Collateral Valuation and Borrower Financial Constraints: Evidence from the Residential Real-Estate Market

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October 2012

Abstract

Borrowers who are financially-constrained have the incentive to influence the valuation process (e.g., conditioning the transaction to go through at a high valuation) in order to borrow a larger loan amount or reduce the interest rate. We show that the average valuation bias in refinance transactions is +3.6%. The bias is higher for highly-leveraged transactions (e.g., +6.5% for cash-out transactions with leverage >95%), and for transactions mediated through a broker (by about +2.2%). Mortgages with inflated valuations are more likely to default, however, lenders account for the valuation bias through pricing. Valuation inflation patterns became more severe in the run-up to the crisis and in bubble cities. In practice, the flexibility that appraisers have in determining valuation allows borrowers and lenders to circumvent the securitizer risk criteria.

Keywords: collateral valuation, lending, banks, loans, default, financial crisis

JEL Classification: G01, G21

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* We benefited from the comments of Brent Ambrose, Joao Coco, Ted Durant, Susan Wachter, Yildiray Yildirim, and of seminar participants at the Weimer School of Advanced Studies in Real Estate and Land Economics. The views in this paper are those of the authors and may not reflect those of the Fannie Mae. Ben-David gratefully acknowledges the financial support of the Dice Center at the Fisher College of Business, The Ohio State University. Contact author: Itzhak Ben-David bendavid@fisher.osu.edu

1. Introduction

Collateral is a central feature of the vast majority of credit contracts. While there is an extensive theoretical and empirical literature in corporate finance on the role of collateral (e.g., Johnson and Stulz, 1985 and Benmelech and Bergman, 2009), we know very little about the valuation methodology of the collateral.[1] An important factor that potentially affects valuations is the financial constraints of borrowers. Specifically, financially-constrained borrowers would be more motivated to maximize the debt capacity of their assets or minimize their interest payment. They can do so by influencing the valuation process: a higher valuation for an asset means a higher debt capacity and a lower interest rate. The implication of this mechanism is that observed leverages of originated loans (measured as loan-to-value ratio) could be underestimated. This mechanism has gained importance given the recent U.S. housing bubble in which borrowers' leverage increased dramatically (Mian and Sufi, 2010 and Haughwout, Lee, Tracy, and de Klaauw, 2011). While there is anecdotal evidence for such pressure on behalf of borrowers,[2] there has been no systematic study that studies the phenomenon and quantifies the effect.

The goal of this paper is to measure the effect of borrowers' pressure to inflate valuations in the residential housing market. Our results reveal that the latitude that appraisers have in determining valuations is used by borrowers and lenders as a way to circumvent leverage restrictions imposed by securitizers and investors.

[1] Economic theory explains the role collateral in debt contracts as an attempt to mitigate agency costs or contracting frictions in a world with asymmetric information. Chan and Thakor (1987) argue that collateral alleviates adverse selection problem while Holmstrom and Tirole (1997) argue that collateral alleviates the moral hazard problem. Inderst and Mueller (2007) show that collateral allow local banks that use soft information to be more competitive against banks that use hard information in their lending. Benmelech, Garmaise, and Moskowitz (2005) find that liquidation values of collateralized assets are first-order determinants of loan contracts' terms.

[2] E.g., McLean, "The Appraisal Racket," Slate.com, November 16, 2010. Also, appraisers tell anecdotes about borrowers and lenders pushing for high valuations (http://appraiserspetition.com/index.htm).

Appraised valuations have a central role in the residential real-estate market since properties are unique assets and most transactions are refinance transactions (i.e., have no transaction price that could indicate about market value). Over the period 2000-2009, 57.7% of residential mortgages were used to refinance existing mortgages (Agarwal, Rosen and Yao 2012). From an empirical point of view, this market strikes a balance between liquidity and informational frictions. On one hand, market participants benefit from a relatively liquid market (e.g., compared to commercial real-estate market) and have the advantage of using accurate and ample transaction data. On the other hand, real-estate markets suffer from information asymmetries (Garmiase and Moskowitz 2003), which potentially allow manipulation of valuations. In total, our estimates of the distortions in valuation of real-estate properties are likely to reflect a lower bound for such effects in less liquid markets.

We use a diff-in-diff empirical setting that allows us to quantify the magnitude of biases related to pressures by borrowers. In general, measuring valuation bias is inherently difficult since evaluators have materially more information than the econometrician. Our estimation approach relies on comparing sale prices to previous valuations of refinance (refi) transactions for the same property. This methodology assumes that prices on purchase transactions reflect an unbiased estimate of the property value, while valuations of refinance transactions, which are generated by experts, are potentially subject to biases. Thus, the average difference between market-adjusted price of a purchase transaction and a preceding refinance transaction would reflect the *valuation bias*.

We measure the *valuation bias* in a large sample of over one million pairs of conforming mortgage transactions that were originated between 1990 and 2011. In the analysis, we standardize valuations and prices (at the metropolitan statistical area (MSA)-quarter level) in

order to be able to compare prices over time as well as control for market prices and for the changes in the composition of transacted assets over time. We address selection issues by taking another difference: we difference our estimates against a sample of pairs of two consecutive purchase transactions.

Using our measurement methodology, we find that valuations in refinance transactions (both cash-out refi and rate/term refi) are higher by about 3.6% than prices of purchase transactions on the same properties. The bias is larger by about 2.2% for transactions that were originated by third party originators, such as mortgage brokers.

When assessing the effect of leverage, we find that the extent of the valuation bias in refinance transactions is correlated with the leverage of the borrower. To illustrate, properties in cash-out refinance transactions with leverage of 95% loan-to-value (LTV), or higher, have a valuation bias of about 6.5% more than properties with LTV of 70% or lower.

As argued above, the economic channel through which financially-constrained borrowers achieve high appraisals is through pressure on the loan officer and indirectly on the appraiser. Evidence supporting this mechanism comes from the application withdrawal rate. Specifically, we document that borrowers at high leverage are more likely to withdraw their loan application than borrowers at low leverage. While the effect is strong for refinance transactions, it is significantly milder for purchase transactions. In other words, highly-leveraged borrowers are more likely to realize their threat to shop for a better deal.

We present evidence that the magnitude of the valuation bias increases with the incentives of borrowers and originators. First, we show that the valuation bias is materially larger for loans that were originated by third-party originators. These originators sell loans to aggregators and are more motivated to accommodate borrowers' needs while less motivated to

originate high-quality loans. Therefore, they might be easier to influence the valuations in order to finish the deal. Second, we show that the magnitude of the valuation bias decreases dramatically as loan sizes approach the jumbo-loan cutoff limit. The reason is that close to this threshold there is weaker motivation for borrowers to inflate valuations, as the size of the loan is already limited.

Next, we investigate default patterns. As expected, the likelihood of default is higher for transactions in which valuations are inflated. To understand whether correcting for valuation bias can explain better default patterns, we conduct a horse race between the observed leverage and the estimated true leverage (i.e., correcting for the inflated valuation). Our results show that the bias-corrected leverage explains default patterns better. This result explains why cash-out refinance loans are considered to have more credit risk and are subject to stricter eligibility and higher fees (Freddie Mac, 2012). Also Elul, Souleles, Chomsisengphet, Glennon, and Hunt (2010) find that cash-out refinances are more likely to default.

We also explore whether lenders priced for the excessive risk of default loans with valuation bias. Our results show that the rate that lenders charge to borrowers is correlated with the bias-corrected leverage and not with the observed leverage. Hence, it appears that lenders did attempt to charge for the valuation bias in their pricing.

Given that lenders appear to correct for the bias, one is intrigued by the role of valuation inflation in the lending process. Why cannot financially-constrained borrowers simply borrow larger amounts without needing to put pressure on lenders and appraisers? There are two potential responses to this question. First, since most loans are securitized, lenders are bound to lending up to 100% of the value of the asset. Without allowing valuation inflation, lenders might lose the large segment of financially-constrained borrowers. Hence, lenders effectively collude

with borrowers to lend them larger amounts than dictated by capital providers. This idea is consistent with Zingales (2012) that lenders bent the rules in order to expand the supply of credit. Second, as valuations reflect experts' opinions they are inherently subjective and subject to influence. So, as long valuations remain susceptible to influence, there will be borrowers who will take advantage of this possibility. In other words, borrowers' adverse selection exists, and at the same time mortgages appear to be well-priced. This situation is similar to the insurance market, where some contracts may lead to adverse selection of insurance clients, however, insurers account for this selection and price contracts accordingly (e.g., Akerlof 1970, Abbring, Chiappori, and Pinquet 2003, Lewis 2011).

We also test whether the inflation of valuations contributed to the housing bubble. We find both time-series and cross-sectional evidence for this account. First, we examine the time-series of valuation inflation. We document that valuation inflation increased over time in parallel to the average price level in the U.S. residential market. Second, we find that MSAs that experienced high price growth during the bubble ("bubble cities") have higher average valuation inflation than those that did not experience such growth. In addition, average borrowers' leverage is higher in bubble cities than in other cities.

Overall, our results are consistent with the idea that financially-constrained borrowers influence valuations of collateralized assets. Valuations in refinance transactions are systematically inflated than purchase transactions, and therefore have higher leverage than what can be observed by outsiders. Although collateral valuation seems like a piece of hard information (see Peteresen 2004), it is subject to manipulation. This effect is especially pronounced for highly-leveraged transactions and for mortgage originated by third party

originators. Our results suggest that both borrowers adversely select into the contract and lenders are aware of the inflation of collateral values and price mortgages correctly.

