Internet Appendix For "Collateral Misreporting in the RMBS Market"

A Data description, model calibration details, and supplemental analysis

A.1 New Century-ABSNet matching description

We merge funded first-lien loans associated with single-unit properties in New Century data with those loans in ABSNet whose originator is either New Century Mortgage Corporation or its subsidiary, Home123 Corporation. We keep loans for which the lien position or the number of units in the underlying property are missing. This results in initial samples of 952,289 loans in the New Century data and 577,899 loans in ABSNet. We first match the loans based on their zip code, first payment date, interest rate type (fixed- or adjustable-rate mortgage), and purpose of transaction (purchase or refinance). Second, we require the New Century's status date to be within 30 days from the loan origination date in ABSNet, and loan amounts and credit scores to be within a $1,000 and 10 points, respectively. Third, we only consider the remaining loan pairs a match when it is unique. This procedure results in 363,623 unique matches, which represents 38.2% on the initial New Century data sample. Restricting the sample based on the criteria described in Section 1.1 results in a sample of 70,325 matched loans, which are described in Table IA.**1**.

To confirm the accuracy of our matching procedure, we repeat the matching exercise with all loans in ABSNet regardless of their originator. Using this methodology, we match 468,676 pairs of loans. Of the 363,623 pairs that we obtained through the original matching, 363,434 (99.95%) coincide with those obtained through the less restrictive matching procedure, which provides reassurance about the accuracy of the database merge.

A.2 Pool selection and pool data calculation description

The unit of observation for our RMBS analysis is the RMBS deal pool, which is a pool of loans that support a specific set of securities within a RMBS deal. For deals with a "Y" structure, we conduct our analysis at the more general loan pool level corresponding to the subordinated securities. From the ABSNet loan data, we calculate pool-level average appraisal difference, percent of refinance loans with round LTV, and control variables, including average FICO score, average CLTV ratio, percentage of loans with low or no documentation, and percentage of loans that are refinance. Like Piskorski, Seru, and Witkin (2015), we restrict our sample to loan pools with at least 25% of loans in our loan sample. In addition, we only consider loan pools for which at least 95% of the underlying loans have both FICO score and CLTV ratio information. Our regressions also control for deal year and fixed effects for the top six underwriters in the sample. The remaining underwriters, which jointly correspond to 247 pools, are grouped together.

We use ABSNet pool and security data to calculate pool-level losses and pricing. Losses are pool-level cumulative realized losses as of September 2014 as a percent of the pool's original balance. Yield spreads are average floating rate interest margins across all of the securities supported by the pool. Because this data is limited to floating rate securities, we limit our analysis to pools in which at least 90% of pool security value comes from floating rate securities with available interest rate margin data. AAA subordination is the fraction of the security balance in the pool that is subordinated to the AAA securities. We calculate this as the minimum subordination of any AAA security in the pool. Security-level credit ratings come from Standard & Poor's, supplemented by Moody's. Because we need credit ratings for this calculation, we limit our analysis to pools in which we have credit ratings for at least 90% of the security value in the pool.

As a control variable, we also collect pool-level overcollateralization. Overcollateralization is based on the difference between subordination and total credit support. We also compute overcollateralization based on reported overcollateralization tranches with similar results.

To eliminate outliers and potential errors in the data, we drop pools with losses, yield spreads, or AAA subordination above the 95^{th} percentile and require pools to have data on all three outcome variables. This results in a sample of 694 loan pools, which come from 681 deals and contain 2.6 million underlying loans. Because we require coverage in our data for

25% of the loans in the pool and round LTV targeting is only relevant for refinance loans, whereas appraisal differences are relevant for both purchase and refinance loans, the sample size for round LTV targeting is 517 pools as opposed to 694 pools.

