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## Abstract

This paper explores an overlooked phenomenon in mortgage markets: repayment of underwater mortgages. Since repayment in this case requires the borrower to use out-of-pocket funds along with the proceeds from the house sale to settle the loan, it may appear unattractive and even irrational. But if the borrower's negative equity is less than the cost of default, which includes credit impairment and possible guilt, repayment of an underwater mortgage is a wealth-maximizing strategy. The paper shows that such repayment indeed occurs, and that it is affected by the same factors commonly used in previous studies of default: the magnitude of home equity and the borrower's credit score, which captures default cost. An increase in either variable raises the likelihood that the underwater loan is terminated by repayment rather than by default. In addition, the paper also generates an estimate of the magnitude of default cost, showing that it rises with borrower credit worthiness, a finding that is new to the literature.


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# 1. 1. Introduction

Suppose that a homeowner's mortgage is underwater, with the loan balance exceeding the house value. The homeowner has accepted a job in another city and therefore wants to terminate the mortgage. Termination could be achieved by defaulting or by selling the house and repaying the mortgage.[1] Along with transferring the sale proceeds to the lender, repayment in this situation would require an additional out-of-pocket payment to the lender equal to the homeowner's negative equity. Whether repayment is preferable to default depends on the magnitude of negative equity (and thus the size of the required out-of-pocket payment) along with the magnitude of "default costs," which capture the various penalties associated with default.[2] While repayment of an underwater mortgage may be an unfamiliar notion, intuition suggests that paying off, say, $15,000 of negative equity could make sense for many borrowers. Doing so, for example, would allow our homeowner to secure immediate mortgage financing in his destination city, rather than enduring the mortgage blacklisting that would result from default (one of its various costs). The homeowner might be reluctant, however, to pay off $75,000 of negative equity.

The first contribution of this paper is to show that repayment of underwater mortgages *actually occurs.* In mortgage data sets commonly used in the literature, it is not possible to distinguish between loans that terminate through refinancing and those that are repaid. However, our unique data enables us to draw this distinction, thereby facilitating the identification of underwater mortgage repayment. The second contribution is to explore the determinants of underwater repayment. While home equity and default costs are recognized as determinants of default in the existing mortgage literature, we explore their role in the repayment of underwater mortgages. Both contributions are new to the literature. To achieve these goals, we restrict our analysis to mortgages that have been terminated, either by default, repayment, or refinancing.[3] The literature on mortgage default, by contrast, uses data without this restriction, including mortgages with ongoing payments (current mortgages). In addition, we focus on termination that involves vacating the house, as happens with our homeowner, thus narrowing the sample to terminations that occur either by

[1] Unless otherwise specified, the term "default" will be used throughout the paper to refer to a delinquency that ultimately leads to foreclosure. Consequently, "default" and "foreclosure" will be used interchangeably.

[2] Section 2 discusses various financial and nonfinancial costs associated with default.

[3] Because refinancing also involves the repayment of the existing mortgage, our use of "repayment" should be understood as the act of paying off the mortgage by selling the property.

default or repayment, omitting loans that are refinanced.[4] Our empirical results thus show the factors that favor repayment over default for the set of borrowers who vacate the house upon termination of the loan.

Following the literature, default costs are partly captured by the borrower's credit score, reflecting the belief that people with good credit have more to lose from default than those whose credit is bad. This assumption is consistent with the work of Brevoort and Cooper (2013), who track credit scores in the years after default. They find that borrowers with higher scores before the event have larger score declines, often ending up in the subprime category regardless of their pre-default status. Furthermore, recovery to initial status on average takes several years longer for those who initially had high scores.

Consistent with the evidence that default is more costly for borrowers with good credit, our results show that a higher credit score makes a borrower more likely to repay an underwater loan.[5] By contrast, default is more likely the smaller (the more negative) is the level of equity. These results thus show that the choice between repayment and default for borrowers with negative equity who are vacating their house responds to these focal variables in the same manner as the default decisions analyzed in the past literature. While this conclusion is perhaps natural, it provides a new insight into the behavior of mortgage borrowers. As discussed further below, our regressions also include a host of other variables that may affect borrower decisions.

Beyond these results on the determinants of repayment for underwater mortgages, a third important contribution of the paper is the use of our simple theoretical framework, along with data on negative equity and house values for mortgage repayers to estimate their default costs. We show that default cost is substantially larger for borrowers in the top credit-score quintile than for borrowers in the lowest quintile, a finding that validates our underlying assumption. This conclusion is entirely new to the literature, and it constitutes a major contribution of the paper.

The literature on mortgage default, which is now vast, is well synthesized and surveyed by Foote et al. (2008) and Foote and Willen (2018). Within this literature, papers that focus on the role of default costs are particularly relevant to our work. Early contributions in this area include Kau et al. (1993, 1994), Riddiough and Thompson (1993), Quigley and Van Order (1995), and more recent work by Bajari et al. (2008) and

[4] A subtlety associated with this sample structure is discussed in the next section.

[5] The credit score in our data is measured at the time of loan origination, not at termination. In the robustness section below, we discuss why this approach is unlikely to be problematic.

Elul et al. (2010), Kau et al. (2011) and Gyourko and Tracy (2014) includes borrower credit scores, as we do, in its default regressions. From a different perspective, Brueckner et al. (2012) show that, by reducing default concerns, strong state-level house-price appreciation allows more borrowers with poor credit scores (and thus low default costs) to secure mortgages in the state.[6]

Much of the advancement in the recent literature lies in clarifying the role of "trigger events" such as job loss, which affect the affordability of mortgage payments, in generating defaults. The traditional approach, which we follow, is to include the unemployment rate as a regression covariate (at the state level), expecting a positive default effect (see for example, Bajari et al. (2008), Goodman et al. (2010), Elul et al. (2010), Gyourko and Tracy (2014)). Using newer approaches, Bhutta et al. (2017) estimate default models with and without negative-equity covariates, viewing the gap in predictions as due to trigger events. Gerardi et al. (2018) use data that allow measurement of financial stress at the individual borrower level, thereby precisely capturing trigger events. Ganong and Noel (2023), who also have access to individual income (bank account) data, use defaults by above-water (positive-equity) borrowers in response to income losses to gauge the contribution of trigger events to default by underwater borrowers, finding it to be large relative to the effect of negative equity. Similarly, using survey data matched to mortgage data, Low (2023) shows that nearly all mortgage defaults involve a liquidity shock (e.g., job loss, divorce, health shocks), and that above-water defaults induced by trigger events are not uncommon. In a related contribution, Low (2022) presents a theoretical model with liquidity shocks and psychic moving costs to explain above-water defaults. Ganong and Noel (2023), Low (2022), and Low's (2023) investigations of positive-equity defaults are new to the literature, and the existence of such defaults by itself reveals the power of trigger events, showing that negative equity is not a default prerequisite, and a negative trigger is often sufficient. By contrast, our motivating example for negative equity repayment can be thought of as a *positive trigger*. The new job in a new city is worth paying off the additional debt.

As explained in more detail in Section 3, our study sample comes from ABSNet,[7] a data provider

[6]Brueckner (2000) investigates distortions to the mortgage market when default costs are private information, unobservable to lenders.

[7]The ABSNet data were compiled by Lewtan Technologies, which sourced the data from trustees and servicers. The company was acquired by Moody's Analytics in 2014. ABSNet data has been used to study mortgage fraud (Griffin and Maturana (2016) and Kruger and Maturana (2021)), the importance of mortgage originators having skin in the game (Demiroglu and James (2012)), mortgage servicer incentives (Diop and Zheng (2022)), the impact of state foreclosure laws on mortgage default (Demiroglu et al. (2014)), mortgage modifications (Agarwal et al. (2017), Maturana (2017), and Korgaonkar (2021)), and the role of subprime

that covers non-agency mortgages, capturing around 90% of the non-agency market during our sample period.[8] ABSNet records whether a loan terminates through foreclosure, but it does not distinguish between terminations that result from refinancing versus loans that are repaid when the owner vacates (sells) the property. To facilitate this distinction, we merge the mortgage data with deeds data from Realtytrac to track ownership changes. For non-foreclosures, a mortgage termination that occurs with an ownership change indicates a property sale (repayment). After various exclusions, our final sample includes around 340,000 (560,000) loans that had negative (positive) equity at termination and were originated in the 2001-2007 period but terminated after 2007 but before 2016 (as noted, termination is either by repayment or default). Our study thus spans the mortgage-termination period from the beginning of the great financial crisis in 2007, which led to the world's second-worst economic recession, through the subsequent economic and housing market recovery. This is an ideal period in which to explore our research question for two reasons. First, as home prices cratered after the 2001-07 housing market boom, many borrowers with mortgages originated during that period found themselves owing far more than their houses were worth. In addition, as the economic crisis deepened, many underwater borrowers also experienced unemployment. With this "double-trigger" event (negative equity along with unemployment) the conditions were ripe for widespread mortgage defaults. As in Ganong and Noel (2023) and Low (2023), our sample also includes defaults by above-water borrowers, and we compare regressions results for the above-water subsample to those for underwater loans.

Our results show that the positive effects of the focal variables (equity and the credit score) on repayment are larger for above-water borrowers, indicating that defaults are more easily deterred by favorable values for these variables when equity is positive. This conclusion makes sense because a major force pushing the borrower toward default (negative equity) is absent in the above-water case. For both the negative- and positive-equity subsamples, we also extend our basic results through regressions that contain interactions between equity and credit score. Although most of our analysis excludes terminations through refinancing, we also examine the effect of this exclusion by creating a new dependent variable indicating whether a loan

borrowers in driving the housing boom (Conklin et al. (2022)).

[8]Non-agency mortgages are conventional mortgages not purchasable by the government-sponsored enterprises (GSEs): the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac). They include loans to low-credit borrowers (subprime mortgages), loans exceeding the GSE lending limits (jumbo mortgages), and loans with deficient income/asset documentation (Alt-A mortgages).

was prepaid *or* refinanced.

Our motivating example focused on the choice between repayment and default for a negative-equity borrower who needs to terminate a mortgage to accept a job offer in another city. While our borrower is thus a mobile individual with good job opportunities, such unobservable borrower characteristics in reality are likely to differ between repayers and defaulters. Defaulters may have poorer labor market opportunities and may be defaulting precisely because of a trigger event such as a job loss, which has occurred on top of an underwater mortgage. Repayers need not be as mobile as in our example (they may have simply bought another house in the same city), but a negative trigger event presumably plays no role in their mortgage termination.

With unobservables likely to differ in these ways across defaulters and repayers, omitted variable bias becomes a possible threat. The absence in our data of any borrower characteristics aside from the credit score limits our ability to address this threat, but the inclusion of the state unemployment rate and median income is a rough attempt to control for trigger events, as in a number of previous papers. The upshot is that our motivating example depicts a much cleaner statistical context than we actually confront, requiring some caution in interpreting our results.

The plan of the paper is as follows. Section 2 presents a simple model of default in the presence of default costs. Section 3 discusses the data. Section 4 presents the regression results, and Section 5 offers conclusions.

## 2. An elementary mortgage-termination model with default costs

This section presents a simple model that frames our empirical question: if a mortgage is to be terminated, either by repayment or default, which is the best choice for the borrower? It is important to first recognize that, since the analysis conditions on termination of the mortgage, the default option (which involves future opportunities) plays no role. However, the cost of default is crucial. As noted above, one element of default cost is mortgage blacklisting, which prevents the borrower from securing a new mortgage for a number of years following a default. Additional costs come from a reduction in the borrower's credit rating, which may raise the interest rate charged on other borrowing (such as car loans) while making it harder to acquire new credit cards. Guilt from abrogating a financial contract may also be an element of default cost, as seen in Guiso et al. (2013). While moving costs are a component of default cost when the choice is between default (which requires relocation) and mortgage continuation (which does not), moving costs play no role in the choice between repayment and default conditional on termination, since both options require relocation.

Consider our homeowner from the introduction, who is moving to a different city and thus needs to terminate his mortgage. Suppose initially that default cost is absent, and let $P$ denote the value of the house and $M$ the mortgage balance. Then, default on the mortgage is preferable to repayment when

$$P \;<\; M, \tag{1}$$

with repayment preferred otherwise. Letting $E$ denote home equity, which is given by $E = P - M$, the rule in (1) becomes $E < 0$, so that default is preferred when equity is negative, with the mortgage underwater (a familiar rule). Ignoring other assets and debts, $E$ represents our borrower's net worth after selling the house and repaying the mortgage, which generates positive proceeds when $E > 0$ but requires an out-of-pocket payment when $E < 0$. By contrast, net worth after default equals zero since both assets and liabilities then disappear. Thus, when equity is negative, default is preferred since it leaves net worth at zero instead of at the negative value resulting from repayment.