The question of attenuation of collateral valuation relates also to the growing literature about manipulations of asset values and credit quality during. Ben-David (2011) presents evidence that homebuyers collude with home sellers to inflate transaction prices in order to increase the debt capacity of the house. Also, Jiang, Nelson, and Vytlacil (2009) present evidence that borrowers inflate their personal income and Garmaise (2012) show that borrowers inflate their reported personal assets. Furthermore, these studies find that manipulation activity is associated with higher probability of default. More broadly, the valuation process of any asset is potentially biased by pressures of the parties involved. Bolton, Freixas, and Shapiro (2007) provide a general model for expert advice and conflict of interest. Michael and Womack (1999) show conflict of interest in security analysts' opinions around IPOs. Allen, Jagtiani, Peristiani, and Saunders (2004) find evidence for conflict of interest by banks advisors in mergers. White (2010) discusses the pressure that credit rating firms experience from bond issuers.

2 Empirical Identification

2.1 Identification Strategy

Our approach is based on comparing a property sale price to an earlier valuation from a refinance transaction of the same property. The basic premise of the analysis is that a sale price reflects arm's length unbiased valuation of the property and therefore can serve as a benchmark valuation.[3] The valuation used in a refinance transaction is potentially subject to valuation bias.

[3] Appraisals are also used in purchase transactions; however, these usually converge to the transaction price, or above. Cho and Megbolugbe (1996) find that 95% of appraisals are either equal to the sale price (30%) or above it (65%).

Therefore, the difference in values between the price in the purchase transaction and the valuation of the refinanced property serves as a proxy for *valuation bias* (with a negative sign).

As a control sample, we use pairs of consecutive purchase transactions to estimate the difference in valuations in the absence of a refinance transaction. Thus, each observation in our sample reflects the difference in valuations either between a purchase transaction and an earlier refinance for the same property, or between two purchase transactions for the same property.

In pursuing this methodology, we face the challenge of changing market environment. Since we compare valuations of the same property over time (either in the form of a sale price or an appraisal), we need to account for changes in general market valuations. We address this issue by standardizing property valuations. We do so by subtracting from the valuation the mean valuation within the MSA-quarter and scaling by the standard deviation of prices of purchase transactions within each MSA-quarter. Adjusted valuations are therefore:

$$adj\ valuation_i = \frac{valuation_i - mean\left(valuation_{MSA,qtr}\right)}{std\ dev(valuation_{MSA,qtr})}.$$

To see how the diff-in-diff methodology works, consider the difference in adjusted valuations of a purchase transaction at $t = 1$ and a preceding refi transaction at $t = 0$. There are four factors that could explain the difference in valuations. First, there could be a valuation bias (affecting the valuation of the refi transaction). Second, the difference in valuations may reflect a change in the valuation of the general market. Third, a selection bias (discussed in Sections 2.2.1 and 2.2.2) could affect the observed differences in valuations. Fourth, an idiosyncratic shock may affect one or the two valuations. The expected value of these effects is by definition zero.

$$adj\ val(purchase, t = 1) - adj\ val(refi, t = 0)$$
$$= -valuation\ bias + \Delta\ market\ value + \ selection\ bias + e.$$

We decompose the difference in valuations also for the two purchase transactions. The analysis is similar, except that in the case of two purchase transactions there is no valuation bias component:

$$adj\ val(purchase, t = 1) - adj\ val(purchase, t = 0)$$
$$= \Delta\, market\ value + \ selection\ bias + u.$$

When differencing the two pairs of valuations, all components drop, and diff-in-diff isolates the valuation bias component:

$$E[adj\ val(purchase, t = 1) - adj\ val(refi, t = 0)]$$
$$- E[adj\ val(purchase, t = 1) - adj\ val(purchase, t = 0)]$$
$$= -valuation\ bias.$$

We implement this idea with a large sample that includes two types of pairs of transactions for the same property: purchase transactions preceded by refinance transactions, and purchase transactions proceeded by purchase transactions. For each pair, we compute the difference in standardized valuations. This is our dependent variable. Our main prediction is that the difference in standardized valuations is significantly different from zero for refinance transactions where zero is the benchmark value for purchase transactions; hence, the independent variables are a refinance dummy (either cash-out refinance or rate/term refinance) along with many other controls. In our specification, coefficient on refinance dummy should be negative—indicating that appraisals are inflated in the previous refinance transaction and the resulting return from refinance-to-purchase is negative compared to purchase-to-purchase pair.

Our dependent variable in Table 2 through 6 is measured in units of price-standard deviation. To convert the results to percentage point terms, we use the table provided in Appendix B. This table shows the mean price and standard deviation for the entire sample. To

convert a result in price-standard deviations to price percentage points, we multiply by ratio of the sample standard deviation divided by the sample mean. On average, this ratio is 0.886; we will use this figure to translate the regression coefficients into economic significance expressed in percentage points.

2.2 Potential Concerns in the Identification Strategy

Our identification strategy raises three main concerns. The first is that both refinancing and purchase transactions are endogenous, i.e., their timing is determined by the homeowner. Second, there could be unobservable characteristics that are associated with a particular type of transaction. Third, since our sample is a subsample of the mortgage universe, there could be selection into our sample based on the quality of the borrower.

2.2.1 Endogenous Refinancing and Selling

One concern is that comparing valuations of properties over time may be biased due to selection transactions into the sample and due to changes in composition of transactions over time. Specifically, homebuyers may be more likely to sell their homes when in profits, i.e., following price run-ups (Genesove and Mayer 1997, Korteweg and Sorenson 2012). Also, the decision to refinance is correlated with the valuation of the property: borrowers may decide to refinance when their property valuation is higher relative to its past valuations. Such behavior could create a selection bias such that we would observe refinancing of winning properties only.

Our empirical design circumvents this concern. Specifically, this type of endogeneity would affect an analysis that compares directly standardized valuation of refinance transactions in the cross-section. Our analysis is different since it measures the *change* in valuation rather

than the level of valuation. Furthermore, since the pairs of transactions that we examine have a specified order—refinance transaction followed by purchase transaction—prevents a situation in which the returns that we measure reflect a pre-refinancing run-up. As long as there is no return predictability in real-estate prices over several years, then our measure of change in valuation is unbiased.

In addition, the procedure of pairing mortgages at the property level generates an implicit look-ahead bias or censoring issue. The reason is that a refi transaction will not enter the sample unless the borrower sells the property in the future. Selling the property is an endogenous decision and may be related to the financial constraints of the borrower. This bias might be of greater extent in later years of the sample period than in earlier years.

We argue that the look-ahead bias is likely to bias the estimates of the valuation bias downwards for the following reason. A determinant of whether individuals sell their home is whether their mortgage balance is below the price of the house (Genesove and Mayer 1997). Borrowers who have an inflated valuation in their refi transaction are less likely to sell their home, and hence less likely to appear in the sample. Thus, our sample will include fewer properties with negative returns between a refi and a purchase transaction, potentially underestimating our measure of valuation bias. To some extent this underestimation is controlled for by having the purchase-to-purchase transactions in the sample.

2.2.2 Change of Composition and Unobservable Characteristics

There is a possibility that the composition of properties changes over time, and therefore affects our estimations. This critique would hold if we used only one set of pairs: refinancing-sale. Then, one could argue that the changing composition of properties in the latter date would

create a bias in the estimation of the valuation bias. However, our tests use two sets of pairs: refinance-to-purchase and purchase-to-purchase. Any change in property composition that would affect the refinance-to-purchase is deemed to affect also the estimation of the difference in valuations of the purchase-to-purchase pair. Since the assessment of the valuation bias is based on diff-in-diff methodology: differencing the estimates generated between the two sets of pairs, this bias, if exists, is differenced away.

Also, there could be a correlation between unobservable characteristics and the timing of transactions. Consider the following example. Suppose borrowers sell their homes when they run down, on average, but refinance them after improving their value (e.g., through remodeling). In this case, we should expect that the difference in transaction values between a refinance and a purchase transaction will be lower than the difference in transaction values between two purchase transactions.

We propose a test that examines whether this alternative explanation has merit. We rely on the widely-known observation that the probability of refinance increases when interest rates low. Interest-rate motivated refinancing is unrelated to the relative valuation of a property, and therefore can serve as an instrument. If the concern is justified, then for a sample of interest-rate/term-driven refinance transactions, we should not observe a valuation bias. We focus on the years 2002 and 2003, where 30-year interest rates declined from 6.5% in 2002 to 5.8% in 2003 and sparked a wave of interest rate driven refinancing: we observe an increase of 71% in the number of pair transactions in our sample (Table 7, compare Columns (3) and (4)). In 2003, the measured valuation bias is not materially different from that is measured in 2002. Specifically, the measured valuation bias on cash-out refinance transactions increased in magnitude from about 2.0% of a price-standard deviation (1.8% of the average price), and the measured valuation

bias on rate/term refinance transactions declined from 1.85% of a price-standard deviation (1.6% of the average price). We conclude that there is little evidence that the concern of unobserved characteristics causes a material bias in our estimations.