A.3 Model calibration

We follow Demiroglu and James (2018) and model *Appraisal* and *AVM* errors as bivariate normal random variables with means equal to true property values and error standard deviations that are equal to one another with correlations of 0.25 and 0.5 respectively for refinance and purchase loans. We calibrate the standard deviations of *Appraisal* and *AVM* such that simulated appraisal difference standard deviations for refinance and purchase loans match the empirical appraisal difference standard deviations reported in Table **1**. The calibrated valuation error standard deviations are 24.3% for refinance loans and 21.3% for purchase loans. The means of *Appraisal* and *AVM* are irrelevant to the simulation because they do not affect appraisal difference calculations. The only difference between Demiroglu and James's (2018) simulation and ours is that we calibrate appraisal and AVM standard deviations so that simulated appraisal difference standard deviations match empirical appraisal difference standard deviations, whereas Demiroglu and James use standard deviations provided by their AVM source.

To model selection, we again follow Demiroglu and James (2018) and assume that loan completion probability is 100% if an appraisal is above the property's true value and is otherwise $max(0, 1 - \beta(V - max(0, A))/V)$, where A represents the appraisal value and V represents the property's true value (which can be normalized to one). The two maximum operators ensure that appraisals and completion probabilities never fall below zero. In practice, they rarely bind and are not important. Intuitively, loan completion probability falls as appraisal value decreases relative to a property's true value. The parameter β is calibrated such that the simulation generates a targeted denial rate, which is based on observed HMDA denial rates.

In our baseline simulations, we follow Demiroglu and James (2018) and assume that denial rates are equal to observed HMDA denial rates for collateral insufficiency. HMDA denial rates are based on matching sample loans to HMDA averages by zip code, loan purpose, and year. As reported in Table **1** the matched HMDA collateral-insufficiency denial rates for our sample are 2.5% for refinance loans and 1.7% for purchase loans. Our baseline simulations are calibrated to match these denial rates. In the simulations, collateral insufficiency is the only reason a loan is not completed, whereas in the data loan applications can be denied or withdrawn for other reasons. Calibrating the simulation to match observed collateral denial rates implicitly makes the assumption that loans are first denied for collateral-insufficiency reasons (thereby determining the appraisal difference distribution) and then complete or fail based on reasons unrelated to appraisals. Denial rates in the model and in the HMDA data are expressed as a percentage of loan applications. The 17.5% denial rate at the high end of our simulations corresponds to 21.2% of completed loans.

Our selection bias results differ from Demiroglu and James (2018) primarily because we focus on measures of appraisal differences that have an expected value of zero in the bias-free benchmark. In Table IA.**6** we report calibration parameters and additional moments, including mean levels of $(A-AVM)/AVM$ and the fraction of loans with $(A-AVM)/AVM$ above 20% and below -20%. Simulations of those statistics are closer to their empirical counterparts, consistent with the results of Demiroglu and James. We also observe HMDA collateral denial rates that are somewhat lower than those reported by Demiroglu and James (e.g., 2.5% compared to 6.5% for refinance collateral denials and 1.7% vs. 1.9% for purchase collateral denials), in part because we consider the period between 2001 and 2007, as opposed to only 2006 and 2007, when collateral denial rates were higher. Sensitivity analysis indicates that these differences are not important.

A.4 Below-price appraisals

To assess subsequent business after producing a below-price appraisal, we match below price appraisals to at-or-above-price appraisals in the same quarter, in the same CBSA, by appraisers with the same number of appraisals in that quarter and the same number of past appraisals. This analysis is based on all first lien purchase loan appraisals in the full New Century data, including appraisals for unfunded loan applications. We then track subsequent appraisal business for the low appraisal and matched control appraisers over the next eight quarters. Panel A of Figure IA.16 plots the results.