Letting default cost be denoted $C$, net worth in the event of default becomes $-C$ rather than zero. Now default is preferred when

$$E \;<\; -C, \quad \text{or} \quad E \,+\, C \;<\; 0, \tag{2}$$

which requires that equity is negative enough to dominate the positive cost of default. The key implication of (2) is that a larger default cost makes (2) harder to satisfy, militating against default and in favor of repayment. With $C$ represented by the borrower's credit score in the regression, it follows that a larger credit score makes default less likely, and repayment more likely, when the mortgage is terminated. Larger (less-negative or more-positive) equity also makes (2) harder to satisfy, yielding the same conclusions.

This framework omits the transactions cost of selling the house as a cost of mortgage repayment. Letting this cost be denoted $T$, the change in net worth from repaying an underwater mortgage equals $E - T$, with both terms negative given $E < 0$. Default is then optimal when

$$E \,-\, T \,<\, -C. \tag{3}$$

We will use this equation in section 4.2 below to estimate a bound on default cost for repayers. In doing so, we view realtor commissions as the main component of transactions cost. These commissions usually amount to 6% of the house value, which suggests that this value can be used as a proxy for transactions cost. The default condition in (3) then implies that, holding equity and default cost constant, default is more likely when the house value is high, a result of higher transactions cost.

Inclusion of transactions cost is also crucial in gaining insight into positive-equity defaults, which we consider along with the most recent literature discussed above. In the model without $T$, such a choice cannot be optimal, because if equity is positive, then $E > -C$ holds and (2) cannot be satisfied, making repayment the preferred termination choice. But in the presence of transactions cost, if $E$ is positive but small, then $E - T$ can be negative in (3), and if sufficiently negative, it can be less than $-C$. In this situation, default is the preferred termination choice even though $E > 0$. When defaulting, the borrower avoids the transaction cost of selling the house, although default cost must be borne. Thus, if $E,\ T,\ C$ are properly aligned, the default choice can be preferred for an above-water mortgage. Ganong and Noel (2023) and Low (2022, 2023) also acknowledge this argument as an explanation for positive-equity defaults, although Low (2022) adds further elements.

To translate this simple framework into a regression context, let default cost be given by $C = X\beta + \epsilon$. $X$ is a row vector of observable borrower characteristics that may affect default cost (including the credit score and income, proxied by the state median value), $\beta$ is a coefficient vector, and $\epsilon$ is an error term representing unobserved borrower characteristics. Appending a coefficient to equity $E$ and suppressing $T$, default (repayment) is then preferable when

$$\alpha E \,+\, X\beta \,+\, \epsilon \,<\, (>)\, 0. \tag{4}$$

Repayment, which is our empirical focus, thus occurs when

$$\epsilon > -(\alpha E + X\beta). \tag{5}$$

The probability of the event in (5) equals $1 - F[-(\alpha E + X\beta)]$, where $F$ is the cumulative distribution function of $\epsilon$. This relationship can be used as the basis for a probit regression or a linear probability model, with a repayment dummy as the dependent variable (we use the latter).

Although trigger events are not part of the simple model sketched above, our empirical framework attempts to capture these events in a rough fashion by including the state unemployment rate and median income as covariates, as in much of past literature. The linear probability models we estimate also include a host of additional loan characteristics as controls, as described below.

## 3. Data

### 3.1. Study Sample

The mortgage data used in this study are from ABSNet, a non-agency mortgage data provider. Our initial sample includes all ABSNet loans that were outstanding at the end of 2007 with their final status recorded in the ABSNet loan history data file at the end of March 2016, the last reporting month available.[9] In addition to the loan origination data, we also collected from ABSNet the loans' balance and status at termination. ABSNet tracks loans from origination to termination, reporting whether a loan was voluntarily repaid by the borrower or foreclosed.

However, ABSNet misses a crucial piece of information about repaid loans that is required for this study. It does not specify whether the repayment of a loan was due to the sale or the refinancing of the property. ABSNet notes if a loan is a refinancing or purchase loan at origination but does not report the source of repayment when the loan is terminated. In the context of this study, it is important that we accurately identify the source of repayment at termination and how that choice may vary depending on the borrower's

[9]This righthand truncation of our observation should not be a problem because the housing market has fully recovered by March 2016.

equity position. To document how the loans were repaid, we merge ABSNet to RealtyTrac.[10] RealtyTrac uniquely identifies the property subject to a lien and provides information on the lien, including the type of lien, the loan amount if applicable, and its purpose (purchase or refinancing). By matching ABSNet to RealtyTrac, we are able to track the next lien on the property and the purpose of the loan associated with that lien, which was used to repay the first loan. Our final sample consists of ABSNet-RealtyTrac matched loans derived as explained below.

### 3.2. Data Description

We started with an initial sample of 5 million first-lien purchase and refinancing loans originated in the continental U.S. between 2001 and 2007. These are loans showing in the ABSNet December 2007 loan update file and the March 2016 ABSNet loan history file.[11] As discussed above, we matched these loans to the RealtyTrac lien data in order to identify the nature of the termination (repaid, refinanced, or foreclosed) by tracking the next lien on the property using the RealtyTrac unique property identifiers. We performed this match using property location (zip code), lien type, loan amount (in thousands), origination date, loan purpose (refinancing or purchase), and number of units. We kept unique matches where the lien registration date in RealtyTrac is within 60 days of the loan origination date in ABSNet. Our match rate was approximately 30%, which is similar to the success rate achieved by Diop et al. (2023) when matching RealtyTrac to McDash, a broader mortgage origination and servicing data set. Our matched ABSNet-RealtyTrac sample consists of 1.41 million loans. As of the end of March 2016, 304,385 (21.6%) of the loans were repaid following the sale of property, 438,760 (31.1%) were refinanced, 595,410 (42.2%) were foreclosed, 46,683 (3.3%) were liquidated via short sales, and only 26,599 (1.9%) were still active. Because this study primarily focuses on terminations where the property is vacated, we use the subsample of 899,795 loans that were terminated by either repayment following the sale of the property or foreclosure. Therefore, our final sample regroups loans that were determined following these three mutually exclusive events: i) a positive equity property sale, ii) a foreclosure, or iii) a negative-equity property sale where the seller pays the lender

[10] RealtyTrac is a real estate information company that compiles mortgage liens sourced from public records and property assessment data sourced from municipal real estate assessment offices.

[11] Our sample is restricted to loans with amounts between \$50,000 and \$5 million, appraised property value between \$50,000 and \$10 million, loan-to-value ratio between 25 and 125, and non-missing property zip code, borrower credit score, and loan balance at termination. The latter data requirement resulted in loans being dropped if no information was available within 6 months of the loan termination date.

for any shortfall between the mortgage balance and the sales proceeds. This third type of termination, which is largely ignored in the literature, is distinct from a short sale, where the lender absolves the borrower of the shortfall.[12]

As is apparent in our discussion above, a critical piece of information required for our analysis is the borrower's equity position, or his perception of it, when the loan was terminated, which for simplicity we take as the value of the property minus the outstanding loan balance at termination.[13] Because there is no independent valuation (appraisal) of the property at termination, we must derive our own value estimate or use an outside automated valuation model (AVM) estimate. We use the former approach to derive our main value estimate by marking to market the original appraised value reported in ABSNet using changes in the three-digit zip code house price index (HPI) from the Federal Housing Finance Agency (FHFA).[14,15] We measure equity as the difference between the mark-to-market value of the property and the loan balance at termination.[16] ABSNet also includes typical loan origination information (e.g., origination date, loan type, loan amount, loan-to-value (LTV) ratio, maturity date, interest rate, property type, occupancy type, and payment status at termination).

Table 1 presents the descriptive statistics for our final study sample, with Table 2 showing average variable values for the full sample as well as for the subsamples of positive- and negative-equity loans. Variable descriptions are in Table A.1. Approximately 34% of the loans were repaid via property sale, while 66% were terminated in foreclosure. The average equity of borrowers in the full sample, defined in this paper as the ratio of equity (updated property value minus loan balance at termination) to the updated property value, is 5%. In the sample, 38% of loans experience negative equity based on our measure. As expected, borrowers' propensity to repay loans varies significantly with equity. As seen in the first two rows of Table 2 and again in Table 3, 6% of terminated negative-equity loans were repaid, with the rest being foreclosures. While repayment of underwater loans is therefore not very common, the volume of such loans

[12]We also include refinanced loans in the additional analysis presented in the robustness section but refrain from including these loans in our main analysis because refinancing is only viable for borrowers with positive equity.

[13]Normally, the relevant information we need is the borrower's estimate of the value of the property. However, this is not observable.

[14]For properties with missing three-digit zip code house price indexes, we use the state's house price index. These cases represent less than 1% of our sample.

[15]We also develop alternative estimates of property values to test the robustness of our results.

[16]As an alternative to the mark-to-market valuation estimate, we will present results in the appendix based on AVM estimates of the value of the property at termination.

is nevertheless appreciable, justifying our focus on this phenomenon. As in Ganong and Noel (2023) and Low (2023), we also observe a relatively high rate of positive-equity (above-water) foreclosures in Table 3. Only a bare majority of our positive-equity loans (51%) were repaid, a surprisingly low share. The high frequency of positive-equity foreclosure may suggest that other trigger events, such as unemployment, were significant drivers of foreclosure during the sample period. Alternatively, these positive-equity foreclosures could be the result of high transaction costs (T) or low default costs (C), as seen in our model.

Returning to Table 1, the summary statistics show that our sample is overwhelmingly made up of single-family, owner-occupied properties: 96% single-family and roughly 85% owner-occupied. The average borrower has a credit score of 680 at origination, which reflects that our sample consists not only of subprime mortgages, but also Alt-A and jumbo loans, which typically were associated with higher credit scores than subprime loans. The median credit score is 682, suggesting no significant skewness in our data. Table 2 shows no discernible differences in property type, occupancy, and credit scores at origination between positive- and negative-equity loans. As was typical during that period, the majority (68%) of our sample consists of adjustable rate mortgages (ARMs). Interestingly, ARM loans are over-represented in the negative-equity loans (82% vs. 60% in the positive-equity group). This pattern could be due to borrowers taking advantage of lower interest rates on ARMs to secure larger loans. Table 2 also shows higher concentrations of interest-only and negative amortization loans among underwater mortgages: 38% vs. 28% and 19% vs. 6%, respectively. This pattern is not surprising because these loans amortize more slowly and are therefore more likely to end in negative-equity territory than loans without these features. In line with the above observations, the average original loan amount is smaller for positive-equity loans ($308,000 vs. $325,000). As expected, borrowers who found themselves in negative-equity territory started with significantly higher leverage both in terms of LTV (82% vs. 78%) and combined LTV (87% vs. 83%), which accounts for other reported loans. Loans originated to refinance existing debt are notably over-represented in underwater mortgages (47% vs. 26%). This pattern may be due to multiple refinancings by borrowers to extract equity as house prices kept soaring during the mortgage credit boom. In summary, independent from the impact of changes in housing market conditions, loans that ended with negative equity started with a significantly higher balance, amortized more slowly, and most likely were refinancing loans.

# 4. Results

## 4.1. Main Results

As explained in the introduction, our main focus is on the effect of the credit score and equity on the type of termination (repayment or foreclosure). Equity is measured as the ratio of updated property value (HPI-adjusted appraised value) minus loan balance at termination to the updated property value at termination, a negative value for underwater loans. As a precursor to the regression results, Table 4 shows repayment vs. foreclosure statistics by quintiles of credit score (Panel A) and quintiles of equity (Panel B). The lower part of Panel A, which pertains to negative equity loans, shows that the split between repayment and foreclosure shifts monotonically in favor of repayment moving up through the credit-score quintiles. In the lowest credit-score quintile, only 1.6% of loans are repaid, while in the highest quintile, 23.7% of loans are repaid. Note that negative equity is fairly constant across credit-score quintiles, ranging between −25.5% and −29.3% of the estimated property value. This pattern suggests that, holding negative equity constant, borrowers' propensity to repay negative-equity loans likely increases with credit score. This pattern is the main prediction of the paper that we seek to formally prove.