2.2.3 Quality-Based Selection into the Sample

As described in detail in Section 3, the data we use come from two sources. The first transaction is financed by prime conventional conforming mortgages by a national insurer. Both jumbo loans with higher loan balance and subprime borrowers with blemished credit are excluded. The second purchase transactions are from public records and thus representative of entire universe of purchase transactions.

This drawback of the data is likely to bias our estimates of the valuation bias downwards. The reason is that the prime borrowers who are included in the sample are less likely to be financially constrained than borrowers excluded from the sample (e.g., Alt-A and subprime borrowers). Since valuation bias is partly driven by financial constraints, then our sample misses on refinance transactions in which valuation bias is high. Therefore, our results should be considered as a conservative estimate of valuation bias.

A related concern is that a bias can be created if we drop foreclosures from the sample. This will leave in the sample mostly properties that did not decrease dramatically in value. There is an extensive literature on price discount of foreclosed properties (Campbell, Giglio, and Pathak (2011), Harding, Rosenblatt, and Yao (2012)). We address this concern by including all transactions, including foreclosures, in the sample. In addition, we include in all regressions controls to whether the mortgage was seriously delinquent or defaulted. Including these controls

do not materially affect our results, partly because the fraction of loans in trouble in this sample of prime borrowers is relatively small.

3 Data

3.1 Data Sources

Our main body of data comes from two sources. First, we collect the mortgage information about the first transaction in each pair using the universe of mortgages securitized by a national insurer from 1990 to 2011. They are conventional, not government loans. These mortgages are conforming loans made to prime borrowers. Conforming mortgages meet the conforming loan limit which has been $417,000 since 2006 for single family one unit. Prime borrowers are borrowers with relatively high credit score (620 or higher) compared to subprime borrowers with blemished credit. In 49% of the cases the lender originated the mortgage (retail origination) and in the rest of cases, the mortgage was sourced by a mortgage broker or a correspondent lender who sell the mortgage to aggregators. Relative to other datasets of securitized loans used in the literature, e.g., LoanPerformance or McDash, our dataset contains loans of higher quality. The original dataset includes about 14.1 million transactions.

The second dataset consists of purchase transactions only. Since we do not require mortgage information for these transactions and because we wish to maximize the sample size, we supplement the issuer's data with public records (e.g., record of deeds) for the second transaction in each pair.

Our final dataset is composed of pairs of transactions for the same property. There are two types of transaction pairs that are of interest (see Section 2 for further details): refinance (either cash-out or rate/term refinance) transaction followed by a purchase transaction, and

purchase transaction followed by a purchase transaction. As explained in Section 2, our interest is in the first transaction since we use it to measure the valuation bias. For each pair, we record the transaction dates, the origination channel of the first transaction, and the characteristics of the mortgage.

For the analysis of application withdrawals we use application data from HMDA for the year 2006. For each application we record characteristics like loan amount, income, loan purpose, loan type, and property type. The dataset includes 34 million mortgage applications.

3.2 Summary Statistics

The summary statistics are presented in Table 1. The average transaction valuation or price for the first transaction in each pair is around $217,000. The average sell price is $241,000. When examining the first transaction in each pair, we find that cash-out refinancing establish 25% of all transactions, rate/term-refi transactions are 34% of all transactions, and the rest are purchase transactions. 51.6% of transactions were sourced in third-party origination (e.g., mortgage brokers and correspondent banks) in the purpose of selling in the secondary market; the rest of loans were sourced by lenders who keep some loans on their books.

The average leverage in the first transaction in each pair is relatively low (75.8%). About 30% of loans have very low loan to value (LTV 70%) ratio. 19% of loans have leverage greater than 70% and lower than 80% and another 18.4% are concentrated at 80% LTV. 3.5% of loans have LTV greater than 80% and lower than or equal to 85%. 11.4% have leverage greater than 85% and lower than or equal to 90%. About 10.5% have leverage greater than 90% but lower than 95% and the rest 7% have LTV greater than 95% and lower than or equal to 100%.

Loan quality of the first transaction in each pair is relatively high. The average FICO credit score is 715. 12.1% of loans defaulted end up in default or foreclosure, and 14.4% of properties were sold when the borrower was at serious delinquency (90+ days past due).

4 Empirical Analysis

4.1 Estimating the Valuation Bias

We begin by estimating the appraisal bias for the entire sample. In Table 2, we regress the change in valuation between a sale and a previous transaction (either a sale or refinance) of the sample property. The variables of interest are the refi indicators of the previous transaction: either cash-out refi[4] or rate/term refi.

We present three generic specifications. In Column (1) we regress the change in standardized valuation figures on cash-out and rate/term refi indicators as well as indicators to whether the price in the second transaction is associated with a default or a serious delinquency. These indicators have negative coefficients since a default or delinquency means that the property is likely to be foreclosed upon and probably sold in a significant discount (Campbell, Giglio, and Pathak 2011; Harding, Rosenblatt, and Yao 2009, 2012). Without these indicators, the discount of a distressed sale of the second transaction can be attributed to a valuation bias in the first transaction. In Column (2), we add property- and mortgage-level characteristics. These characteristics relate to the first transaction of the pair. In Column (3) we add two series of fixed effects: for the MSA interacted with the month of the first transaction and for the MSA interacted with the month of the second transaction.

[4] Greenspan and Kennedy (2008) assess the uses of cash from cash-out refinancing as financing consumer spending, outlays for home improvements, debt repayment, and acquisition of assets.

We focus on Column (3), which control for property- and mortgage-level characteristics as well as have fixed effects. Purchase-to-purchase pair is the benchmark category for cash-out and rate/term-term refi, and have the assumed coefficient of 0. Compared to them, the valuation bias on cash-out refi is about 4.1% of a price-standard deviation (Column (3)), and a similar magnitude for rate/term refi. This suggests that there is a significant valuation bias between appraisals for refinance and contract prices of sales, but there is little difference between appraisals for cash-out and rate/term-term refinance.

To quantify the economic magnitude, we turn to Appendix B, which presents mean purchase transaction values and standard deviations for the entire sample. Across years, the ratio between the standard deviation and the mean property value ranges from 0.76 to 1.08 for the national sales population, with an average of 0.886. Thus, a valuation bias of 4.1% of a price-standard deviation translates to 3.1% to 4.4% of prices for the national average, with a mean bias of 3.6% of the average house price. In terms of dollar value inflation, these figures translate to $11,700 in 2011, when the mean house price is nearly $247,000.

Overall, these estimates show that valuation bias is economically important. Appraisals that are based on refinance transactions are inflated on average by 3.6%. Given that 25% of all mortgage transactions are cash-out refi transactions and 34% are rate/term refi transactions, our results indicate that the bias is economically material.

4.2 Leverage and Valuation Bias

The main hypothesis of the paper is that borrowers' leverage is correlated with the valuation bias. To test this hypothesis, we regress our measure of the valuation bias (the

difference in the standardized values) on cash-out and refi dummies interacted with leverage dummies, in addition to controls and fixed effects.

The regressions are presented in Table 3, Columns (1) to (3). They show that the valuation bias increases with the leverage. We focus on Column (3) which includes the full set of controls and fixed effects. Specifically, this specification includes property level controls, controls for whether the second transaction in the pair has defaulted or is in serious default, and fixed effects for the interaction MSA and calendar quarter for both the first and second transactions in each pair. The regression indicates that the valuation bias increases almost in a monotonic fashion with leverage and that the correlation is of a first-order economic magnitude.

To illustrate the magnitude of the effect, compare the valuation bias for low- vs. high-leveraged refinanced loans. Relative to loans with leverage lower than or equal to 70% (base), loans with leverage greater than 95% have a valuation bias of 6.3% more price-standard deviations for rate/term refi (5.6% of average prices) to 7.3% price-standard deviations for cash-out refi (6.5% of average prices). Thus, moving from mortgages at≤70% LTV to mortgages at >95% LTV, valuation bias for cash-out refi transactions increases by 25% of a standard deviation.[5]

In sum, borrower leverage is strongly correlated with the extent of valuation bias. This finding is consistent with the idea that financially constrained borrowers demand higher appraisals on refinance transactions. The implication of this result is that the leverage of refi mortgages is much higher than appears when valuation bias is considered. This is potential explanation to the finding that refi transactions are more likely to default than purchase transactions.

[5] From Table 1: the standard deviation of the difference in the price-standard deviations between two transactions is 24.2%.

4.3 Application Withdrawal

The economic mechanism that ties valuation levels and financial constraints is the pressure that borrowers apply on loan officers. Specifically, borrowers could threat loan officers to shop around for better loan quotes. A manifestation of this prediction would an application withdrawal rate that increase with borrowers' leverage. When the leverage is higher, the valuation of the underlying asset is more important to the borrower, and therefore deviation from the desired value may result in the borrower trying to get a loan with another lender.

To test this prediction, we turn to the HMDA dataset that provides information about loan applications. HMDA, however, does not provide information about the valuation of the underlying asset; to overcome this obstacle, we define leverage as loan amount divided by income. Borrowers have a higher leverage is loan/income is higher. For each loan purpose (purchase, cashout refi, rate/term refi) and within each month we split borrowers to ten bins according to borrowers' leverage. Due to the large size of the dataset, we focus on a single year – 2006; overall we have 34 million observations.

To derive the sensitivity of application withdrawal to leverage decline we run a regression of an application withdrawal dummy on leverage bin dummies. In addition we control for loan type, and property type.