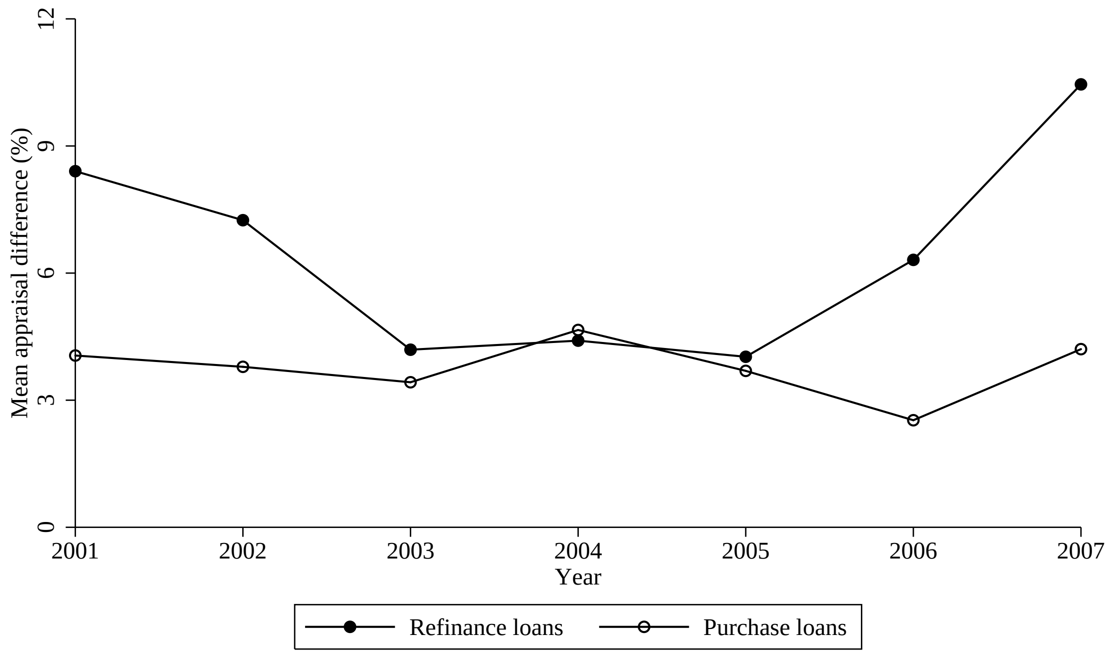
By construction the low appraisal and control appraisers have similar experience. This results in nearly identical appraisal counts in quarters -4 to -1. In the quarter of the low appraisal both groups have exactly the same number of appraisals by construction. Because the event quarter has significantly elevated appraisals by construction (specifically, 1.95 appraisals in Panel A of Figure IA.16), we omit this quarter to make the scale of the plot easier to interpret. During the 8 quarters after the below-price appraisal, low appraisers experience reduced appraisal business relative to control appraisers.

In Panel B of Figure IA.16 we consider how a below-price appraisal impacts inexperienced appraisers (defined as appraisers with no New Century appraisals during any previous quarter) compared to experienced appraisers. Having a past track record may decrease an appraiser's sensitivity to low appraisals. Consistent with this prediction, inexperienced appraisers experience significantly reduced business after below-price appraisals whereas experienced low appraisers' subsequent business is similar to the control group.