The upper part of panel A pertains to positive-equity loans. It shows that, as in the case of underwater loans, the share of loans repaid rises with the credit-score quintile. In each quintile, this share is higher than the corresponding share for underwater loans, rising from a low of 19.8% in the lowest quintile to 86.8% in the highest quintile. Positive equity also rises across the credit-score quintiles, from a low of 20.8% of value in the lowest quintile to 32.6% in the highest quintile, indicating that the substantial amount of money that is being left on the table by above-water defaulters. Of course, disentangling the separate credit score and equity effects requires the regression analysis that is reported below.

Panel B shows statistics by equity quintile, with the lower part again pertaining to negative-equity loans. As mean (negative) equity rises across quintiles, moving from −66.1% of value in the lowest quintile to −3.6% in the highest quintile, the share of loans repaid rises as well, from 1.6% to 12.7%. The same pattern is seen for positive-equity loans in the upper part of Panel B. As mean equity in the quintiles rises from 7.2% to 64.7%, the share of these loans repaid rises from 25.1% to 86.9%. Again, the repayment percentages of positive-equity loans are larger in each case than for negative-equity loans. As noted, the importance of trigger events in mortgage default and ultimately foreclosure shows in the significant share of loans with large positive equity ending in foreclosure. A staggering 40% of terminated loans with an average equity of 29% equity (third equity quintile of Panel B) ended in foreclosure.

Table 5, which reports the basic regression results, confirms the patterns seen in Table 4. The regressions are linear probability models with the dependent variable equal to 1 for loans that are repaid and 0 for foreclosures. Results for positive-equity loans are shown in the first column, while the second column shows results for negative-equity loans. The third column shows results for the full sample, allowing the key coefficients to differ by subsample. All the regressions have fixed effects for origination and termination years and zip code, and coefficient standard errors are clustered by zip code. Full regression results, including coefficients on the additional control variables not shown in Table 5, are reported in Table A.2 of the appendix.

As was seen in Table 4, a higher credit score makes repayment more likely for both positive- and negative-equity loans, as reflected in the significantly positive credit-score coefficients in the first two columns of Table 4. In addition, the positive coefficients on the equity measure show that higher equity makes repayment more likely for both positive- and negative-equity loans, as was seen in Table 4. However, Table 5 shows an additional pattern that the statistics in Table 4 could not reveal. In particular, both the credit-score and equity effects are *larger for positive-equity than for negative-equity loans.* Therefore better credit and higher equity appear to be more effective at inducing repayment (and thus preventing foreclosure) when a loan is above water than when it is underwater, a natural outcome given that a key force pushing the borrower toward default (negative equity) is then absent. These conclusions, however, are based only on a comparison of coefficients from different regressions, and to carry out a proper statistical test, we use the full-sample regression in the third column of Table 5. In this regression, the credit-score and equity effects are allowed to differ by interacting a negative-equity dummy with each of these variables.

The un-interacted credit score and equity coefficients are positive, indicating positive effects for above-water loans (for which the dummy is zero). Moreover, for each of these variables, the interaction coefficient is significantly negative, indicating that the credit-score and equity effects are smaller for negative-equity loans than for positive-equity loans. This pattern confirms more rigorously the conclusions drawn from the separate regressions in the first two columns of the table. Intuitively, since we would expect the impetus for repayment to be stronger for above-water loans than for underwater loans, we would also expect the forces that tip the borrower's decision toward repayment (a higher credit-score and equity level) to have a greater impact for such loans.

An additional variable identified by the theory of section 2 is house value, measured at mortgage termination. The prediction is that a high value, by raising transactions cost, makes repayment of a loan less likely. This prediction is upheld by the negative property-value coefficients in Table 5. While this result is welcome, the coefficient's sign is actually sensitive to the composition of the set of control variables, in contrast to the stability of the coefficients of equity and credit score. The negative property-value effect should thus be viewed with some caution.

Many of the control variables in Table 5's regressions also have effects on repayment. The variables designed to capture trigger events, the state-level unemployment rate and median income, perform mostly as expected, with the unemployment coefficient significantly negative in the positive-equity and full-sample regressions. But the coefficient is significant with the wrong sign (positive) in the negative-equity regression. The median-income coefficient is significant with the expected positive sign in the positive- and negative-equity regressions but is insignificant in the full-sample regression. These results suggest that our state-level variables are not doing a very good job of capturing trigger events. But it is not clear that use of better variables (were they available) would change our main qualitative findings on the effects of the credit score and equity.

Among the other controls, the results also show that large loans are more likely to be repaid, and that repayment of refinancing loans is less likely, results that hold in all three regressions. In addition, ARM loans and loans with a high initial interest rate are uniformly less likely to repay. The ARM effect possibly captures the default-inducing trigger event of an ARM interest-rate reset, an event that may be more punishing the higher is the initial interest rate. Single-family loans are more likely to repay, and a higher mortgage rate at termination also makes repayment more likely. This latter effect seems counterintuitive given that consumers are less likely to seek a mortgage on a new house, which requires repayment of their existing mortgage, when interest rates are high. The effects of the remaining controls are inconsistent across the three regressions in Table 5. The regressions contain a number of additional control variables whose coefficients are not reported, and the full set of results is shown in Table A.2 in the appendix.

Tables 6 and 7 present the kinds of comparisons seen in Table 4 in a regression setting. Table 6 allows the effect of equity on repayment to depend on the credit-score quintile, while Table 7 allows the effect of the credit score to depend on the equity quintile. In Table 6, the first and third columns, which lack interaction terms, show positive equity effects on repayment along with dummy-variable coefficients for credit-score quintiles. As can be seen, these dummy coefficients rise monotonically across the credit-score quintiles, recapitulating the positive effect from the continuous credit-score variable in Table 5. Note that the equity coefficient and most of the quintile dummy coefficients are larger in the positive-equity regression than in the negative-equity regression, again recapitulating Table 5.

Turning to the second and fourth columns on Table 6, which contain the interaction variables, we can see that, because the interaction coefficients for positive-equity loans in the second column are positive for quintiles 2, 3, and 4, the equity effect on repayment is larger in credit-score quintiles 2, 3, and 4 than in quintile 1, where the effect is given by the positive uninteracted equity coefficient. The negative coefficient of the quintile 5 coefficient shows that the equity effect is smaller in that quintile than in quintile 1. Therefore, for positive-equity loans, the equity effect has a hump-shaped pattern across credit-score quintiles, a pattern that is perhaps unexpected.

For negative-equity loans, the interaction coefficients in the fourth column are all positive, and they rise in magnitude across the credit-score quintiles. Therefore, for underwater loans, the equity effect on repayment becomes larger moving up through the credit-score quintiles. An increase in equity thus raises the likelihood of repayment most for a high-credit-score borrower, an outcome that seems intuitive.

Turning to Table 7, the first and third columns, which again lack interaction terms, show a positive credit-score effect on repayment along with dummy-variable coefficients for equity quintiles. In both columns, these dummy coefficients rise monotonically across the equity quintiles, recapitulating Table 5's positive effect from the continuous equity variable. Again, the credit-score coefficient and all of the quintile dummy coefficients are larger in the first than in the third column.

In column 2, the coefficients of the equity-quintile/credit-score interactions rise then fall across the quantiles, showing that, for above-water loans, the credit-score effect on repayment has a hump-shaped pattern across equity quintiles. In column 4, the interaction coefficients are monotonically increasing across the quintiles, so that the credit-score impact on repayment becomes larger moving up through the equity quintiles. Therefore, for underwater loans, an increase in the credit score raises the likelihood of repayment most when equity is in the highest quintile, again an intuitive result. These results obviously parallel those in Table 6.

### 4.2. Estimating Default Cost

We can ask whether our data combined with our theoretical framework allow us to gauge the magnitude of default costs, something that to our knowledge has not been done before in the literature. To start, since satisfaction of the previous default condition (3), $E - T < -C$, makes default optimal, satisfaction of $E - T > -C$ or

$$-E + T \; < \; C \tag{6}$$

makes repayment optimal. For an underwater mortgage, $-E > 0$ and $-E + T$ is the positive out-of-pocket amount the borrower needs to provide in order to pay off the mortgage. When this amount is less than default cost, repayment is optimal.

Viewed differently, when (6) holds as an equality, it indicates the *maximum value of negative equity (measured positively) for which repayment is optimal*. Letting $-\widehat{E}$ denote this maximum value, it satisfies $-\widehat{E} + T = C$. In view of this equality, $-\widehat{E}$ depends on $C$ and $T$, rising with default cost and falling with transactions cost. Our approach is to use this insight, along with data on how negative equity and transactions cost vary across credit-score quintiles, to back out the variation of default cost across these credit-score quintiles.

The calculations make use of the data in Table 8, which show mean and median values of negative equity and property value across the five credit-score quintiles. As can be seen, both negative equity (measured positively) and value rise across the quintiles. Writing the previous equation for each quintile $i$, $i = 1, \ldots, 5$, yields

$$-\widehat{E}_i \; + \; T_i \; = \; C_i, \quad i = 1, \ldots, 5, \tag{7}$$

where default cost depends on the quintile, presumably rising with $i$. Knowing the (mean) property value $P_i$ in quintile $i$, and recognizing that transactions cost from selling a house consists mainly of the 6% realtor commissions, (7) can be rewritten as

$$-\widehat{E}_i \;+\; 0.06P_i \;=\; C_i, \quad i = 1, \ldots, 5. \tag{8}$$

Viewing the mean negative equity in the quintile as an indicator of the maximum amount the quintile's repayers will tolerate, the RHS of (8) can be calculated, yielding an estimate of default cost for each quintile. Since both mean negative equity (measured positively) and mean value rise across quintiles in Table 8, the implied $C_i$ also rises with $i$, confirming our fundamental assumption regarding credit scores and default costs.[17] However, it is more useful to couch this conclusion in terms of interquartile differences. Using (8), the difference in default cost between the 5th and 1st credit-score quintiles is given by

$$C_5 \;-\; C_1 \;=\; -\widehat{E}_5 \;-\; (-\widehat{E}_1) \;+\; 0.06(P_5 - P_1) \;=\; 20{,}429. \tag{9}$$

Thus, default cost is more than $20,000 larger for a borrower in the highest credit-score quintile than for a borrower in the lowest quintile. This value seems plausible given the likely much greater cost of credit impairment and mortgage blacklisting for the most credit-worthy borrowers, as documented by Brevoort and Cooper (2013) .[18] Derivation of this number is an important contribution of the paper.[19]

## 4.3. Robustness Checks

Table 9 presents robustness checks for the basic specification in Table 5. To check the possible effect of measurement error in equity around the value of zero, the first robustness check drops observations where equity is between −5% and +5% of property value. The second check is to exclude loans in the repaid category that had been delinquent but were repaid at termination.[20] The third check is to add an observation-

[17]While Table 4 showed that negative equity is around -20% of value, the numbers in Table 8 are much smaller, and the reason is that they pertain only to repaid loans whereas Table 4 covers all negative-equity loans.

[18]Using median values, (9) yields a similar number: $20,563.

[19]Using a table like Table 8 for negative-equity defaulters (as opposed to repayers), an upper bound (as opposed to lower bound) on default cost can be computed for each credit-score quintile. Like the lower bounds, these upper bounds rise across the quintiles. But the upper bound is inappropriately *smaller* than the lower bound in several quintiles, This outcome suggests that a focus on the precise levels of the individual bounds may not very useful, with attention better focused on how the bounds vary across the quintiles, as is done above.

[20]Of the 19,472 negative equity repayers, only 1,103 were in delinquency prior to repayment. Delinquency would reduce credit scores and thus the incentive to repay an underwater mortgage. This information addresses a potential concern about our measurement of credit status. In particular, since the credit score in our data is captured at the time of loan origination, not at termination,

level income variable generated by using the debt-to-income ratio (DTI) for the loan at origination.

The main regularities seen in Table 5's coefficients were positive equity and credit-score effects on repayment. As can be seen from columns 1 and 5 of Table 9, these same regularities hold for the most important robustness check, the one addressing equity measurement error. The same conclusions hold for the other robustness checks, as can be seen in columns 2 and 6, in columns 3 and 7 (the first two modifications are imposed together), and columns 4 and 8 (where all three modfications are applied together), showing substantial robustness of the earlier results. Note the property-value coefficient also remains negative in the all the regressions of Table 9. Robustness checks for the interaction specifications in Tables 6 and 7 are shown in Tables A.3 and A.4 in the appendix. These tables again show strong robustness of interaction results.