We plot the coefficients of the leverage dummies in Figure 1. The figure shows that for refi transactions the likelihood to withdrawal applications increases with leverage, and is especially higher for the highest decline. In contrasts, for purchase transactions, the sensitivity of withdrawal is not increasing that sharply for leverage. This is consistent with the idea that appraisals are less important for highly-leveraged borrowers in purchase transactions.

Overall, this evidence is supportive of the hypothesis that highly-leveraged borrowers withdraw applications because they are unable to achieve their desired valuation levels.

4.4 Variation in the Incentives to Influence Valuations

Next, we explore two situations in which the incentives of borrowers to influence valuations are modified.

4.4.1 Third-Party Originators

Loans in our dataset are originated through two sources: lenders and third-party originations. While lenders originate loans in order to keep them on their balance sheet or sell them to mortgage securitizers, third-party originators originate loans for the sole purpose of selling them, without the intention of keeping any of the loans.

From the perspective of the borrower, third-party originators are easier to influence since they sensitivity to the risk of the loan is lower (they do not carry the loan on their balance sheets). There is anecdotal evidence that loans originated by third-party originators have inflated valuations. In November 2007 New-York Attorney General, Andrew Cuomo, filed a suit against the mortgage lender Washington Mutual. The allegation was that between July 2006 and April 2007 Washington Mutual put pressure on its appraisal company, eAppraiseIT, to generate high appraisals. Washington Mutual threatened to transfer business to eAppraiseIT‘s competitors, and in a number of cases actually discontinued its contract. eAppraiseIT bowed to Washington Mutual and produced a list of “proven accepted [by Washington Mutual] list” of appraisers. Other appraisers did not receive appraisal assignments.[6]

[6] See Wamu-eAppraiseIT case coverage on http://www.reuters.com/article/2012/09/28/us-appraisal-settlement-idUSBRE88R02520120928. Also, other media resources include

According to interviews with industry practitioners and industry resources, Wamu is not necessarily an outlier. First, interviews with a loan officer[7] and appraisers[8] reveal that borrowers put pressure to inflate their appraisals. Second, borrowers have access to resources helping to achieve higher valuations.[9] Third, appraisers organized a petition that includes thousands of signatures and hundreds of testimonials of appraisers about pressure from loan officers.[10] Finally, recent legislation attempts to combat the phenomenon.[11]

Therefore, we anticipate that the degree of the bias in valuation will be greater for loans that were originated by third-party originators. Although all mortgages in our dataset were securitized, we can distinguish between mortgages that were originated by third party originators or by retail lenders. In Table 4, Panel A, Column (1), we regress the spread in difference in standardized valuations on refi dummies interacted with an indicator to whether the loan was originated by a third party originator. The regressions show that refi mortgages that were

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http://www.washingtonpost.com/wp-dyn/content/article/2007/02/02/AR2007020200712.html, http://www.myrecordjournal.com/latestnews/article_15198981-28a6-575f-9b68-b93a607e64c4.html, http://www.mortgagenewsdaily.com/4252005_Appraisal_Fraud.asp.

[7] We interviewed a loan officer who worked in one of the largest mortgage originators. He reports that "…there were times that appraisers had to file restraining orders against borrowers for harassment after their appraisal value 'came in low.' Just that phrase alone is telling... no one in the mortgage business ever says 'borrower's expectations were too high' or 'purchase price was unrealistic.' It's always 'low appraisal' or 'value was cut' or something implying the appraiser is at fault." Further on appraisal inflation see an interview with appraiser Kathy Coon: Aaron, Bob, 2006, Appraisal Buzz interview with Kathy Coon, *Appraisal Buzz*, July 2006.

[8] In background interviews with appraisers, we learned that during the real-estate bubble lenders "black listed" appraisers who did not agree to provide the desired valuations.

[9] For example, www.namethatvalue.com and http://eziniearticles.com/?How-to-Influence-an-Appraiser&id=3201545.

[10] Thousands of appraisers signed a petition calling against lender black-listing appraisers who do not conform to the requested numbers (see http://appraiserspetition.com/index.htm). On this website can find testimonials of appraisers about being black-listed by lenders. Some representative comments include: "I have lost clients for not hitting a number," "Appraisers are like pawns in some financial firm's game. If they don't get what they want, they blacklist you," "Appraisals need to be ordered by someone without a vested interest in the value," "This is the single largest problem that faces the appraisal industry today."

[11] In late 2010, the Federal Reserve issued an updated set of appraisal rules requiring appraisals to operate independently from mortgage originators. See Donna Borak, "Rules set for 'Independent Appraisers,'" American Banker, December 3, 2010. See also http://www.mortgagenewsdaily.com/5112005_Aprraisers_On_Pressure_And_Reform.asp and http://www.publicintegrity.org/2009/06/17/2842/despite-new-rules-appraisers-say-pressure-remains.

originated through a third party origination channel have significantly higher valuations by about 2.5% of a price-standard deviation (2.2% of the average price).

In Columns (2) and (3) we include two variations of lender fixed effects: lender × calendar quarter fixed effects, and lender × MSA × calendar year fixed effects. The regressions show that the effect of appraisal bias loses more than half of its economic magnitude. This indicates that the identity of the lender is an important determinant of appraisal bias.

4.4.2 Maximum Loan Size

Another dimension in which borrowers' incentives vary is the dollar size of the loan with respect to the maximal loan size allowed. Specifically, the federal government sets a conforming loan limit on an annual basis; this cap increases over the years, and currently held at $417,000.

This cap on loan size allows testing the motives of borrowers. Specifically, our conjecture is that there are two motives for borrowers to attempt and influence the valuation of the underlying assets. First, by inflating the value of the asset, borrowers can borrow a higher amount, because lenders often determine the maximum loan amount as a fraction of the value of the underlying asset (i.e., loan-to-value ratio). Second, by inflating the valuation amount, borrowers can benefit from a lower interest rate as loans with lower LTV have lower interest rate. When a loan reaches the dollar size cap, then the first motive for influencing valuations is shut off: there is no point in influencing the valuation in order to borrow more. The second motive, however, still exists.

Therefore, our prediction is that loans that are closer to the jumbo-loan cutoff have smaller valuation bias. The prediction is tested in Table 4, Columns (2) to (4). We stratify the sample by the ratio of the loan size to the jumbo-loan cutoff at the relevant year. The results

show that cash-out refi loans that are close to the conforming loan limits do not have inflated valuations. Rate/term refi loans exhibit a sharp decline in the valuation bias, from 4.1% of a price-standard deviation (3.6% of the average price) for low loan values to 2.3% of a price-standard deviation (2.0% of the average price) for loans near the jumbo-loan cutoff. One explanation for the different behavior between cash-out and rate/term refis is that cash-out refi borrowers' objective is to maximize the amount that they withdraw and therefore the jumbo-loan cutoff drastically reduces their motive to influence valuations. Conversely, rate/term refi borrowers' objective is to lower the rate that they pay; hence, even given a maximal loan value it still might be worthwhile for some borrowers to push the valuation in order to benefit from better financing terms.

5 Borrower Default and Valuation Bias

The valuation bias has the potential of being an important determinant for borrower default. If valuations of refinance transactions are inflated, then their observed leverage should be downward biased. The prediction is therefore that loans with more severe valuation bias are more likely to default. Such a result would be consistent with the finding of Lacour-Little and Malpezzi (2003) that appraisals that are higher than valuations predicted by a hedonic model predict future borrower default. Similarly, Kelly (2007) shows that discrepancy between actual appraisals and AVM is associated with future borrower default.

In this section, we test this prediction in a two-stage procedure. The idea is to run a default regression as customary in the literature (i.e., on indicators of the observed CLTV and on mortgage characteristics), and then test whether the residuals of this regression contain additional

information that can be explained by the CLTV recalculated based on the deflated property value.

We begin with a base specification, which is the standard default regression (e.g., see Ambrose and Capone 1998, Deng, Quigley, and Van Order 2000) in Table 5, Column (1). The dependent variable is a dummy indicating whether the mortgage defaulted in the first 12 months since origination. The dependent variables include mortgage characteristics,[12] as in previous regressions, as well as fixed effects for MSA interacted with calendar quarter. The regression is a probit regression and the table presents the marginal effects. As expected, the likelihood of borrower default increases with the as observed CLTV.

Then, we regress the residuals from the first-stage regression on leverage indicators that reflect the recalculate leverage based on the deflated asset values. We calculate the residuals from the regression and test whether they can be explained by the recalculated leverage. The residuals are calculated as the actual default indicator minus the predicted value. We also recalculate the leverage as loan / recalculated value, where the recalculated value is deflated for refi transactions according to their relevant values based on Tables 2 and 3, Panel A. The results of the regression of the residuals on the indicators of the recalculated CLTV values are presented in Column (2). The regression shows that the residuals of default increase with the recalculated leverage. This means that the recalculated leverage contains information that is not contained the observed leverage.

We also conduct a placebo analysis in which we test whether there is information contained the recalculated leverage which is not contained in the observed CLTV. The test is simply a rerun of the test of Columns (3) and (4), but in reverse order, i.e., regressing first the

[12] Control variables include FICO score, indicators for mortgage products (30-year FRM, 15-year FRM, ARM), investor dummy, condo dummy, excess premium, and debt to income ratio.

default indicator on the recalculated CLTV indicator. Then, we regress the residuals on indicators of the observed CLTV. The first-stage regression in Column (3) shows that the likelihood of default increases monotonically with the recalculated CLTV.