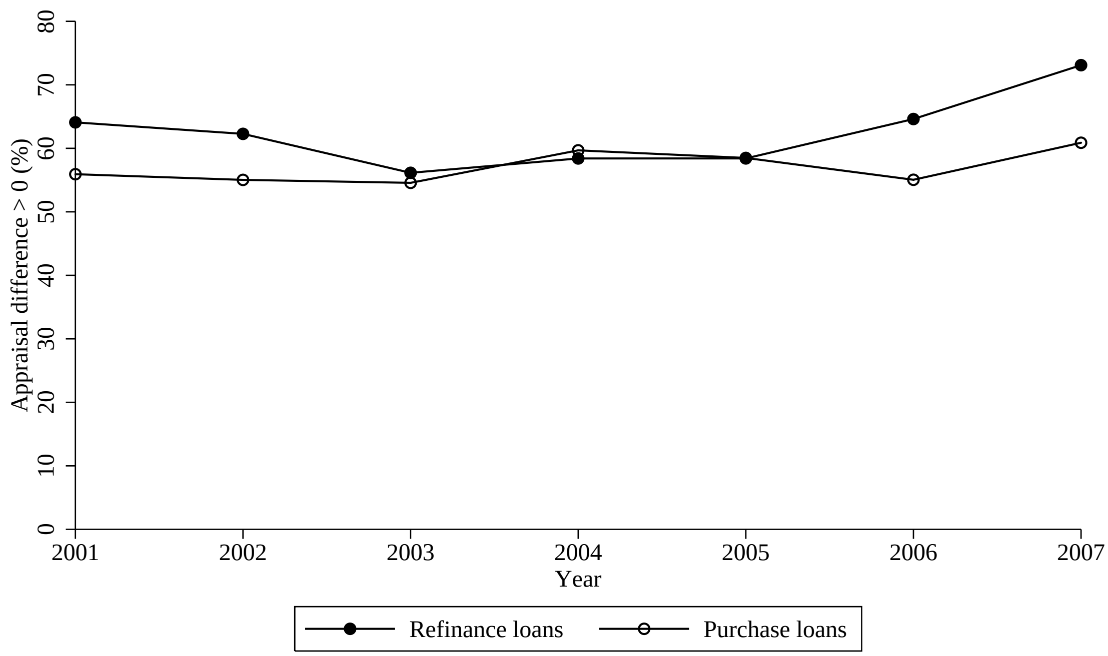
B Supplemental figures and tables

Figure IA.1. **Time-series of appraisal differences**

Panel A: Mean appraisal difference



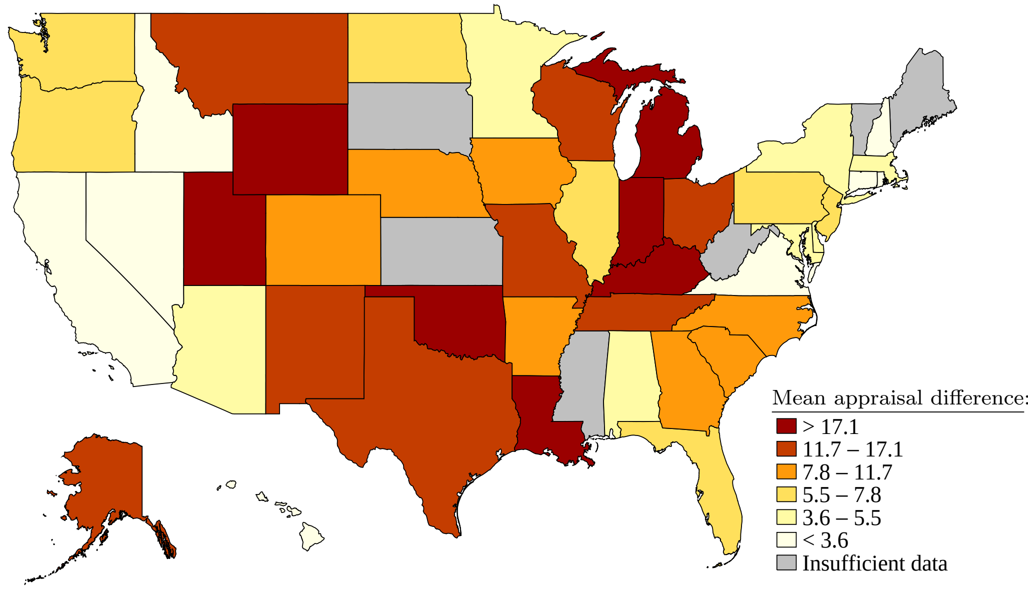
Panel B: Appraisal difference greater than zero