Recalling that loans that were terminated by refinancing were dropped from the sample, an additional robustness check is to combine those observations with repaid loans in a new category denoted "Repaid or Refinanced," with foreclosed loans remaining the other category. This change overturns our clean focus on terminations that require the borrower to vacate the house, but it is worthwhile seeing how it affects the results.

Appendix Tables A.5, A.6 and A.7 replicate Tables 5, 6 and 7 under this modification. As can be seen, the main conclusions of the earlier tables remain: the effects of equity and credit score on loan termination by repayment or refinancing remain positive, and the effects of these variables are larger for positive-equity loans.

## 5. Conclusion

This paper has explored an overlooked phenomenon in mortgage markets: repayment of underwater mortgages. Since repayment in this case requires the borrower to use out-of-pocket funds along with the proceeds from the house sale to settle the loan, it may appear unattractive and even irrational. But if the borrower's negative equity is less than the cost of default, which includes credit impairment and possible guilt, repayment of an underwater mortgage is a wealth-maximizing strategy.

it could be a "stale" measure of a borrower's credit status (and default costs). But since underwater repayers are rarely late on their mortgages, it follows that their credit scores, and hence default costs, are still high at loan termination. Moreover, as seen below, cxcluding underwater repayers with mortgage delinquencies has no material impact on our regression results.

Our paper shows that repayment of underwater mortgages indeed occurs, and that it is affected by the same factors commonly used in previous studies of default: the magnitude of home equity and the borrower's credit score, which captures default cost. An increase in either variable raises the likelihood that the underwater loan is terminated by repayment rather than by default. Another contribution of the paper, which does not rely on regression analysis, is use of our theoretical model along with summary statistics by credit-score quintile to estimate how default cost varies across these quintiles. We show the this cost is much higher for the most credit-worthy borrowers than for those in the lowest quintile. To our knowledge, this is the first such default-cost estimate in the literature.

Following the recent literature, our data also include defaults on above-water mortgages, occurrence of which may prompt the same disbelief as repayment of underwater loans. Trigger events and avoidance of the transactions cost of selling a home may, however, make above-water default rational. But we show that the same factors that make underwater repayment more likely make above-water defaults less likely: greater equity or a better credit score. Moreover, we show that the effects of both these variables on the likelihood of repayment are stronger for above-water loans than for underwater loans. This conclusion is intuitive given the greater attractiveness of repayment when equity is positive.

# References

Agarwal, S., Amromin, G., Ben-David, I., Chomsisengphet, S., Piskorski, T., and Seru, A. (2017). Policy intervention in debt renegotiation: Evidence from the home affordable modification program. *Journal of Political Economy*, 125(3):654–712.

Bajari, P., Chu, C. S., and Park, M. (2008). An empirical model of subprime mortgage default from 2000 to 2007. Technical report, National Bureau of Economic Research.

Bhutta, N., Dokko, J., and Shan, H. (2017). Consumer ruthlessness and mortgage default during the 2007 to 2009 housing bust. *The Journal of Finance*, 72(6):2433–2466.

Brevoort, K. P. and Cooper, C. R. (2013). Foreclosure's wake: The credit experiences of individuals following foreclosure. *Real Estate Economics*, 41(4):747–792.

Brueckner, J. K. (2000). Mortgage default with asymmetric information. *The Journal of Real Estate Finance and Economics*, 20:251–274.

Brueckner, J. K., Calem, P. S., and Nakamura, L. I. (2012). Subprime mortgages and the housing bubble. *Journal of Urban Economics*, 71(2):230–243.

Conklin, J. N., Frame, W. S., Gerardi, K., and Liu, H. (2022). Villains or scapegoats? The role of subprime borrowers in driving the u.s. housing boom. *Journal of Financial Intermediation*, 51.

Demiroglu, C., Dudley, E., and James, C. M. (2014). State foreclosure laws and the incidence of mortgage default. *Journal of Law and Economics*, 57(1):225–280.

Demiroglu, C. and James, C. (2012). How important is having skin in the game? Originator-sponsor affiliation and losses on mortgage-backed securities. *The Review of Financial Studies*, 25(11):3217–3258.

Diop, M., Yavas, A., and Zhu, S. (2023). Appraisal inflation and private mortgage securitization. *Available at SSRN 3657595*.

Diop, M. and Zheng, C. (2022). Mortgage servicing fees and servicer incentives during loss mitigation. *Management Science*, 0(0).

Elul, R., Souleles, N. S., Chomsisengphet, S., Glennon, D., and Hunt, R. (2010). What "triggers" mortgage default? *American Economic Review*, 100(2):490–494.

Foote, C. L., Gerardi, K., and Willen, P. S. (2008). Negative equity and foreclosure: Theory and evidence. *Journal of Urban Economics*, 64(2):234–245.

Foote, C. L. and Willen, P. S. (2018). Mortgage-default research and the recent foreclosure crisis. *Annual Review of Financial Economics*, 10:59–100.

Ganong, P. and Noel, P. (2023). Why do borrowers default on mortgages? *The Quarterly Journal of Economics*, 138(2):1001–1065.

Gerardi, K., Herkenhoff, K. F., Ohanian, L. E., and Willen, P. S. (2018). Can't pay or won't pay? Unemployment, negative equity, and strategic default. *The Review of Financial Studies*, 31(3):1098–1131.

Goodman, L. S., Ashworth, R., Landy, B., and Yin, K. (2010). Negative equity trumps unemployment in predicting defaults. *The Journal of Fixed Income*, 19(4):67–72.

Griffin, J. M. and Maturana, G. (2016). Who facilitated misreporting in securitized loans? *The Review of Financial Studies*, 29(2):384–419.

Guiso, L., Sapienza, P., and Zingales, L. (2013). The determinants of attitudes toward strategic default on mortgages. *The Journal of Finance*, 68(4):1473–1515.

Gyourko, J. and Tracy, J. (2014). Reconciling theory and empirics on the role of unemployment in mortgage default. *Journal of Urban Economics*, 80:87–96.

Kau, J. B., Keenan, D. C., and Kim, T. (1993). Transaction costs, suboptimal termination and default probabilities. *Real Estate Economics*, 21(3):247–263.

Kau, J. B., Keenan, D. C., and Kim, T. (1994). Default probabilities for mortgages. *Journal of Urban Economics*, 35(3):278–296.

Kau, J. B., Keenan, D. C., Lyubimov, C., and Slawson, V. C. (2011). Subprime mortgage default. *Journal of Urban Economics*, 70(2):75–87.

Korgaonkar, S. (2021). The limited benefits of mortgage renegotiation during the great recession. *Available at SSRN 2924981*.

Kruger, S. and Maturana, G. (2021). Collateral misreporting in the residential mortgage-backed security market. *Management Science*, 67(5):2729–2750.

Low, D. (2022). An empirically-disciplined theory of mortgage default. *Consumer Financial Protection Bureau Office of Research Working Paper No. 2021-01*.

Low, D. (2023). What triggers mortgage default? New evidence from linked administrative and survey data. *Review of Economics and Statistics (Forthcoming)*.

Maturana, G. (2017). When are modifications of securitized loans beneficial to investors? *The Review of Financial Studies*, 30(11):3824–3857.

Quigley, J. M. and Van Order, R. (1995). Explicit tests of contingent claims models of mortgage default. *The Journal of Real Estate Finance and Economics*, 11:99–117.

Riddiough, T. J. and Thompson, H. E. (1993). Commercial mortgage pricing with unobservable borrower default costs. *Real Estate Economics*, 21(3):265–291.

# Tables

Table 1. Descriptive Statistics of the Full Sample

| *Variable* | *N. Obs.* | *Mean* | *Std. Dev.* | *Min* | *Max* |
|---|---|---|---|---|---|
| Repaid | 899,795 | 0.338 | | 0 | 1 |
| Foreclosed | 899,795 | 0.662 | | 0 | 1 |
| Credit Score (00s) | 899,795 | 6.80 | 0.70 | 3.00 | 8.49 |
| Negative Equity | 899,795 | 0.380 | | 0 | 1 |
| Equity | 899,795 | 0.050 | 0.330 | -6.249 | 1 |
| LTV | 899,795 | 80 | 10 | 25 | 125 |
| Property Value (log) | 899,795 | 12.473 | 0.738 | 10.195 | 16.294 |
| Loan Amount (log) | 899,795 | 12.411 | 0.705 | 10.820 | 15.425 |
| Refinancing Loan | 899,795 | 0.338 | | 0 | 1 |
| Non-Owner Occupancy | 899,795 | 0.148 | | 0 | 1 |
| Occupancy Unknown | 899,795 | 0.007 | | 0 | 1 |
| Interest Rate | 899,783 | 6.692 | 2.046 | 1.000 | 11.800 |
| Loan Term (log) | 883,639 | 5.906 | 0.123 | 4.094 | 6.400 |
| DTI | 899,795 | 0.012 | 0.069 | 0.000 | 0.500 |
| DTI Missing | 899,795 | 0.763 | | 0 | 1 |
| PMI | 899,795 | 0.099 | | 0 | 1 |
| PMI Missing | 899,795 | 0.284 | | 0 | 1 |
| Neg. Amortization | 899,795 | 0.104 | | 0 | 1 |
| ARM | 899,795 | 0.682 | | 0 | 1 |
| Balloon | 899,795 | 0.083 | | 0 | 1 |
| Interest Only | 899,795 | 0.318 | | 0 | 1 |
| Interest Only Missing | 899,795 | 0.017 | | 0 | 1 |
| Single Family | 899,795 | 0.963 | | 0 | 1 |
| Inflation | 899,795 | 222.061 | 8.449 | 207.667 | 238.034 |
| Mortgage Rates | 899,795 | 4.786 | 0.844 | 3.345 | 6.572 |
| Unemployment Rate | 899,795 | 8.460 | 2.344 | 2.600 | 13.700 |
| HPI End | 899,795 | 199.509 | 47.260 | 98.400 | 636.220 |
| HPI Origination | 899,795 | 240.689 | 62.267 | 108.450 | 642.300 |
| HPI Volatility (Std. Dev.) | 899,795 | 25.975 | 17.503 | 0.784 | 87.928 |
| Second Mortgage | 899,795 | 0.067 | | 0 | 1 |
| Median Income (000s) | 899,795 | 80.807 | 29.448 | 2.499 | 250.001 |

Note: The variable descriptions are in Table A.1 of the appendix.