We conduct this exercise in Columns (3) and (4) of Table 5. The results show that only the indicator of the highest leverage bin is significant in the expected sign, suggesting that our measure of recalculated leverage does not capture all relevant variation.

Comparing the results in Columns (2) and (4) demonstrate the recalculated leverage provides a refined measure of the true leverage of borrowers and therefore predicts default better.

6 Is the Valuation Bias Priced by Banks?

Lenders typically measure the risk of loans based on three primary variables: loan purpose, credit score (FICO), and leverage and price them accordingly.[13] An important empirical question is whether lenders were aware of the distortion created by the valuation bias and attempted to price it.

To answer this question we repeat the default specification in Table 5, this time with a dependent variable that is the original mortgage rate an in an OLS framework. As in the default regressions, the variables of interest include two sets of leverage dummies: the original CLTV and the recalculated CLTV (corrected for origination channel and for leverage-based bias). In addition, we include the usual battery of controls. Temporal variation in the interest rates and differences of adjustable rate mortgages vs. fixed-rate mortgages are captured in the time-fixed effects (MSA interacted with calendar quarter) and product controls.

As in Table 5, our test is a horse race between the observed CLTV and recalculated CLTV. The results are presented in Table 6. Column (1) shows that baseline regression, where

[13] E.g., these are the main determinants of the interest spread charged to borrowers (Freddie Mac, 2012).

mortgage rates are regressed on CLTV dummies. The regression shows that the rates increase monotonically with leverage, where mortgages at the highest observed leverage (95%<CLTV≤100%) pay 0.51% more than mortgages with leverage of 70% or less. In Column (2), we regress the residuals from the Column (1) on dummies of recalculated leverage. The regression shows that recalculated CLTV measure parses monotonically leverage for high leverage mortgages (95% CLTV and above).

As in Table 5, we conduct also a placebo analysis, but reversing the order of regressions. Column (3) shows that the raw mortgage rate increases monotonically with the recalculated leverage. When regressing the residuals from this regression on indicator of the observed leverage (Column (4)), we see that there is virtually no information left in the residuals. Hence, the recalculated leverage parses well the mortgage rate charged by banks.

It is hard to determine whether rates are well-priced with respect to leverage, i.e., whether their level reflects the risk associated with these mortgages. One of the reasons for this is that our sample is not long enough. Most of our sample is in pre-2007 period, where default rates were relatively low. The last part of our sample includes the financial crisis, however, this period could be considered as an extreme event in the distribution of outcomes. The other reason is that mortgage pricing is complicated and there is not fixed formula between default rate and mortgage rate. Therefore, our results confirm directionally that lenders try to price the valuation bias in loans but we cannot answer whether they have priced adequately or not.

If lenders priced extra risk related to valuation bias, why would these borrowers still accept the contract? One answer is that these financially constrained borrowers have higher valuation function than the high rate lender charges. They accept simply because they have to do

so to maximize the loan amount for lower the interest rate when a better resolution does not exist. This clearly is an adverse selection problem.

7 Valuation Bias and the Real-Estate Bubble

Of special interest is the relation of valuation bias and the housing bubble at the beginning of the 2000s. We provide two tests in this respect: a time-series analysis and a cross-sectional analysis.

7.1 Time-Series Analysis

The purpose of the time-series analysis is to test whether the magnitude of the valuation bias changed over time. We conduct the analysis by splitting the sample by the year of the first transaction in each pair and by comparing the valuation bias over the time.

The results of the analysis are presented in Table 7. The table shows that the valuation bias increased during the bubble period through 2006 when national home price peaked. Specifically, valuation bias in cash-out refi transactions was 0.7% of price-standard deviation (0.6% of the average price) in 1990-2000. It increases over time and peaks in 2006 at 4.9% of price-standard deviation (4.3% of the average price). Valuation bias in 2007-2011 is higher at 6.9% of price-standard deviation (cash-out refi) and 7.7% of price-standard deviation (rate/term refi). These numbers translate to 6.1% and 6.8% of the average price, respectively. The valuation bias in 2007-2011 can potentially be attributed by the tendency of appraisers to overstate valuations of assets during down markets (e.g., Cannon and Cole 2011).

7.2 Cross-Sectional Analysis

In our cross-sectional analysis we focus on the largest 20 MSA that are covered by the Case-Shiller index. We classify MSAs as having low-, mid-, and high-price ex post growth based on the Case-Shiller between 2001 and 2006. Then, we execute the regressions again for transactions (first transaction in each pair) that took place between 2001 and 2006. To mitigate a bias due to selective sales of properties based on changes in prices (as described in Korteweg and Sorenson 2012), we require the purchase transaction in each pair of transactions to take place no later than in 2007. We divide the 20 MSAs into 3 cohorts based on their cumulative home price growth from 2001 to 2006: high growth—top 7 MSAs, medium growth—middle 7 MSAs and low growth—bottom 6 MSAs.

The analysis, presented in Table 8, shows that appraisals in ex post high-growth areas exhibited higher valuation bias, for cash-out refis only. While the average valuation bias for cash-out transactions in high-price growth is 1.8% (1.6% of the average price) of price-standard deviation, it is 1.4% of a price-standard deviation (1.2% of the average price) in medium price-growth areas and only 0.6% of a price-standard deviation (0.5% of the average price) in low price-growth areas. The figures for the rate/term refi exhibit a similar pattern. Clearly, high home price appreciation comes with higher valuation bias or vice versa.

8 Discussion and Conclusion

The valuation of the collateral is often subject to pressures from borrowers, pressures which increase with the financial constraints of the borrower. In this paper we present evidence that these pressures result in substantial deviations in the underlying asset valuation. We show

that valuations of refinance transactions that require valuation assessments by human appraisers are biased upwards on average. The bias is more severe for situations in which borrowers and lenders are interested in originating larger mortgages: i.e., valuations are inflated for highly-leveraged mortgages and for third party originations (mortgages are more likely to be sold to third parties).

The biases identified in the paper have important implications for loan pricing and default models. We show that inflation of the collateral value implies that the leverage calculated based on the observed valuation of the asset is downwards-biased, creating a systematic bias in standard default models. As proposed, these models can be improved by correcting the leverage to account for the bias in valuation. We find that lenders account for the bias in valuation and charge interest so that properties that are over-appraised pay higher interest.

Our evidence highlights a puzzle in the lending process. Financially-constrained borrowers put pressure to increase borrowing amounts. However, lenders appear to understand this mechanism and adjust mortgage rates accordingly so that they reflect the bias in valuation and correctly account for the higher likelihood of default of loans supported by inflated collateralized assets. Why cannot borrowers need to go through the pressure channel instead of simply borrow larger amounts from lenders outright? We offer two explanations for this phenomenon. First, both borrowers and lenders are constrained by lending rules that are imposed by the secondary market and by convention. In particular, there is almost no lending beyond 100% of loan-to-value in the U.S.[14] Inflating valuations allows both borrowers and lenders to informally collude and circumvent the rigid rules (in the spirit of Zingales (2012)). It is important to note that this explanation kicks the can down the road; one can ask why the secondary market

[14] Interestingly, in some countries (e.g., common wealth countries: U.K., New Zealand, Australia) lenders allow leverage higher than 100% at the time of origination of residential mortgages.

has such rigid lending rules? While we do not have a good explanation for this, it is possible that secondary market investors take the mortgage characteristics as given and do not question the precision of the valuation. The second explanation is based on the heterogeneity in the population of borrowers. Specifically, since for many borrowers, the financial constraints are not completely relaxed even if lending rules were more lax, there will always be an incentive to inflate valuations. Therefore, no matter which bounds investors and lenders put on leverage, collateral will always be inflated by financially-constrained borrowers, and lenders respond optimally.

The biases in the valuation process could potentially be resolved by properly designing institutions and processes. In March 2010, the GSEs began requiring appraisers of residential properties to be ordered by an appraisal management companies, not directly by loan officers. Unfortunately, since our methodology requires two consecutive transactions on each property, it cannot effectively test yet whether the valuation bias was indeed eliminated following this change in process. We also note that even if the contractual frictions would be mitigated, it will be difficult to eliminate the valuation bias that occurs due to the use of outdated information.

Although our data and results come from the residential real-estate market, the findings have general implications in corporate finance. We chose the residential housing market for the study since it allows to empirically estimating the valuation bias: it is liquid enough to have sufficient transactions for a quantitative study, and at the same time appraisers have enough latitude to inflate valuations. In other areas of finance, assessment of value is often done in domains where assets are complex (e.g., firms, securities), and thus it is hard to pin down a systematic bias. Nevertheless, such bias is likely to exist given that the experts valuing the assets are subject to pressures by the parties involved in the transaction.