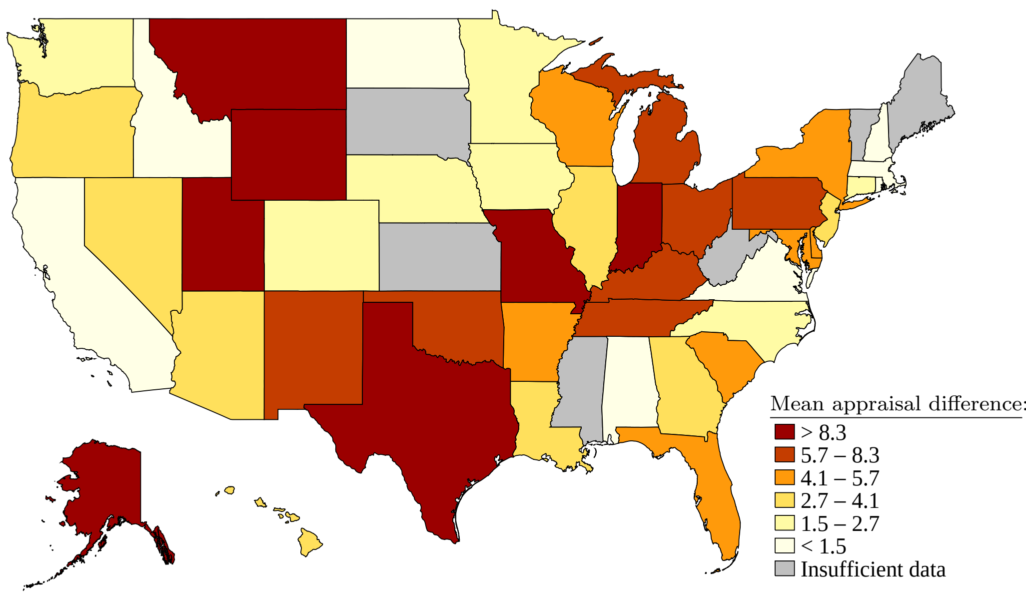
This figure plots the mean appraisal difference and the fraction of loans with an appraisal difference greater than zero for refinance loans and purchase loans by year. Appraisal difference is defined as the difference between appraised value and AVM value, divided by the average of both values.