Table 2. Mean Variable Values for the Full Sample and Negative- and Positive-Equity Loans

| *Variable* | *Full Sample* | | *Negative Equity* | | *Positive Equity* | |
|---|---|---|---|---|---|---|
| | *N. Obs.* | *Mean* | *N. Obs.* | *Mean* | *N. Obs.* | *Mean* |
| Repaid | 899,795 | 0.338 | 341,875 | 0.057 | 557,920 | 0.511 |
| Foreclosed | 899,795 | 0.662 | 341,875 | 0.943 | 557,920 | 0.489 |
| Credit Score (00s) | 899,795 | 6.80 | 341,875 | 6.67 | 557,920 | 6.87 |
| Negative Equity | 899,795 | 0.380 | | | | |
| Equity | 899,795 | 0.050 | 341,875 | -0.284 | 557,920 | 0.254 |
| LTV | 899,795 | 80 | 341,875 | 82 | 557,920 | 78 |
| Property Value (log) | 899,795 | 12.473 | 341,875 | 12.299 | 557,920 | 12.580 |
| Loan Amount (log) | 899,795 | 12.411 | 341,875 | 12.529 | 557,920 | 12.339 |
| Refinancing Loan | 899,795 | 0.338 | 341,875 | 0.469 | 557,920 | 0.258 |
| Non-Owner Occupancy | 899,795 | 0.148 | 341,875 | 0.135 | 557,920 | 0.156 |
| Occupancy Unknown | 899,795 | 0.007 | 341,875 | 0.006 | 557,920 | 0.008 |
| Interest Rate | 899,783 | 6.692 | 341,869 | 6.693 | 557,914 | 6.691 |
| Loan Term (log) | 883,639 | 5.906 | 331,794 | 5.937 | 551,845 | 5.887 |
| DTI | 899,795 | 0.012 | 341,875 | 0.016 | 557,920 | 0.009 |
| DTI Missing | 899,795 | 0.763 | 341,875 | 0.740 | 557,920 | 0.776 |
| PMI | 899,795 | 0.099 | 341,875 | 0.064 | 557,920 | 0.121 |
| PMI Missing | 899,795 | 0.284 | 341,875 | 0.309 | 557,920 | 0.269 |
| Neg. Amortization | 899,795 | 0.104 | 341,875 | 0.187 | 557,920 | 0.054 |
| ARM | 899,795 | 0.682 | 341,875 | 0.823 | 557,920 | 0.596 |
| Balloon | 899,795 | 0.083 | 341,875 | 0.138 | 557,920 | 0.050 |
| Interest Only | 899,795 | 0.318 | 341,875 | 0.377 | 557,920 | 0.282 |
| Interest Only Missing | 899,795 | 0.017 | 341,875 | 0.019 | 557,920 | 0.016 |
| Single Family | 899,795 | 0.963 | 341,875 | 0.967 | 557,920 | 0.960 |
| Inflation | 899,795 | 222.061 | 341,875 | 221.311 | 557,920 | 222.520 |
| Mortgage Rates | 899,795 | 4.786 | 341,875 | 4.732 | 557,920 | 4.819 |
| Unemployment Rate | 899,795 | 8.460 | 341,875 | 9.685 | 557,920 | 7.708 |
| HPI End | 899,795 | 199.509 | 341,875 | 182.404 | 557,920 | 209.990 |
| HPI Origination | 899,795 | 240.689 | 341,875 | 280.536 | 557,920 | 216.272 |
| HPI Volatility (Std. Dev.) | 899,795 | 25.975 | 341,875 | 37.376 | 557,920 | 18.988 |
| Second Mortgage | 899,795 | 0.067 | 341,875 | 0.085 | 557,920 | 0.055 |
| Median Income (000s) | 899,795 | 80.807 | 341,875 | 72.590 | 557,920 | 85.841 |

Note: The variable descriptions are in Table A.1 of the appendix.

Table 3. Mortgage Loan Termination According to Equity Position

| | *Full Sample* | | *Positive Equity* | | *Negative Equity* | |
|---|---|---|---|---|---|---|
| | *N. Obs.* | *Percent* | *N. Obs.* | *Percent* | *N. Obs.* | *Percent* |
| Repaid | 304,385 | 33.83 | 284,913 | 51.07 | 19,472 | 5.70 |
| Foreclosed | 595,410 | 66.17 | 273,007 | 48.93 | 322,403 | 94.30 |
| *Total* | *899,795* | *100.00* | *557,920* | *100.00* | *341,875* | *100.00* |

Note: Our study sample includes loans showing in the ABSNet January 2008 loan update data set that were terminated by the end as reported in the ABSNet March 2016 loan history database, the end of the study period, matched to loans in the RealtyTrac Recorder database, which allows us to link loans to properties to identify if loans were repaid with the sale of the property or refinanced. "*Repaid*" designates loans repaid from the sale of the sale of the property, whereas "*Foreclosed*" identifies loans whose properties were foreclosed due to borrower delinquency. We separately report loan statuses for the full sample and by borrower equity position (*"Positive Equity"* or *"Negative Equity"*) based on the estimated property values at loan termination – the adjusted appraisal values of the properties using three-digit zip code house price indexes from the Federal Housing Finance Agency (FHFA).

Table 4. Loan Termination by Credit Score and Equity Quintiles

| ***Panel A: Credit Score Quintiles*** | *Quintile 1* | *Quintile 2* | *Quintile 3* | *Quintile 4* | *Quintile 5* |
|---|---|---|---|---|---|
| *Positive Equity:* | | | | | |
| *N. Loans* | *116,575* | *105,580* | *106,605* | *109,309* | *119,851* |
| *Average Equity* | *0.21* | *0.21* | *0.24* | *0.28* | *0.33* |
| Loan Status (%): | | | | | |
| Repaid | 19.82 | 31.43 | 48.04 | 67.09 | 86.85 |
| Foreclosed | 80.18 | 68.57 | 51.96 | 32.91 | 13.15 |
| *Negative Equity:* | | | | | |
| *N. Loans* | *81,310* | *95,230* | *81,129* | *54,961* | *29,245* |
| *Average Equity* | *-0.28* | *-0.29* | *-0.29* | *-0.28* | *-0.25* |
| Loan Status (%): | | | | | |
| Repaid | 1.61 | 2.45 | 4.64 | 9.31 | 23.74 |
| Foreclosed | 98.39 | 97.55 | 95.36 | 90.69 | 76.26 |

| ***Panel B: Equity Quintiles*** | *Quintile 1* | *Quintile 2* | *Quintile 3* | *Quintile 4* | *Quintile 5* |
|---|---|---|---|---|---|
| *Positive Equity:* | | | | | |
| *N. Loans* | *156,027* | *138,349* | *121,650* | *92,522* | *49,372* |
| *Average Equity* | *0.07* | *0.19* | *0.29* | *0.41* | *0.65* |
| Loan Status (%): | | | | | |
| Repaid | 25.09 | 44.53 | 59.83 | 73.99 | 86.91 |
| Foreclosed | 74.91 | 55.47 | 40.17 | 26.01 | 13.09 |
| *Negative Equity:* | | | | | |
| *N. Loans* | *71,434* | *70,122* | *68,886* | *67,049* | *64,384* |
| *Average Equity* | *-0.66* | *-0.36* | *-0.21* | *-0.12* | *-0.36* |
| Loan Status (%): | | | | | |
| Repaid | 1.64 | 2.64 | 4.50 | 7.73 | 12.68 |
| Foreclosed | 98.36 | 97.36 | 95.50 | 92.27 | 87.32 |

Note: This table reports the number of loans (*N. Loans*), average equity (*Average Equity*), and loan termination status (*Repaid* or *Foreclosed*) as a percentage of total loans by credit score quintiles in Panel A and equity quintiles in Panel B. The credit-score quintiles are based on credit scores at origination – credit score quintiles: FICO 300 - 623, 624 - 670, 671 - 711, 712 - 756, and 757 - 849 at origination. Panel B presents the same data by quintiles for positive- and negative-equity loans at termination. Our sample includes ABSNet-RealtyTrac matched loans as described in Table 3. *Average Equity* is the mean of borrower equity measured as the ratio of updated property value (HPI- adjusted appraised value) minus loan balance at termination to the updated property value at termination.

Table 5. Loan Repayment vs. Foreclosure as a Function of Equity and Credit Score

| *Sample:* | *Positive Equity* | *Negative Equity* | *Full Sample* |
|---|---|---|---|
| *Dependent Variable:* | *Repaid* | *Repaid* | *Repaid* |
| Credit Score | 0.1070*** | 0.0431*** | 0.1086*** |
| | (0.0011) | (0.0013) | (0.0010) |
| Negative Equity Dummy × Credit Score | | | -0.0162*** |
| | | | (0.0003) |
| Equity | 0.5938*** | 0.1738*** | 0.6681*** |
| | (0.0059) | (0.0108) | (0.0062) |
| Negative Equity Dummy × Equity | | | -0.6340*** |
| | | | (0.0079) |
| Property Value | -0.0629*** | -0.1513*** | -0.0903*** |
| | (0.0041) | (0.0135) | (0.0040) |
| Unemployment Rate | -0.0209*** | 0.0025* | -0.0117*** |
| | (0.0012) | (0.0011) | (0.0010) |
| Median Income | 0.0011*** | 0.0004* | 0.0001 |
| | (0.0002) | (0.0002) | (0.0001) |
| Loan Amount | 0.0870*** | 0.1953*** | 0.1265*** |
| | (0.0038) | (0.0137) | (0.0038) |
| Refinancing Loan | -0.4702*** | -0.0884*** | -0.2940*** |
| | (0.0027) | (0.0017) | (0.0030) |
| Non-Owner Occupancy | -0.0029 | 0.0131*** | -0.0035* |
| | (0.0018) | (0.0016) | (0.0015) |
| Interest Rate | -0.0326*** | -0.0055*** | -0.0202*** |
| | (0.0005) | (0.0002) | (0.0004) |
| Loan Term | 0.0611*** | -0.0460*** | 0.0427*** |
| | (0.0037) | (0.0046) | (0.0034) |
| DTI | -0.0371*** | -0.0086* | -0.0056 |
| | (0.0086) | (0.0037) | (0.0051) |
| ARM | -0.0884*** | -0.0404*** | -0.0774*** |
| | (0.0012) | (0.0015) | (0.0010) |
| Single Family | 0.0698*** | 0.0446*** | 0.0646*** |
| | (0.0035) | (0.0026) | (0.0026) |
| Inflation | -0.0049*** | 0.0007** | -0.0039*** |
| | (0.0003) | (0.0002) | (0.0002) |
| Mortgage Rates | 0.0187*** | 0.0107*** | 0.0135*** |
| | (0.0017) | (0.0013) | (0.0012) |
| Additional Control Variables | Y | Y | Y |
| Origination-Year FE | Y | Y | Y |
| Termination-Year FE | Y | Y | Y |
| Location (Zip Code) FE | Y | Y | Y |
| Clustered SE (Zip Code) | Y | Y | Y |
| Observations | 550,940 | 330,511 | 882,753 |
| Adjusted R-squared | 0.575 | 0.219 | 0.590 |

Note: This table reports linear probability model (LPM) estimation using OLS of the likelihood of loan termination (repayment vs. foreclosure). *Repaid* is a binary variable identifying whether a loan was paid off with the sale of the property or the foreclosure of the property. Columns (1), (2), and (3) report LPM likelihood of loan termination (repayment) for positive-equity loans, negative-equity loans, and the full sample, respectively. The additional variables included in these regressions are the same as in the appendix Table A.2. In parentheses are White-robust standards errors clustered at the zip code level. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

Table 6. Likelihood of Loan Repayment by Credit-Score Quintiles

| *Sample:* | *Positive Equity* | | *Negative Equity* | |
|---|---|---|---|---|
| *Dependent Variable:* | *Repaid* | *Repaid* | *Repaid* | *Repaid* |
| Credit-Score Quintile 2 | -0.0044** | -0.0609*** | -0.0109*** | -0.0078*** |
| | (0.0017) | (0.0027) | (0.0009) | (0.0014) |
| Credit-Score Quintile 3 | 0.0477*** | -0.0296*** | -0.0058*** | 0.0063*** |
| | (0.0020) | (0.0030) | (0.0010) | (0.0017) |
| Credit-Score Quintile 4 | 0.1266*** | 0.0761*** | 0.0209*** | 0.0565*** |
| | (0.0021) | (0.0034) | (0.0014) | (0.0025) |
| Credit-Score Quintile 5 | 0.2104*** | 0.2686*** | 0.1251*** | 0.2250*** |
| | (0.0023) | (0.0032) | (0.0033) | (0.0059) |
| Equity | 0.5777*** | 0.4801*** | 0.1871*** | 0.1225*** |
| | (0.0058) | (0.0085) | (0.0108) | (0.0120) |
| Credit-Score Quintile 2 × Equity | | 0.2763*** | | 0.0117*** |
| | | (0.0101) | | (0.0029) |
| Credit-Score Quintile 3 × Equity | | 0.3466*** | | 0.0410*** |
| | | (0.0101) | | (0.0037) |
| Credit-Score Quintile 4 × Equity | | 0.2264*** | | 0.1220*** |
| | | (0.0107) | | (0.0061) |
| Credit-Score Quintile 5 × Equity | | -0.1217*** | | 0.3729*** |
| | | (0.0097) | | (0.0168) |
| Property Value | -0.0772*** | -0.0816*** | -0.1908*** | -0.1851*** |
| | (0.0041) | (0.0040) | (0.0135) | (0.0155) |
| Control Variables | Y | Y | Y | Y |
| Origination-Year FE | Y | Y | Y | Y |
| Termination-Year FE | Y | Y | Y | Y |
| Location (Zip Code) FE | Y | Y | Y | Y |
| Clustered SE (Zip Code) | Y | Y | Y | Y |
| *Observations* | *550,940* | *550,940* | *330,511* | *330,511* |
| *Adjusted R-squared* | *0.580* | *0.584* | *0.234* | *0.244* |