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Appendix A. Variable Definition

Variable	Definition
Difference in standardized valuations (%)	The sample includes all pairs of transactions where the first transaction took place during the sample period. For each purchase transaction we match a past transaction (either sale or refi transaction) and calculate the standardized price difference between the transactions. Standardized prices are the difference between in the price and the mean price in the MSA-quarter and are expressed in standard deviation (calculated based on the distribution of sale prices in the MSA-quarter). The variable is the difference in standardized prices between the second transaction and the first transaction.
Cash-out refi	An indicator to whether a transaction is a cash-out refi transaction (loan balance increases by more than certain percentage).
Rate/term refi	An indicator to whether a transaction is a rate/term refi transaction (loan balance does not increase except closing cost).
Originated by third party	An indicator to whether the loan was originated by a broker or correspondent bank.
3-month local market returns	Change in the Case-Shiller house-price index over the previous quarter. Variable available to for the top 20 MSAs.
$X\% < LTV \leq Y\%$	An indicator to whether the loan-to-value of the loan is between X% and Y%.
Defaulted within 12 months	An indicator to whether the first transaction in the pair of transactions defaulted (90+ days past due) within a year.
Serious delinquency	An indicator to whether the second transaction in the pair of transactions considered had a serious delinquency (60+ days past due) in the second transaction.
FICO / 100 (at origination)	FICO credit score at the origination of the mortgage. (Variable is divided by 100)
LTV	The combined loan-to-value of the mortgage, ranging from 1 to 100.
Short-term ARM indicator	An indicator to whether the mortgage is a short-term (teaser period <= 3 years) adjustable rate mortgage (ARM).
Hybrid ARM indicator	An indicator to whether the mortgage is a hybrid adjustable rate mortgage (ARM). Teaser period can be 5, 7 or 10 years and rate resets every year after the teaser period.
Fixed rate 15-year mortgage (or 30 year)	An indicator to whether the mortgage is a 15-year (or 30-year) fixed rate mortgage.
Excess premium	The residual of a regression of the mortgage rate on mortgage characteristics.
Owner-occupier indicator	An indicator to whether the property is owned by an owner-occupier.
Debt-to-income ratio	Back end ratio: a ratio of the monthly housing expense plus other debt payments divided by monthly income.
Condo indicator	An indicator to whether the property is a condo (as opposed to a single- or multi-family home)
House-price index growth	Quarter-on-quarter house price growth in the Case-Shiller index for the MSA.
Valuation bias	The average appraisal in the MSA-quarter as estimated from a MSA-quarter-level regressions.

Appendix B. Average Transaction Prices, per Year

The table shows mean transaction values as well as standard deviation for the sample.

Year	Mean	Std Dev	Std Dev / Mean
1990	135,494	112,580	0.831
1991	135,385	108,875	0.804
1992	135,253	108,723	0.804
1993	134,127	103,223	0.770
1994	137,301	109,805	0.800
1995	137,806	120,539	0.875
1996	142,626	114,385	0.802
1997	151,019	134,668	0.892
1998	159,989	136,833	0.855
1999	170,833	159,458	0.933
2000	184,463	172,627	0.936
2001	193,177	170,325	0.882
2002	215,140	185,515	0.862
2003	238,301	202,831	0.851
2004	269,151	240,285	0.893
2005	300,360	267,254	0.890
2006	302,896	265,790	0.877
2007	297,378	278,456	0.936
2008	281,071	266,634	0.949
2009	251,064	236,599	0.942
2010	252,395	257,314	1.019
2011	246,820	266,506	1.080
Average			0.886

Table 1. Summary Statistics

The table presents summary statistics for the data used in the study.

Variable	N	Mean	Std dev	Min	Q25	Q50	Q75	Max
Prior sale price or appraised value (t = 0)	1,011,749	216,913	123,333	9,000	130,000	185,000	273,913	1,000,000
Sale price (t = 1)	1,011,749	240,879	141,850	9,000	140,000	205,000	304,000	1,000,000
Difference in std dev (%)	1,011,749	-4.765	24.205	-102.02	-16.85	-2.96	9.31	67.77
Total returns between transactions	1,011,749	9.418	29.867	-110.29	-1.73	10.71	26.30	85.02
Cash-out refi	1,011,749	0.250	0.433	0.00	0.00	0.00	1.00	1.00
Rate refi	1,011,749	0.339	0.474	0.00	0.00	0.00	1.00	1.00
Originated by third party	1,011,749	0.516	0.500	0.00	0.00	1.00	1.00	1.00
3-month local market returns	431,580	0.022	0.031	-0.15	0.01	0.02	0.04	0.22
CLTV $\leq$ 70%	1,011,749	0.298	0.457	0.00	0.00	0.00	1.00	1.00
70% < CLTV < 80%	1,011,749	0.194	0.396	0.00	0.00	0.00	0.00	1.00
CLTV = 80	1,011,749	0.184	0.388	0.00	0.00	0.00	0.00	1.00
80% < CLTV $\leq$ 85%	1,011,749	0.035	0.184	0.00	0.00	0.00	0.00	1.00
85% < CLTV $\leq$ 90%	1,011,749	0.114	0.318	0.00	0.00	0.00	0.00	1.00
90% < CLTV $\leq$ 95	1,011,749	0.105	0.307	0.00	0.00	0.00	0.00	1.00
95% < CLTV	1,011,749	0.069	0.254	0.00	0.00	0.00	0.00	1.00
Defaulted	1,011,749	0.121	0.326	0.00	0.00	0.00	0.00	1.00
Serious delinquency	1,011,749	0.144	0.351	0.00	0.00	0.00	0.00	1.00
FICO / 100 (at origination)	1,011,749	7.146	0.576	3.00	6.76	7.21	7.61	8.99
Combined LTV	1,011,749	0.758	0.167	0.03	0.68	0.80	0.90	1.00
Short-term ARM indicator	1,011,749	0.034	0.181	0.00	0.00	0.00	0.00	1.00
Hybrid ARM indicator	1,011,749	0.089	0.284	0.00	0.00	0.00	0.00	1.00
Fixed rate 15-year mortgage	1,011,749	0.187	0.390	0.00	0.00	0.00	0.00	1.00
Fixed rate 30-year mortgage	1,011,749	0.690	0.462	0.00	0.00	1.00	1.00	1.00
Excess premium	1,011,749	-0.009	0.749	-4.03	-0.51	-0.04	0.42	7.83
Owner-occupier indicator	1,011,749	0.945	0.228	0.00	1.00	1.00	1.00	1.00
Debt-to-income ratio	1,011,749	0.344	0.136	0.00	0.25	0.34	0.42	1.00
Condo indicator	1,011,749	0.042	0.201	0.00	0.00	0.00	0.00	1.00

Table 2. Estimating the Average Valuation Bias in Refinance transactions

The table explores the valuation bias at cash-out and rate/term refi transactions. Sample observations are based on pairs of transactions on the same property, where the dependent variable measures the difference in appraisals for the second minus the first transaction. *Defaulted* and *serious delinquency* indicators are dummies indicating whether the second transaction in the pair defaulted (foreclosure) or was at serious delinquency (90+ days past due). *Cash-out refi* and *Rate/term refi* indicators describe the first transaction in each pair. Mortgage controls include information about the first transaction. FICO credit score (at origination), combined loan-to-value (LTV), short-term ARM indicator, hybrid ARM indicator, fixed rate 15-year mortgage, fixed rate 30-year mortgage, excess premium, owner-occupier indicator, debt-to-income ratio, condo indicator, property size, property age. *MSA × YYQQ FE* are MSA-quarter fixed effects. There are MSA-quarter fixed effects for the first transaction in the each pair as well as for the second transaction. Variable definitions are in Appendix A. All regressions are OLS regressions. Standard errors are clustered at the calendar quarter level. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable:	Difference in standardized values (%)		
	(1)	(2)	(3)
Cash-out refi	-3.50***	-2.92***	-4.08***
	(-33.12)	(-28.14)	(-44.93)
Rate refi	-3.52***	-3.26***	-4.05***
	(-39.44)	(-36.44)	(-48.67)
Defaulted	-11.25***	-12.02***	-13.06***
	(-47.72)	(-52.77)	(-61.71)
Serious delinquency	-7.95***	-7.47***	-9.26***
	(-48.98)	(-45.65)	(-51.14)
FICO (at origination)		0.58***	0.37***
		(11.07)	(6.83)
Combined LTV		5.35***	12.91***
		(20.43)	(54.35)
Short-term ARM indicator		-1.03***	-1.91***
		(-7.23)	(-12.23)
Hybrid ARM indicator		0.56***	-1.55***
		(5.40)	(-14.98)
Fixed rate 15-year mortgage		2.20***	2.97***
		(26.06)	(35.92)
Fixed rate 30-year mortgage		1.71***	0.53***
		(16.31)	(5.25)
Excess premium		-0.65***	0.01
		(-12.47)	(0.28)
Owner-occupier indicator		-4.19***	-4.77***
		(-35.84)	(-37.12)
Debt-to-income ratio		-0.67**	-2.77***
		(-3.28)	(-12.76)
Condo indicator		1.61***	-0.67***
		(9.62)	(-4.84)
MSA × YYQQ (first transaction) FE	No	No	Yes
MSA × YYQQ (second transaction) FE	No	No	Yes
Observations	1,011,749	1,011,749	1,011,749
Adj R^2	0.068	0.072	0.390