Figure IA.2. **Geographic distribution of appraisal differences**

Panel A: Refinance loans

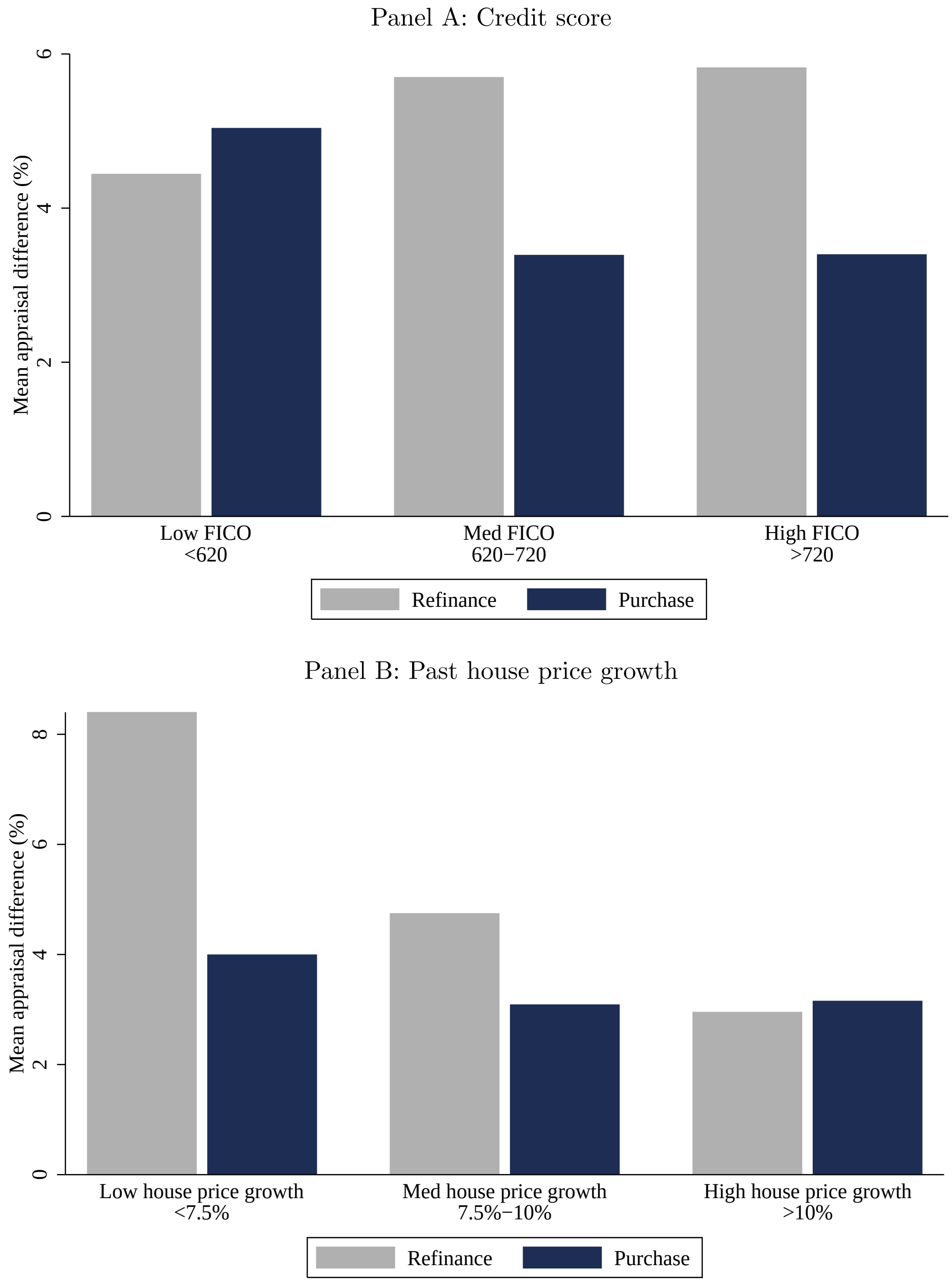


Panel B: Purchase loans



This figure plots average appraisal differences for refinance loans and purchase loans by state. Appraisal difference is defined as the difference between appraised value and AVM value, divided by the average of both values. States with less than one hundred observations are omitted.

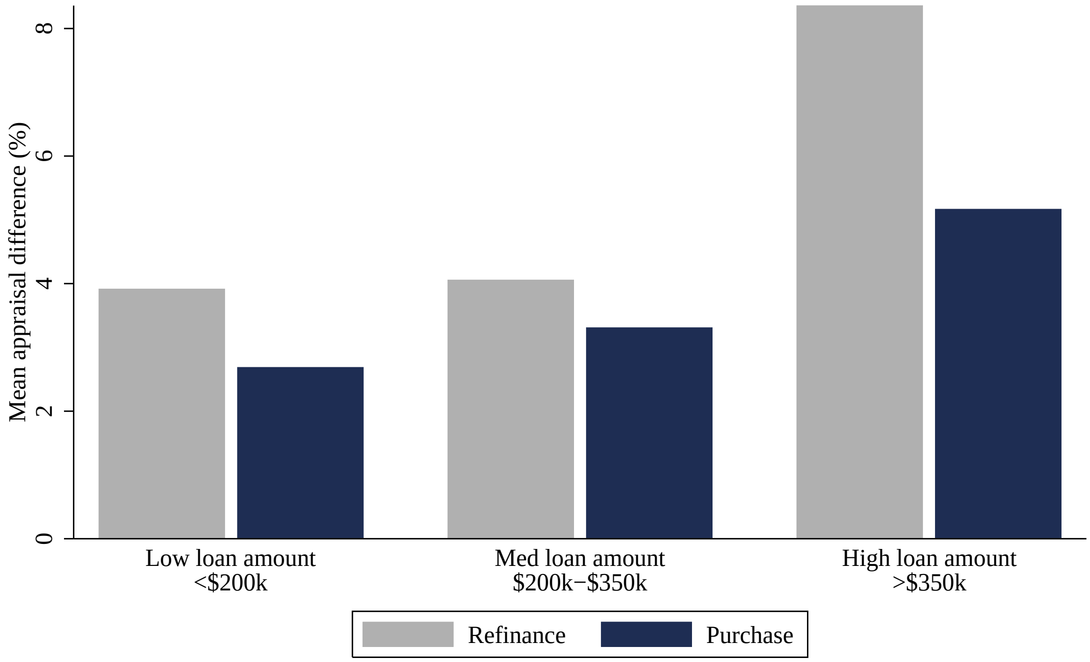
Figure IA.3. Appraisal difference by loan characteristics