Note: This table reports linear probability model (LPM) estimation of loan termination (repayment vs foreclosure) using OLS for positive- and negative-equity loans at termination with the inclusion of credit-score quintiles (defined in Table 4) interacted with equity. *Repaid* is a binary variable identifying whether a loan was paid off with the sale of the property or foreclosed. The control variables included in these regressions are the same as in the appendix Table A.2. In parentheses are White-robust standards errors clustered at the zip code level. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

Table 7. Likelihood of Loan Repayment by Equity Quintiles

| *Sample:* | *Positive Equity* | | *Negative Equity* | |
|---|---|---|---|---|
| *Dependent Variable:* | *Repaid* | *Repaid* | *Repaid* | *Repaid* |
| Equity Quintile 2 | 0.1084*** | -0.3166*** | 0.0216*** | -0.0505*** |
| | (0.0017) | (0.0139) | (0.0017) | (0.0103) |
| Equity Quintile 3 | 0.2008*** | -0.2592*** | 0.0393*** | -0.1553*** |
| | (0.0020) | (0.0158) | (0.0024) | (0.0129) |
| Equity Quintile 4 | 0.2782*** | -0.0696*** | 0.0688*** | -0.3853*** |
| | (0.0025) | (0.0183) | (0.0032) | (0.0158) |
| Equity Quintile 5 | 0.3362*** | 0.2840*** | 0.1134*** | -0.5789*** |
| | (0.0033) | (0.0222) | (0.0038) | (0.0184) |
| Credit Score | 0.1084*** | 0.0670*** | 0.0432*** | 0.0011 |
| | (0.0011) | (0.0019) | (0.0013) | (0.0012) |
| Equity Quintile 2 × Credit Score | | 0.0630*** | | 0.0109*** |
| | | (0.0021) | | (0.0016) |
| Equity Quintile 3 × Credit Score | | 0.0678*** | | 0.0295*** |
| | | (0.0024) | | (0.0020) |
| Equity Quintile 4 × Credit Score | | 0.0513*** | | 0.0683*** |
| | | (0.0027) | | (0.0025) |
| Equity Quintile 5 × Credit Score | | 0.0104** | | 0.1038*** |
| | | (0.0032) | | (0.0029) |
| Property Value | -0.0672*** | -0.0645*** | -0.1027*** | -0.0949*** |
| | (0.0040) | (0.0040) | (0.0075) | (0.0074) |
| Control Variables | Y | Y | Y | Y |
| Origination-Year FE | Y | Y | Y | Y |
| Termination-Year FE | Y | Y | Y | Y |
| Location (Zip Code) FE | Y | Y | Y | Y |
| Clustered SE (Zip Code) | Y | Y | Y | Y |
| *Observations* | *550,940* | *550,940* | *330,511* | *330,511* |
| *Adjusted R-squared* | *0.578* | *0.579* | *0.224* | *0.234* |

Note: his table reports linear probability model (LPM) estimation of loan termination (repayment vs foreclosure) using OLS for positive- and negative-equity loans at termination with the inclusion of equity quintiles interacted with credit score. *Repaid* is a binary variable identifying whether a loan was paid off with the sale of the property or foreclosed. We generate separate quintile groups for positive and negative equity loans at termination. The control variables included in these regressions are the same as in the appendix Table A.2. In parentheses are White-robust standards errors clustered at the zip code level. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

Table 8. Borrower Equity and Property Value at Loan Termination by Credit Score Quintiles for Repaid Negative-Equity Loans

| | *Quintile 1* | *Quintile 2* | *Quintile 3* | *Quintile 4* | *Quintile 5* |
|---|---|---|---|---|---|
| ***Equity* ($)** | | | | | |
| Mean | -2,414 | -3,831 | -5,096 | -5,525 | -5,753 |
| Median | -1,011 | -2,072 | -3,240 | -3,710 | -3,946 |
| ***Property Value* ($)** | | | | | |
| Mean | 192,866 | 279,393 | 372,714 | 430,857 | 477,691 |
| Median | 155,821 | 221,109 | 310,364 | 396,233 | 449,626 |

Note: This table reports average and median borrower equity position and property value in dollars at termination for repaid negative-equity loans by credit score quintiles. The credit-score quintiles are based on credit scores at origination – credit score quintiles: FICO 300 - 623, 624 - 670, 671 - 711, 712 - 756, and 757 - 849 at origination. Our sample includes ABSNet-RealtyTrac matched loans as described in Table 3. *Average Equity* is the mean of borrower equity measured as the ratio of updated property value (HPI-adjusted appraised value) minus loan balance at termination to the updated property value at termination.

Table 9. Robustness Checks: Equity Measurement Error, Default at Termination, and Income

| *Sample:* | *Positve Equity* | | | | *Negative Equity* | | | |
|---|---|---|---|---|---|---|---|---|
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* | *(8)* |
| *Dependent Variable:* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* |
| Credit Score | 0.1042*** | 0.1102*** | 0.1077*** | 0.1215*** | 0.0352*** | 0.0419*** | 0.0341*** | 0.0289*** |
| | (0.0011) | (0.0011) | (0.0011) | (0.0021) | (0.0012) | (0.0013) | (0.0012) | (0.0015) |
| Equity | 0.5448*** | 0.6035*** | 0.5562*** | 0.6671*** | 0.1452*** | 0.1686*** | 0.1399*** | 0.1519*** |
| | (0.0060) | (0.0060) | (0.0060) | (0.0108) | (0.0106) | (0.0106) | (0.0104) | (0.0116) |
| Property Value | -0.0504*** | -0.0657*** | -0.0533*** | -0.1302*** | -0.1291*** | -0.1513*** | -0.1275*** | -0.1520*** |
| | (0.0040) | (0.0042) | (0.0041) | (0.0088) | (0.0140) | (0.0133) | (0.0137) | (0.0162) |
| Unemployment Rate | -0.0215*** | -0.0218*** | -0.0225*** | -0.0346*** | 0.0009 | 0.0024* | 0.0010 | -0.0004 |
| | (0.0012) | (0.0012) | (0.0013) | (0.0024) | (0.0011) | (0.0011) | (0.0010) | (0.0015) |
| Median Income | 0.0011*** | 0.0011*** | 0.0011*** | 0.0020*** | 0.0004 | 0.0004 | 0.0003 | 0.0005 |
| | (0.0002) | (0.0002) | (0.0002) | (0.0003) | (0.0002) | (0.0002) | (0.0002) | (0.0003) |
| Loan Amount | 0.0709*** | 0.0893*** | 0.0733*** | 0.1397*** | 0.1689*** | 0.1933*** | 0.1655*** | 0.1873*** |
| | (0.0038) | (0.0039) | (0.0039) | (0.0086) | (0.0142) | (0.0135) | (0.0139) | (0.0163) |
| Refinancing Loan | -0.5032*** | -0.4561*** | -0.4887*** | -0.4448*** | -0.0724*** | -0.0839*** | -0.0689*** | -0.0528*** |
| | (0.0028) | (0.0027) | (0.0027) | (0.0034) | (0.0016) | (0.0017) | (0.0015) | (0.0019) |
| Interest Rate | -0.0346*** | -0.0319*** | -0.0339*** | -0.0258*** | -0.0046*** | -0.0052*** | -0.0043*** | -0.0013*** |
| | (0.0006) | (0.0005) | (0.0006) | (0.0011) | (0.0002) | (0.0002) | (0.0002) | (0.0003) |
| DTI | -0.0367*** | -0.0932*** | -0.0971*** | -0.1549*** | -0.0068 | -0.0127*** | -0.0096** | -0.0160 |
| | (0.0093) | (0.0088) | (0.0096) | (0.0442) | (0.0035) | (0.0035) | (0.0033) | (0.0192) |
| ARM | -0.0896*** | -0.0881*** | -0.0898*** | -0.1007*** | -0.0340*** | -0.0381*** | -0.0317*** | -0.0310*** |
| | (0.0012) | (0.0012) | (0.0013) | (0.0027) | (0.0015) | (0.0014) | (0.0014) | (0.0021) |
| Borrower Income | | | | 0.0000 | | | | -0.0000 |
| | | | | (0.0000) | | | | (0.0000) |
| Additional Control Variables | Y | Y | Y | Y | Y | Y | Y | Y |
| Fixed Effects | Y | Y | Y | Y | Y | Y | Y | Y |
| Equity Measurement Error | √ | | √ | √ | √ | | √ | √ |
| Default at Termination | | √ | √ | √ | | √ | √ | √ |
| Borrower Income | | | | √ | | | | √ |
| *Observations* | *500,489* | *533,833* | *483,977* | *113,750* | *286,205* | *329,408* | *285,496* | *87,072* |
| *Adjusted R-squared* | *0.577* | *0.575* | *0.577* | *0.547* | *0.187* | *0.213* | *0.181* | *0.216* |

Note: This table presents robustness checks of our linear probability model (LPM) estimation of loan termination (repayment vs. foreclosure) using OLS for positive- and negative-equity loans at termination using the model as columns (1) and (2) of Table 5. *Repaid* is a binary variable identifying whether a loan was paid off with the sale of the property or foreclosed. Columns (1) and (5) control for potential error in equity value calculation by excluding loans with equity falling between -5% and 5%, exclusive. Columns (2) and (6) removed loans repaid loans that were delinquent at termination. Columns (3) and (7) control for both equity measurement errors and loan delinquency at termination. In addition to controlling for equity measurement errors and delinquency, columns (4) and (8) include borrower income estimated from DTI ratio at origination. The full set of control variables included in these regressions are the same as in the appendix Table A.2. The fixed effects include origination-year, termination-year, and zip code fixed effects. In parentheses are White-robust standards errors clustered at the zip code level. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

# A. Appendix

Table A.1. Variable Description

| *Variable* | *Description* | *Source* |
|---|---|---|
| Repaid | A binary variable set to 1 if the loan is terminated with the sale of the property | ABSNet/RealtyTrac |
| Foreclosed | A binary variable set to 1 if the loan is terminated with the foreclosure of the property | ABSNet |
| Credit Score | The primary borrower's FICO score at loan origination divided by 100 | ABSNet |
| Property Value | The log of the estimated value (HPI- adjusted appraised value) of the property at termination | ABSNet (estimated) |
| Negative Equity | A binary variable set to 1 if the estimated value of the property is less than the loan balance at termination | ABSNet (estimated) |
| Equity | The ratio of HPI- adjusted appraised value minus loan balance at termination to the updated property value at termination | ABSNet (estimated) |
| Loan Amount | The log of the loan amount at origination | ABSNet |
| Refinancing Loan | A binary variable set to 1 for refinancing loans | ABSNet |
| Non-Owner Occupancy | A binary variable equal to 1 if the property is not occupied by the owner | ABSNet |
| Occupancy Unknown | A binary variable equal to 1 if the occupancy of the property is unknown | ABSNet |
| Interest Rate | Original interest rate on the loan | ABSNet |
| Loan Term (log) | The log value of the original loan term | ABSNet |
| DTI | Total debt-to-income ratio at origination | ABSNet |
| DTI Missing | A binary variable equal to 1 if DTI information is missing | ABSNet |
| Borrower Income | Estimated at origination using DTI and annual loan payment, in thousands (000s) | ABSNet (estimated) |
| PMI | A binary variable equal to 1 if private mortgage insurance was required | ABSNet |
| PMI Missing | A binary variable equal to 1 if PMI information is missing | ABSNet |
| Neg. Amortization | A binary variable identifying mortgages with negative amortization | ABSNet |
| ARM | A binary variable identifying adjustable rate mortgages | ABSNet |
| Balloon | A binary variable identifying mortgages with a balloon payment structure | ABSNet |
| Interest Only | A binary variable equal to 1 if the mortgage includes interest-only payments | ABSNet |
| Interest Only Missing | A binary variable identifying mortgages with missing interest-only information | ABSNet |
| Second Mortgage | A binary variable indicating whether there was a silent second lien on the property | ABSNet |
| Single Family | A binary variable identifying single-family properties | ABSNet |
| Inflation | Monthly consumer price index at loan termination | St. Louis Fed |
| Mortgage Rate | Monthly average 30-year fixed rate mortgage rates at loan termination | St. Louis Fed |
| Unemployment Rate | Annual state unemployment rate | BLS |
| HPI End | Quarterly 3-digit zip code house price index at loan origination | FHFA |
| HPI Origination | Quarterly 3-digit zip code house price index at loan termination | FHFA |
| HPI Volatility | Standard deviation of quarterly 3-digit house price index over 20 quarters at loan termination | FHFA |
| Median Income | State median annual income of homeowners 2007-11 and 2012-16 in thousands (000s) | ACS |