Table 3. Valuation Bias and Borrower Leverage

The table explores the valuation bias with respect to borrower leverage. Sample observations are based on pairs of transactions on the same property, where the dependent variable measures the difference in appraisals for the second minus the first transaction. *Defaulted* and *serious delinquency* indicators are dummies indicating whether the second transaction in the pair defaulted (foreclosure) or was at serious delinquency (90+ days past due). *Cash-out refi* and *Rate/term refi* indicators describe the first transaction in each pair. Mortgage controls include information about the first transaction. FICO credit score (at origination), combined loan-to-value (LTV), short-term ARM indicator, hybrid ARM indicator, fixed rate 15-year mortgage, fixed rate 30-year mortgage, excess premium, owner-occupier indicator, debt-to-income ratio, condo indicator, property size, property age. *MSA × YYQQ FE* are MSA-quarter fixed effects. There are MSA-quarter fixed effects for the first transaction in the each pair as well as for the second transaction. Variable definitions are in Appendix A. All regressions are OLS regressions. Standard errors are clustered at the calendar quarter level. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: Difference in standardized values (%)			
	(1)	(2)	(3)
Cash-out refi			
× CLTV ≤ 70%	0.06	0.22***	-0.61***
	(1.11)	(3.90)	(-3.73)
× 70% < CLTV < 80%	0.10	0.01	-2.18***
	(1.66)	(0.09)	(-11.22)
× CLTV = 80%	-0.35***	-0.39***	-2.86***
	(-5.03)	(-5.02)	(-13.00)
× 80% < CLTV ≤ 85%	-0.65***	-0.59***	-2.85***
	(-5.36)	(-4.60)	(-8.47)
× 85% < CLTV ≤ 90%	-0.84***	-0.72***	-2.52***
	(-9.44)	(-7.05)	(-8.99)
× 90% < CLTV ≤ 95%	-1.39***	-0.78*	-3.24***
	(-4.27)	(-2.34)	(-3.98)
× 95% < CLTV	-3.79***	-2.91***	-7.32***
	(-6.24)	(-4.78)	(-4.69)
Rate refi			
× CLTV ≤ 70%	-2.03***	0.85***	-0.50***
	(-16.27)	(6.41)	(-3.72)
× 70% < CLTV < 80%	-3.11***	-2.37***	-3.44***
	(-28.59)	(-21.43)	(-30.32)
× CLTV = 80%	-5.56***	-5.18***	-5.66***
	(-42.91)	(-40.04)	(-40.97)
× 80% < CLTV ≤ 85%	-6.02***	-5.87***	-6.24***
	(-34.20)	(-33.36)	(-31.93)
× 85% < CLTV ≤ 90%	-5.16***	-5.53***	-5.88***
	(-37.91)	(-40.60)	(-40.40)
× 90% < CLTV ≤ 95%	-4.53***	-5.46***	-5.31***
	(-24.10)	(-28.90)	(-25.83)
× 95% < CLTV	-3.32***	-5.11***	-6.26***
	(-6.53)	(-10.02)	(-11.32)
Defaulted + Serious delinquency indicators	Yes	Yes	Yes
Mortgage controls	No	Yes	Yes
MSA × YYQQ (first transaction) FE	No	No	Yes
MSA × YYQQ (second transaction) FE	No	No	Yes
Observations	1,011,749	1,011,749	1,011,749
Adj R^2	0.069	0.076	0.392

Table 4. Determinants of Valuation Bias

The table explores the determinants of the valuation bias. Sample observations are based on pairs of transactions on the same property, where the dependent variable measures the difference in appraisals for the second minus the first transaction. *Defaulted* and *serious delinquency* indicators are dummies indicating whether the second transaction in the pair defaulted (foreclosure) or was at serious delinquency (90+ days past due). *Cash-out refi* and *Rate/term refi* indicators describe the first transaction in each pair. Mortgage controls include information about the first transaction. FICO credit score (at origination), combined loan-to-value (LTV), short-term ARM indicator, hybrid ARM indicator, fixed rate 15-year mortgage, fixed rate 30-year mortgage, excess premium, owner-occupier indicator, debt-to-income ratio, condo indicator, property size, property age. *MSA × YYQQ FE* are MSA-quarter fixed effects. There are MSA-quarter fixed effects for the first transaction in the each pair as well as for the second transaction. Variable definitions are in Appendix A. All regressions are OLS regressions. Standard errors are clustered at the calendar quarter level. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Third Party Origination and Lender Fixed Effects

Dependent variable:	Difference in standardized values (%)		
	(1)	(2)	(3)
Cash-out refi	-2.82***	-1.49***	-1.41***
	(-26.31)	(-33.07)	(-33.57)
x Third Party Originator	-2.25***		
	(-20.83)		
Rate refi	-2.57***	-0.39***	-0.07
	(-26.17)	(-9.32)	(-1.71)
x Third Party Originator	-2.85***		
	(-28.71)		
MSA × YYQQ (first transaction) FE	Yes	Yes	Yes
MSA × YYQQ (second transaction) FE	Yes	Yes	Yes
Lender × YYQQ (first transaction) FE	No	Yes	Yes
Lender × MSA × Year (first transaction) FE	No	Yes	Yes
Observations	1,011,749	1,011,749	1,011,749
Adj R^2	0.335	0.071	0.085

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Table 4. Determinants of Valuation Bias (Cont.)

Panel B: Jumbo-Loan Cutoff

Dependent variable:	Difference in standardized values (%)			
Sample restriction (% of loan limit):	0%-85%	85%-95%	95%-98%	98%-100%
	(1)	(2)	(3)	(4)
Cash-out refi	-4.20***	-3.02***	-3.05***	-0.83
	(-45.50)	(-6.77)	(-3.48)	(-0.99)
Rate refi	-4.14***	-3.24***	-2.69**	-2.25**
	(-49.51)	(-7.87)	(-3.11)	(-2.74)
Defaulted + Serious delinquency indicators	Yes	Yes	Yes	Yes
Mortgage controls	Yes	Yes	Yes	Yes
MSA × YYQQ (first transaction) FE	Yes	Yes	Yes	Yes
MSA × YYQQ (second transaction) FE	Yes	Yes	Yes	Yes
Observations	920,388	47,796	11,282	13,142
Adj R^2	0.088	0.074	0.079	0.053

Table 5. Borrower Default and Valuation Bias

The table explores the valuation bias across MSAs according to their price growth during the bubble period 2001-2006. MSAs are sorted to three categories according to their ex post growth between 2000 and 2006. Sample observations are based on pairs of transactions on the same property, where the dependent variable measures the difference in appraisals for the second minus the first transaction. *Defaulted* and *serious delinquency* indicators are dummies indicating whether the second transaction in the pair defaulted (foreclosure) or was at serious delinquency (90+ days past due). *Cash-out refi* and *Rate/term refi* indicators describe the first transaction in each pair. Mortgage controls include information about the first transaction. FICO credit score (at origination), combined loan-to-value (LTV), short-term ARM indicator, hybrid ARM indicator, fixed rate 15-year mortgage, fixed rate 30-year mortgage, excess premium, owner-occupier indicator, debt-to-income ratio, condo indicator, property size, property age. *MSA × YYQQ FE* are MSA-quarter fixed effects. There are MSA-quarter fixed effects for the first transaction in the each pair as well as for the second transaction. Variable definitions are in Appendix A. All regressions are OLS regressions. Standard errors are clustered at the calendar quarter level. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable:	Defaulted within 12 months (0/1) × 100			
	Main test		Placebo	
	Stage 1	Stage 2	Stage 1	Stage 2
	(1)	(2)	(3)	(4)
Observed CLTV				
70< CLTV <80	0.06***			-0.01***
	(8.86)			(-6.09)
CLTV = 80	0.12***			-0.01***
	(16.24)			(-3.34)
80< CLTV <=85	0.16***			-0.01
	(15.59)			(-1.77)
85< CLTV <=90	0.23***			-0.01***
	(23.55)			(-4.07)
90< CLTV <=95	0.30***			-0.00
	(26.02)			(-0.47)
95< CLTV <=100	0.62***			0.13***
	(43.86)			(21.56)

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Table 5. Borrower Default and Valuation Bias (Cont.)

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Dependent variable:	Defaulted within 12 months (0/1) × 100			
	Main test		Placebo	
	Stage 1	Stage 2	Stage 1	Stage 2
	(1)	(2)	(3)	(4)
…				
Recalculated CLTV				
70< CLTV <80		-0.01***	0.04***	
		(-4.61)	(5.86)	
CLTV = 80		-0.01*	0.06***	
		(-2.49)	(6.84)	
80< CLTV <=85		-0.02***	0.07***	
		(-8.84)	(8.68)	
85< CLTV <=90		-0.01*	0.14***	
		(-2.04)	(15.22)	
90< CLTV <=95		0.01*	0.21***	
		(2.30)	(19.74)	
95< CLTV <=100		0.08***	0.46***	
		(15.50)	(37.41)	
100< CLTV <=105		0.09***	0.39***	
		(8.62)	(21.95)	
105< CLTV <=110		0.13***	0.49***	
		(5.44)	(15.76)	
110< CLTV		0.16***	0.52***	
		(4.64)	(11.68)	
Other controls	Yes	No	Yes	No
MSA × YYQQ	Yes	No	Yes	No
Observations	1,011,749	1,011,749	1,011,749	1,011,749
Pseudo-R^2	0.140	0.002	0.140	0.003

Table 6. Mortgage Interest and Valuation Bias

The table explores the valuation bias across MSAs according to their price growth during the bubble period 2001-2006. MSAs are sorted to three categories according to their ex post growth between 2000 and 2006. Sample observations are based on pairs of transactions on the same property, where the dependent variable measures the difference in appraisals for the second minus the first transaction. *Defaulted* and *serious delinquency* indicators are dummies indicating whether the second transaction in the pair defaulted (foreclosure) or was at serious delinquency (90+ days past due). *Cash-out refi* and *Rate/term refi* indicators describe the first transaction in each pair. Mortgage controls include information about the first transaction. FICO credit score (at origination), combined loan-to-value (LTV), short-term ARM indicator, hybrid ARM indicator, fixed rate 15-year mortgage, fixed rate 30-year mortgage, excess premium, owner-occupier indicator, debt-to-income ratio, condo indicator, property size, property age. *MSA × YYQQ FE* are MSA-quarter fixed effects. There are MSA-quarter fixed effects for the first transaction in the each pair as well as for the second transaction. Variable definitions are in Appendix A. All regressions are OLS regressions. Standard errors are clustered at the calendar quarter level. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable:	Interest rate (%)			
	Main test		Placebo	
	Stage 1	Stage 2	Stage 1	Stage 2
	(1)	(2)	(3)	(4)
Observed CLTV				
70< CLTV <80	0.05***			0.00
	(18.62)			(1.32)
CLTV = 80	0.10***			0.00
	(31.26)			(0.39)
80< CLTV <=85	0.19***			0.01
	(38.60)			(1.38)
85< CLTV <=90	0.25***			-0.02***
	(59.69)			(-6.91)
90< CLTV <=95	0.34***			-0.00
	(69.92)			(-1.07)
95< CLTV <=100	0.51***			0.04***
	(92.43)			(11.14)

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Table 6. Mortgage Interest and Valuation Bias (Cont.)

