
Median unadjusted savings	\$45,473	\$44,590	\$45,939	\$49,752	\$41,962	\$49,443	\$42,490
Median adjusted savings	\$11,568	\$11,357	\$11,694	\$12,765	\$10,633	\$12,605	\$10,828
Source: Calculations from CoreLogic Data							
Sample of loans originated prior to November 2010 and active in December 2010.							
All refinancing savings calculations include transaction costs of one point (one percent of the unpaid balance) plus \$2000.							
Above optimal threshold calculated using Agarwal et al. (2013) formula. See text for details.							
Income and BA measures are county-level averages from US Census.							
Median FICO score is 773, Median household income is \$61,555, and median fraction of residents with a BA is 33.8%.							

Table 4. NLS Mail Campaign Summary Statistics

Wave		
1		
	Number of letters sent	446
	% who refinanced	15.9%
	Median original interest rate	6.2%
	Median unadjusted savings for those that refinanced	\$24,500
	Median unadjusted savings for those that did not refinance	\$17,700
Wave		
2		
	Number of letters sent	140
	% who refinanced	24.3%
	Median original interest rate	6.1%
	Median unadjusted savings for those that refinanced	\$29,900
	Median unadjusted savings for those that did not refinance	\$24,700
Wave		
3		
	Number of letters sent	193
	% who refinanced	13.0%
	Median original interest rate	6.1%
	Median unadjusted savings for those that refinanced	\$48,200
	Median unadjusted savings for those that did not refinance	\$26,400

Note: This table summarizes the three waves of NLS refinancing mail campaigns, undertaken in May 2011, July 2012, and May 2013, respectively. The first two waves included outgoing calls from loan officers, whereas the third wave was exclusively conducted by mail.

Appendix Figure 1. Example of NLS Letter

Name
Address
City, State Zip
Loan #

Date

Your mortgage company, Neighborhood Lending Services (NLS), has a one-time offer to reduce your mortgage interest rate. You have been selected because you have shown that you are able to make your mortgage payments on time, so we would like to give you the opportunity to take advantage of today's lower interest rates.

This is an offer to **refinance** your primary mortgage you have NLS.

For a limited time, we are offering you a **fixed-rate of X.XX%** to refinance your NLS loan. In addition to this lower fixed-rate, we are offering the following incentives:

- **No application fee**
- **Streamlined processing**
- **Appraisal fee can be included in the loan**
- **Reduced loan origination fee of 1% of your loan amount**
- **Loan terms up to 30 years (or less if you desire)**
- **Possible closing cost assistance and other assistance for income-eligible borrowers**

This allows you to take advantage of this lower rate with no out of pocket costs. You could be enjoying your new, lower fixed –rate loan before the summer is over.

To take advantage of this offer, certain conditions apply:

- **You must apply for this refinance loan by July 12, 2013**
- **Loans are subject to an appraisal of your home**
- **You must be current on your NLS loan(s) payments**
- **No cash out is allowed - this loan is solely to refinance your existing NLS loan**
- **New co-borrowers cannot be added to the loan**

If you would like to apply immediately, contact one of our Loan Officers below to start your application for this lower-rate refinance loan.