## Table A.2. Likelihood of Loan Termination: Full Results

| *Sample:* | *Positive Equity* | *Negative Equity* | *Full Sample* |
|---|---|---|---|
| *Dep. Variable:* | *Repaid* | *Repaid* | *Repaid* |
| Credit Score | 0.1070*** | 0.0431*** | 0.1086*** |
| | (0.0011) | (0.0013) | (0.0010) |
| Negative Equity Dummy × Credit Score | | | -0.0162*** |
| | | | (0.0003) |
| Equity | 0.5938*** | 0.1738*** | 0.6681*** |
| | (0.0059) | (0.0108) | (0.0062) |
| Negative Equity Dummy × Equity | | | -0.6340*** |
| | | | (0.0079) |
| Property Value | -0.0629*** | -0.1513*** | -0.0903*** |
| | (0.0041) | (0.0135) | (0.0040) |
| Unemployment Rate | -0.0209*** | 0.0025* | -0.0117*** |
| | (0.0012) | (0.0011) | (0.0010) |
| Median Income | 0.0011*** | 0.0004* | 0.0001 |
| | (0.0002) | (0.0002) | (0.0001) |
| Loan Amount | 0.0870*** | 0.1953*** | 0.1265*** |
| | (0.0038) | (0.0137) | (0.0038) |
| Refinancing Loan | -0.4702*** | -0.0884*** | -0.2940*** |
| | (0.0027) | (0.0017) | (0.0030) |
| Non-Owner Occupancy | -0.0029 | 0.0131*** | -0.0035* |
| | (0.0018) | (0.0016) | (0.0015) |
| Occupancy Unknown | 0.0364*** | 0.0248*** | 0.0349*** |
| | (0.0047) | (0.0051) | (0.0038) |
| Interest Rate | -0.0326*** | -0.0055*** | -0.0202*** |
| | (0.0005) | (0.0002) | (0.0004) |
| Loan Term | 0.0611*** | -0.0460*** | 0.0427*** |
| | (0.0037) | (0.0046) | (0.0034) |
| DTI | -0.0371*** | -0.0086* | -0.0056 |
| | (0.0086) | (0.0037) | (0.0051) |
| DTI Missing | 0.0040** | 0.0065*** | -0.0003 |
| | (0.0014) | (0.0010) | (0.0010) |
| PMI | 0.0111*** | 0.0204*** | 0.0112*** |
| | (0.0017) | (0.0020) | (0.0014) |
| PMI Missing | -0.0193*** | -0.0227*** | -0.0248*** |
| | (0.0013) | (0.0009) | (0.0009) |
| Neg. Amortization | -0.1485*** | -0.0399*** | -0.0978*** |
| | (0.0033) | (0.0027) | (0.0025) |
| ARM | -0.0884*** | -0.0404*** | -0.0774*** |
| | (0.0012) | (0.0015) | (0.0010) |
| Balloon | -0.0555*** | -0.0070*** | -0.0339*** |
| | (0.0030) | (0.0015) | (0.0017) |
| Interest Only | -0.0410*** | -0.0254*** | -0.0475*** |
| | (0.0014) | (0.0014) | (0.0010) |
| Interest Only Missing | -0.0486*** | -0.0159*** | -0.0483*** |
| | (0.0041) | (0.0021) | (0.0026) |
| Single Family | 0.0698*** | 0.0446*** | 0.0646*** |
| | (0.0035) | (0.0026) | (0.0026) |
| Inflation | -0.0049*** | 0.0007** | -0.0039*** |
| | (0.0003) | (0.0002) | (0.0002) |
| Mortgage Rates | 0.0187*** | 0.0107*** | 0.0135*** |
| | (0.0017) | (0.0013) | (0.0012) |
| HPI End | -0.0002*** | 0.0003*** | 0.0003*** |
| | (0.0000) | (0.0000) | (0.0000) |
| HPI Origination | -0.0003*** | -0.0001** | -0.0007*** |
| | (0.0000) | (0.0000) | (0.0000) |
| HPI Volatility | 0.0025*** | 0.0006*** | 0.0022*** |
| | (0.0001) | (0.0001) | (0.0001) |
| Second Mortgage | -0.0880*** | -0.0409*** | -0.0797*** |
| | (0.0025) | (0.0013) | (0.0016) |
| Fixed Effects | Y | Y | Y |
| Observations | 550,940 | 330,511 | 882,753 |
| Adjusted R-squared | 0.575 | 0.219 | 0.590 |

Note: This table reports the full results of linear probability model (LPM) estimation of loan termination by repayment vs. foreclosure reported in Table 5. The set of fixed effects includes loan origination and termination years, and location (zip code) fixed effects. In parentheses are White-robust standards errors clustered at the zip code level. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

Table A.3. Robustness Checks: Equity Measurement Error, Default at Termination, and Income (Credit Score-Quintile Interactions)

| *Sample:* | *Positve Equity* | | | | *Negative Equity* | | | |
|---|---|---|---|---|---|---|---|---|
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* | *(8)* |
| *Dependent Variable:* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* |
| Credit-Score Quintile 2 | -0.0609*** | -0.0606*** | -0.0614*** | -0.0453*** | -0.0089*** | -0.0075*** | -0.0085*** | -0.0069*** |
| | (0.0032) | (0.0026) | (0.0032) | (0.0063) | (0.0014) | (0.0014) | (0.0013) | (0.0021) |
| Credit-Score Quintile 3 | -0.0183*** | -0.0337*** | -0.0239*** | -0.0337*** | 0.0028 | 0.0051** | 0.0019 | -0.0033 |
| | (0.0035) | (0.0030) | (0.0035) | (0.0067) | (0.0017) | (0.0017) | (0.0017) | (0.0025) |
| Credit-Score Quintile 4 | 0.0966*** | 0.0724*** | 0.0926*** | 0.0655*** | 0.0445*** | 0.0547*** | 0.0427*** | 0.0307*** |
| | (0.0038) | (0.0034) | (0.0038) | (0.0071) | (0.0026) | (0.0025) | (0.0025) | (0.0035) |
| Credit-Score Quintile 5 | 0.2809*** | 0.2717*** | 0.2847*** | 0.2687*** | 0.2005*** | 0.2202*** | 0.1959*** | 0.1760*** |
| | (0.0035) | (0.0032) | (0.0036) | (0.0071) | (0.0067) | (0.0059) | (0.0067) | (0.0076) |
| Equity | 0.5018*** | 0.4709*** | 0.4942*** | 0.5184*** | 0.1071*** | 0.1194*** | 0.1033*** | 0.1271*** |
| | (0.0094) | (0.0086) | (0.0095) | (0.0199) | (0.0115) | (0.0117) | (0.0113) | (0.0107) |
| Credit-Score Quintile 2 × Equity | 0.2520*** | 0.2779*** | 0.2561*** | 0.2279*** | 0.0050 | 0.0110*** | 0.0047 | -0.0044 |
| | (0.0114) | (0.0102) | (0.0115) | (0.0248) | (0.0028) | (0.0028) | (0.0027) | (0.0038) |
| Credit-Score Quintile 3 × Equity | 0.2795*** | 0.3650*** | 0.3013*** | 0.3698*** | 0.0278*** | 0.0375*** | 0.0253*** | 0.0093* |
| | (0.0111) | (0.0102) | (0.0112) | (0.0236) | (0.0036) | (0.0036) | (0.0035) | (0.0046) |
| Credit-Score Quintile 4 × Equity | 0.1327*** | 0.2545*** | 0.1606*** | 0.2892*** | 0.0887*** | 0.1174*** | 0.0847*** | 0.0761*** |
| | (0.0114) | (0.0108) | (0.0116) | (0.0228) | (0.0058) | (0.0060) | (0.0057) | (0.0070) |
| Credit-Score Quintile 5 × Equity | -0.1939*** | -0.1004*** | -0.1752*** | -0.0605** | 0.3091*** | 0.3642*** | 0.3018*** | 0.2953*** |
| | (0.0102) | (0.0099) | (0.0104) | (0.0207) | (0.0169) | (0.0167) | (0.0168) | (0.0156) |
| Property Value | -0.0714*** | -0.0840*** | -0.0739*** | -0.1440*** | -0.1557*** | -0.1838*** | -0.1532*** | -0.1738*** |
| | (0.0040) | (0.0041) | (0.0041) | (0.0088) | (0.0155) | (0.0152) | (0.0153) | (0.0158) |
| Borrower Income | | | | 0.0000 | | | | -0.0000 |
| | | | | (0.0000) | | | | (0.0000) |
| Control Variables | Y | Y | Y | Y | Y | Y | Y | Y |
| Fixed Effects | Y | Y | Y | Y | Y | Y | Y | Y |
| Equity Measurement Error | √ | | √ | √ | √ | | √ | √ |
| Default at Termination | | √ | √ | √ | | √ | √ | √ |
| Borrower Income | | | | √ | | | | √ |
| *Observations* | *500,489* | *533,833* | *483,977* | *113,750* | *286,205* | *329,408* | *285,496* | *87,072* |
| *Adjusted R-squared* | *0.586* | *0.584* | *0.586* | *0.555* | *0.208* | *0.238* | *0.203* | *0.241* |

Note: This table presents robustness checks of our linear probability model (LPM) estimation of loan termination (repayment vs. foreclosure) using OLS for positive- and negative-equity loans at termination using the model as columns (2) and (4) of Table 6. *Repaid* is a binary variable identifying whether a loan was paid off with the sale of the property or foreclosed. Columns (1) and (5) control for potential error in equity value calculation by excluding loans with equity falling between -5% and 5%, exclusive. Columns (2) and (6) removed loans repaid loans that were delinquent at termination. Columns (3) and (7) control for both equity measurement errors and loan delinquency at termination. In addition to controlling for equity measurement errors and delinquency, columns (4) and (8) include borrower income estimated from the DTI ratio at origination. The control variables included in these regressions are the same as in the appendix Table A.2. The fixed effects include origination-year, termination-year, and zip code fixed effects. In parentheses are White-robust standards errors clustered at the zip code level. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

Table A.4. Robustness Checks: Equity Measurement Error, Default at Termination, and Income (Equity-Quintile Interactions)