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Dependent variable:	Interest rate (%)			
	Main test		Placebo	
	Stage 1	Stage 2	Stage 1	Stage 2
	(1)	(2)	(3)	(4)
…				
Recalculated CLTV				
70< CLTV <80		-0.01**	0.03***	
		(-2.91)	(12.54)	
CLTV = 80		-0.01*	0.04***	
		(-2.20)	(11.17)	
80< CLTV <=85		-0.00	0.09***	
		(-0.82)	(26.95)	
85< CLTV <=90		0.00	0.18***	
		(1.27)	(45.10)	
90< CLTV <=95		0.01*	0.28***	
		(1.98)	(61.80)	
95< CLTV <=100		0.01**	0.42***	
		(3.18)	(82.23)	
100< CLTV <=105		0.11***	0.46***	
		(11.80)	(45.93)	
105< CLTV <=110		0.22***	0.63***	
		(11.80)	(32.57)	
110< CLTV		0.39***	0.78***	
		(11.46)	(23.11)	
Other controls	Yes	No	Yes	No
MSA × YYQQ	Yes	No	Yes	No
Observations	1,011,749	1,011,749	1,011,749	1,011,749
Adj-R^2	0.056	0.001	0.057	0.000

Table 7. Time Series of Valuation Bias

The table explores the valuation bias over time. The sample includes all pairs of transactions where the first transaction took place during the sample period. Sample observations are based on pairs of transactions on the same property, where the dependent variable measures the difference in appraisals for the second minus the first transaction. *Defaulted* and *serious delinquency* indicators are dummies indicating whether the second transaction in the pair defaulted (foreclosure) or was at serious delinquency (90+ days past due). *Cash-out refi* and *Rate/term refi* indicators describe the first transaction in each pair. Mortgage controls include information about the first transaction. FICO credit score (at origination), combined loan-to-value (LTV), short-term ARM indicator, hybrid ARM indicator, fixed rate 15-year mortgage, fixed rate 30-year mortgage, excess premium, owner-occupier indicator, debt-to-income ratio, condo indicator, property size, property age. *MSA × YYQQ FE* are MSA-quarter fixed effects. There are MSA-quarter fixed effects for the first transaction in the each pair as well as for the second transaction. Variable definitions are in Appendix A. All regressions are OLS regressions. Standard errors are clustered at the calendar quarter level. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

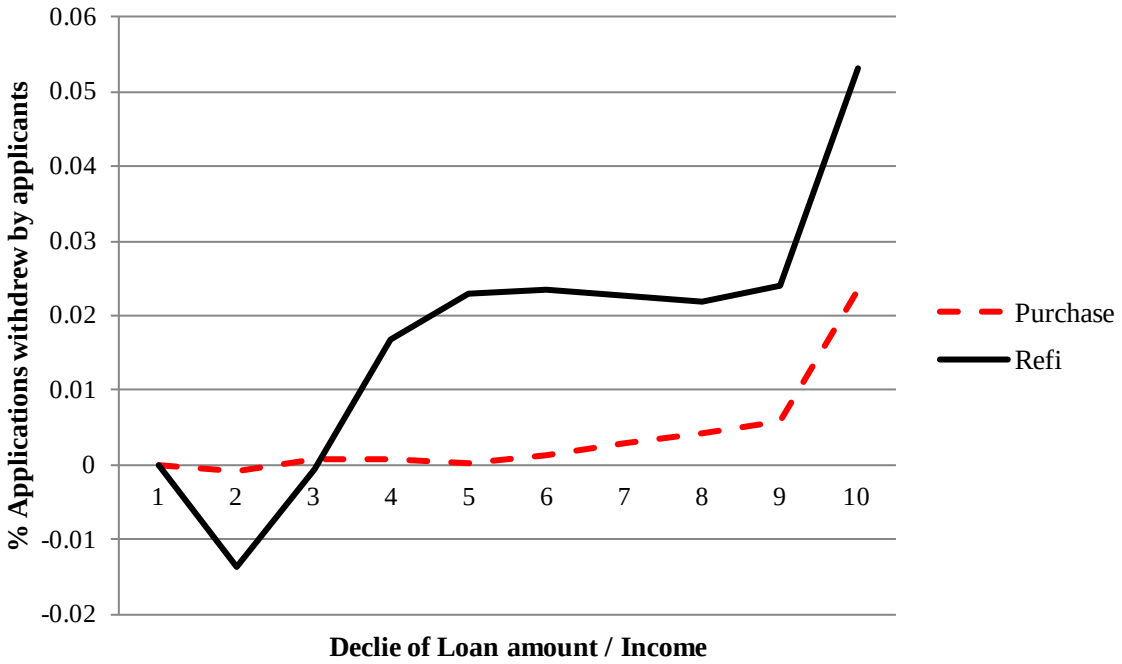
Dependent variable:	Difference in standardized values (%)							
Sample (first transaction):	1990-2000	2001	2002	2003	2004	2005	2006	2007-2011
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cash-out refi	-0.69***	-1.44***	-1.95***	-2.05***	-2.66***	-3.14***	-4.93***	-6.87***
	(-6.31)	(-8.42)	(-12.14)	(-14.18)	(-15.18)	(-17.35)	(-24.16)	(-39.85)
Rate refi	-1.60***	-1.71***	-1.91***	-1.81***	-2.16***	-2.56***	-5.49***	-7.70***
	(-17.67)	(-10.67)	(-13.41)	(-13.93)	(-12.84)	(-12.64)	(-22.07)	(-45.30)
Defaulted + Serious delinquency indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mortgage controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MSA × YYQQ (first transaction) FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MSA × YYQQ (second transaction) FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	273,227	86,171	125,523	213,524	87,470	70,844	55,695	99,295
Adj R^2	0.364	0.379	0.375	0.368	0.397	0.439	0.479	0.468

Table 8. Valuation Bias Across MSAs, by Price Growth 2000-2006

The table explores the valuation bias across MSAs according to their price growth during the bubble period 2001-2006. MSAs are sorted to three categories according to their ex post growth between 2000 and 2006. Sample observations are based on pairs of transactions on the same property, where the dependent variable measures the difference in appraisals for the second minus the first transaction. *Defaulted* and *serious delinquency* indicators are dummies indicating whether the second transaction in the pair defaulted (foreclosure) or was at serious delinquency (90+ days past due). *Cash-out refi* and *Rate/term refi* indicators describe the first transaction in each pair. Mortgage controls include information about the first transaction. FICO credit score (at origination), combined loan-to-value (LTV), short-term ARM indicator, hybrid ARM indicator, fixed rate 15-year mortgage, fixed rate 30-year mortgage, excess premium, owner-occupier indicator, debt-to-income ratio, condo indicator, property size, property age. *MSA × YYQQ FE* are MSA-quarter fixed effects. There are MSA-quarter fixed effects for the first transaction in the each pair as well as for the second transaction. Variable definitions are in Appendix A. All regressions are OLS regressions. Standard errors are clustered at the calendar quarter level. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable:	Difference in standardized values (%)		
MSA growth:	Low	Mid	High
	(1)	(2)	(3)
Cash-out refi	-0.58***	-1.42***	-1.81***
	(-4.34)	(-9.58)	(-9.29)
Rate refi	-1.06***	-1.08***	-2.25***
	(-8.89)	(-7.67)	(-13.69)
Defaulted + Serious delinquency indicators	Yes	Yes	Yes
Mortgage controls	Yes	Yes	Yes
MSA × YYQQ (first transaction) FE	Yes	Yes	Yes
MSA × YYQQ (second transaction) FE	Yes	Yes	Yes
Observations	186,051	129,046	125,094
Adj R^2	0.379	0.391	0.409

Figure 1. Withdrawal Rates by Leverage



The figure shows the withdrawal rates by leverage of mortgage applicants. The data used is HMDA data for 2006, and the figure presents coefficients from regressions by loan purpose of withdrawal (0/1) on leverage decile indicators and controls loan type, and property type. Leverage is defined as loan / income. Standard errors are at the magnitude of 0.0003.