| *Sample:* | *Positve Equity* | | | | *Negative Equity* | | | |
|---|---|---|---|---|---|---|---|---|
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* | *(8)* |
| *Dependent Variable:* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* | *Repaid* |
| Equity Quintile 2 | -0.2553*** | -0.3344*** | -0.2722*** | -0.3100*** | -0.0557*** | -0.0478*** | -0.0529*** | -0.0351** |
| | (0.0148) | (0.0139) | (0.0149) | (0.0288) | (0.0102) | (0.0101) | (0.0101) | (0.0133) |
| Equity Quintile 3 | -0.2012*** | -0.2989*** | -0.2392*** | -0.3175*** | -0.1674*** | -0.1464*** | -0.1588*** | -0.1692*** |
| | (0.0165) | (0.0159) | (0.0167) | (0.0303) | (0.0131) | (0.0128) | (0.0130) | (0.0179) |
| Equity Quintile 4 | -0.0138 | -0.1155*** | -0.0576** | -0.2103*** | -0.4001*** | -0.3717*** | -0.3863*** | -0.3866*** |
| | (0.0187) | (0.0185) | (0.0190) | (0.0335) | (0.0163) | (0.0156) | (0.0161) | (0.0228) |
| Equity Quintile 5 | 0.3286*** | 0.2413*** | 0.2882*** | 0.2020*** | -0.5188*** | -0.5653*** | -0.5107*** | -0.5013*** |
| | (0.0225) | (0.0226) | (0.0230) | (0.0454) | (0.0269) | (0.0183) | (0.0268) | (0.0431) |
| Credit Score | 0.0692*** | 0.0666*** | 0.0688*** | 0.0738*** | 0.0035** | 0.0015 | 0.0036** | -0.0006 |
| | (0.0021) | (0.0019) | (0.0021) | (0.0037) | (0.0011) | (0.0011) | (0.0011) | (0.0015) |
| Equity Quintile 2 × Credit Score | 0.0515*** | 0.0656*** | 0.0539*** | 0.0593*** | 0.0112*** | 0.0104*** | 0.0107*** | 0.0077*** |
| | (0.0022) | (0.0021) | (0.0022) | (0.0043) | (0.0016) | (0.0016) | (0.0016) | (0.0021) |
| Equity Quintile 3 × Credit Score | 0.0566*** | 0.0736*** | 0.0622*** | 0.0737*** | 0.0307*** | 0.0279*** | 0.0291*** | 0.0304*** |
| | (0.0025) | (0.0024) | (0.0025) | (0.0045) | (0.0021) | (0.0020) | (0.0021) | (0.0028) |
| Equity Quintile 4 × Credit Score | 0.0405*** | 0.0583*** | 0.0472*** | 0.0695*** | 0.0698*** | 0.0658*** | 0.0674*** | 0.0671*** |
| | (0.0028) | (0.0028) | (0.0028) | (0.0049) | (0.0026) | (0.0025) | (0.0026) | (0.0036) |
| Equity Quintile 5 × Credit Score | 0.0013 | 0.0174*** | 0.0079* | 0.0265*** | 0.0914*** | 0.1011*** | 0.0896*** | 0.0875*** |
| | (0.0033) | (0.0033) | (0.0033) | (0.0063) | (0.0043) | (0.0029) | (0.0042) | (0.0067) |
| Property Value | -0.0657*** | -0.0667*** | -0.0678*** | -0.1343*** | -0.0620*** | -0.0943*** | -0.0620*** | -0.0644*** |
| | (0.0040) | (0.0041) | (0.0040) | (0.0089) | (0.0071) | (0.0073) | (0.0070) | (0.0091) |
| Borrower Income | | | | 0.0000 | | | | -0.0000 |
| | | | | (0.0000) | | | | (0.0000) |
| Control Variables | Y | Y | Y | Y | Y | Y | Y | Y |
| Fixed Effects | Y | Y | Y | Y | Y | Y | Y | Y |
| Equity Measurement Error | √ | | √ | √ | √ | | √ | √ |
| Default at Termination | | √ | √ | √ | | √ | √ | √ |
| Borrower Income | | | | √ | | | | √ |
| *Observations* | *500,489* | *533,833* | *483,977* | *113,750* | *286,205* | *329,408* | *285,496* | *87,072* |
| *Adjusted R-squared* | *0.581* | *0.579* | *0.581* | *0.549* | *0.197* | *0.227* | *0.191* | *0.230* |

Note: This table presents robustness checks of our linear probability model (LPM) estimation of loan termination (repayment vs. foreclosure) using OLS for positive- and negative-equity loans at termination using the model as in columns (2) and (4) Table 7. *Repaid* is a binary variable identifying whether a loan was paid off with the sale of the property or foreclosed. Columns (1) and (5) control for potential error in equity value calculation by excluding loans with equity falling between -5% and 5%, exclusive. Columns (2) and (6) removed loans repaid loans that were delinquent at termination. Columns (3) and (7) control for both equity measurement errors and loan delinquency at termination. In addition to controlling for equity measurement errors and delinquency, columns (4) and (8) include borrower income estimated from the DTI ratio at origination. The control variables included in these regressions are the same as in the appendix Table A.2. The fixed effects include origination-year, termination-year, and zip code fixed effects. In parentheses are White-robust standards errors clustered at the zip code level. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

Table A.5. Likelihood of Loan Repayment or Refinancing

| *Sample:* | *Positive Equity* | *Negative Equity* | *Full Sample* |
|---|---|---|---|
| *Dep. Variable:* | *Repaid or Refinanced* | *Repaid or Refinanced* | *Repaid or Refinanced* |
| Credit Score | 0.1016*** | 0.0763*** | 0.1118*** |
| | (0.0009) | (0.0018) | (0.0008) |
| Negative Equity Dummy × Credit Score | | | -0.0321*** |
| | | | (0.0004) |
| Equity | 0.8145*** | 0.2803*** | 0.8097*** |
| | (0.0066) | (0.0142) | (0.0065) |
| Negative Equity Dummy × Equity | | | -0.5592*** |
| | | | (0.0100) |
| Property Value | -0.1336*** | -0.1584*** | -0.1137*** |
| | (0.0035) | (0.0172) | (0.0037) |
| Unemployment Rate | -0.0208*** | 0.0021 | -0.0145*** |
| | (0.0014) | (0.0015) | (0.0010) |
| Median Income | 0.0019*** | 0.0009*** | 0.0012*** |
| | (0.0002) | (0.0002) | (0.0001) |
| Loan Amount | 0.1467*** | 0.2128*** | 0.1338*** |
| | (0.0032) | (0.0173) | (0.0034) |
| Refinancing Loan | 0.0155*** | -0.0091*** | 0.0108*** |
| | (0.0011) | (0.0012) | (0.0009) |
| Non-Owner Occupancy | -0.0332*** | -0.0011 | -0.0270*** |
| | (0.0017) | (0.0019) | (0.0015) |
| Interest Rate | -0.0373*** | -0.0065*** | -0.0230*** |
| | (0.0005) | (0.0003) | (0.0004) |
| Loan Term | 0.1246*** | -0.0678*** | 0.1015*** |
| | (0.0025) | (0.0061) | (0.0024) |
| DTI | -0.0591*** | -0.0227*** | -0.0480*** |
| | (0.0076) | (0.0046) | (0.0049) |
| ARM | -0.1122*** | -0.0570*** | -0.1000*** |
| | (0.0011) | (0.0017) | (0.0010) |
| Single Family | 0.0512*** | 0.0541*** | 0.0521*** |
| | (0.0032) | (0.0031) | (0.0026) |
| Inflation | -0.0060*** | 0.0001 | -0.0049*** |
| | (0.0002) | (0.0003) | (0.0002) |
| Mortgage Rates | 0.0212*** | 0.0173*** | 0.0185*** |
| | (0.0015) | (0.0017) | (0.0011) |
| Additional Control Variables | Y | Y | Y |
| Origination-Year FE | Y | Y | Y |
| Termination-Year FE | Y | Y | Y |
| Location (Zip Code) FE | Y | Y | Y |
| Clustered SE (Zip Code) | Y | Y | Y |
| *Observations* | *973,589* | *343,786* | *1,318,663* |
| *Adjusted R-squared* | *0.376* | *0.215* | *0.546* |

Note: This table reports linear probability model (LPM) estimation of loan termination by repayment or refinancing vs. foreclosure using OLS. The dependent variable is a binary variable set to 1 if a loan terminated either with the sale of the property or foreclosure and 0 otherwise. Columns (1), (2), and (3) report LPM likelihood of loan termination (repayment) for the full sample, positive-equity loans, and negative-equity loans at termination, respectively. The additional variables included in these regressions are the same as in the appendix Table A.2. In parentheses are White-robust standards errors clustered at the zip code level. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

Table A.6. Likelihood of Loan Repayment or Refinancing by Credit-Score Quintiles

| *Sample* | *Positive Equity* | | *Negative Equity* | |
|---|---|---|---|---|
| *Dependent Variable* | *Repaid or Refi* | *Repaid or Refi* | *Repaid or Refi* | *Repaid or Refi* |
| Credit-Score Quintile 2 | 0.0081*** | 0.0046 | 0.0022 | 0.0050** |
| | (0.0016) | (0.0026) | (0.0011) | (0.0019) |
| Credit-Score Quintile 3 | 0.0680*** | 0.1026*** | 0.0207*** | 0.0355*** |
| | (0.0018) | (0.0031) | (0.0014) | (0.0023) |
| Credit-Score Quintile 4 | 0.1390*** | 0.2564*** | 0.0648*** | 0.1098*** |
| | (0.0018) | (0.0033) | (0.0020) | (0.0034) |
| Credit-Score Quintile 5 | 0.1909*** | 0.4381*** | 0.1841*** | 0.2921*** |
| | (0.0020) | (0.0029) | (0.0039) | (0.0065) |
| Equity | 0.8060*** | 1.1179*** | 0.3004*** | 0.2232*** |
| | (0.0065) | (0.0071) | (0.0144) | (0.0153) |
| Credit-Score Quintile 2 × Equity | | 0.0254*** | | 0.0119** |
| | | (0.0073) | | (0.0040) |
| Credit-Score Quintile 3 × Equity | | -0.1301*** | | 0.0516*** |
| | | (0.0079) | | (0.0050) |
| Credit-Score Quintile 4 × Equity | | -0.3795*** | | 0.1586*** |
| | | (0.0083) | | (0.0079) |
| Credit-Score Quintile 5 × Equity | | -0.6938*** | | 0.4181*** |
| | | (0.0071) | | (0.0189) |
| Property Value | -0.1392*** | -0.1361*** | -0.2172*** | -0.2138*** |
| | (0.0035) | (0.0032) | (0.0173) | (0.0194) |
| Additional Control Variables | Y | Y | Y | Y |
| Origination-Year FE | Y | Y | Y | Y |
| Termination-Year FE | Y | Y | Y | Y |
| Location (Zip Code) FE | Y | Y | Y | Y |
| Clustered SE (Zip Code) | Y | Y | Y | Y |
| *Observations* | *973,589* | *973,589* | *343,786* | *343,786* |
| *Adjusted R-squared* | *0.379* | *0.394* | *0.225* | *0.233* |

Note: This table reports linear probability model (LPM) estimation of loan termination by repayment or refinancing vs. foreclosure using OLS for positive- and negative-equity loans at termination with credit-score quintiles (defined in Table 4) interacted with equity. dependent variable is a binary variable set to 1 if a loan terminated either with the sale of the property or refinancing and 0 otherwise. The control variables included in these regressions are the same as in the appendix Table A.2. In parentheses are White-robust standards errors clustered at the zip code level. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

Table A.7. Likelihood of Loan Repayment or Refinancing by Equity Quintiles

| *Sample* | *Positive Equity* | | *Negative Equity* | |
|---|---|---|---|---|
| *Dependent Variable* | *Repaid or Refi* | *Repaid or Refi* | *Repaid or Refi* | *Repaid or Refi* |
| Equity Quintile 2 | 0.1084*** | -0.3166*** | 0.0216*** | -0.0505*** |
| | (0.0017) | (0.0139) | (0.0017) | (0.0103) |
| Equity Quintile 3 | 0.2008*** | -0.2592*** | 0.0393*** | -0.1553*** |
| | (0.0020) | (0.0158) | (0.0024) | (0.0129) |
| Equity Quintile 4 | 0.2782*** | -0.0696*** | 0.0688*** | -0.3853*** |
| | (0.0025) | (0.0183) | (0.0032) | (0.0158) |
| Equity Quintile 5 | 0.3362*** | 0.2840*** | 0.1134*** | -0.5789*** |
| | (0.0033) | (0.0222) | (0.0038) | (0.0184) |
| Credit Score | 0.1084*** | 0.0670*** | 0.0432*** | 0.0011 |
| | (0.0011) | (0.0019) | (0.0013) | (0.0012) |
| Equity Quintile 2 x Credit Score | | 0.0630*** | | 0.0109*** |
| | | (0.0021) | | (0.0016) |
| Equity Quintile 3 x Credit Score | | 0.0678*** | | 0.0295*** |
| | | (0.0024) | | (0.0020) |
| Equity Quintile 4 x Credit Score | | 0.0513*** | | 0.0683*** |
| | | (0.0027) | | (0.0025) |
| Equity Quintile 5 x Credit Score | | 0.0104** | | 0.1038*** |
| | | (0.0032) | | (0.0029) |
| Property Value | -0.0672*** | -0.0645*** | -0.1027*** | -0.0949*** |
| | (0.0040) | (0.0040) | (0.0075) | (0.0074) |
| Additional Control Variables | Y | Y | Y | Y |
| Origination-Year FE | Y | Y | Y | Y |
| Termination-Year FE | Y | Y | Y | Y |
| Location (Zip Code) FE | Y | Y | Y | Y |
| Clustered SE (Zip Code) | Y | Y | Y | Y |
| *Observations* | *550,940* | *550,940* | *330,511* | *330,511* |
| *Adjusted R-squared* | *0.578* | *0.579* | *0.224* | *0.234* |

Note: This table reports linear probability model (LPM) estimation of loan termination by repayment or refinancing vs. foreclosure using OLS for positive- and negative-equity loans at termination with the equity quintiles (defined in Table 4) interacted with credit score. dependent variable is a binary variable set to 1 if a loan terminated either with the sale of the property or refinancing and 0 otherwise. The control variables included in these regressions are the same as in the appendix Table A.2. In parentheses are White-robust standards errors clustered at the zip code level. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.