This figure plots the average appraisal difference by credit score at origination, zip code-level house price growth from 2001 to 2007 (from Zillow), loan amount, zip code-level income in 2001 (from the SOI IRS database), zip code-level population density (from the 2000 Decennial Census), and zip code-level house market liquidity (measured as the number of purchase transactions reported by DataQuick in the loan's zip code during the 12 months prior to loan origination month). Appraisal difference is the difference between appraised value and AVM value, divided by the average of both values.

Figure IA.3 (continued). Appraisal difference by loan characteristics

Panel C: Loan amount



Panel D: Household income

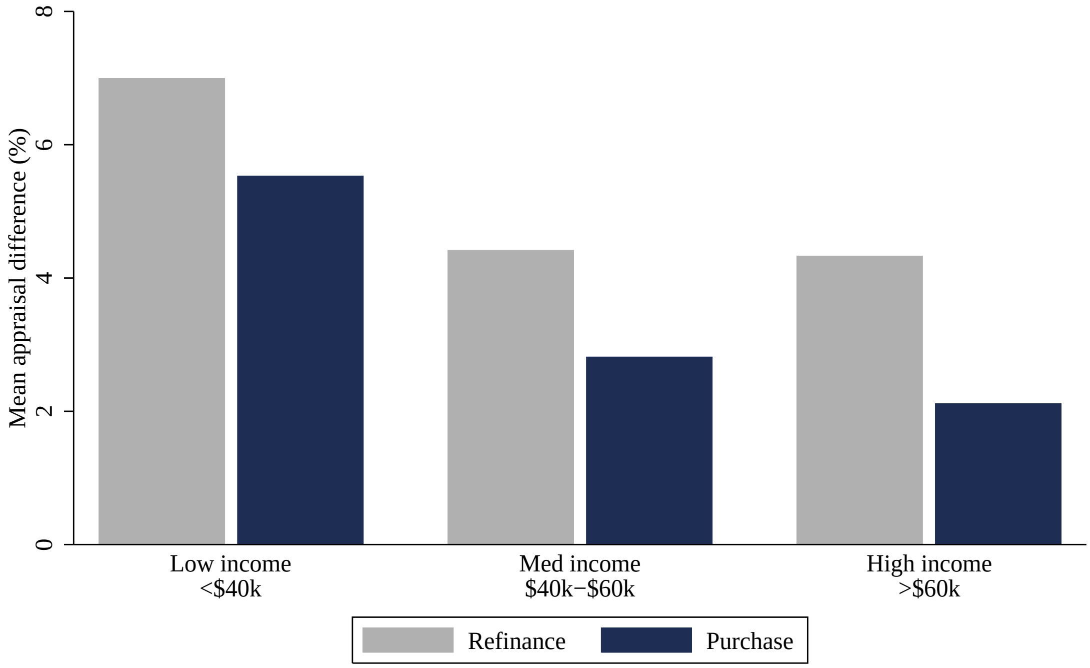
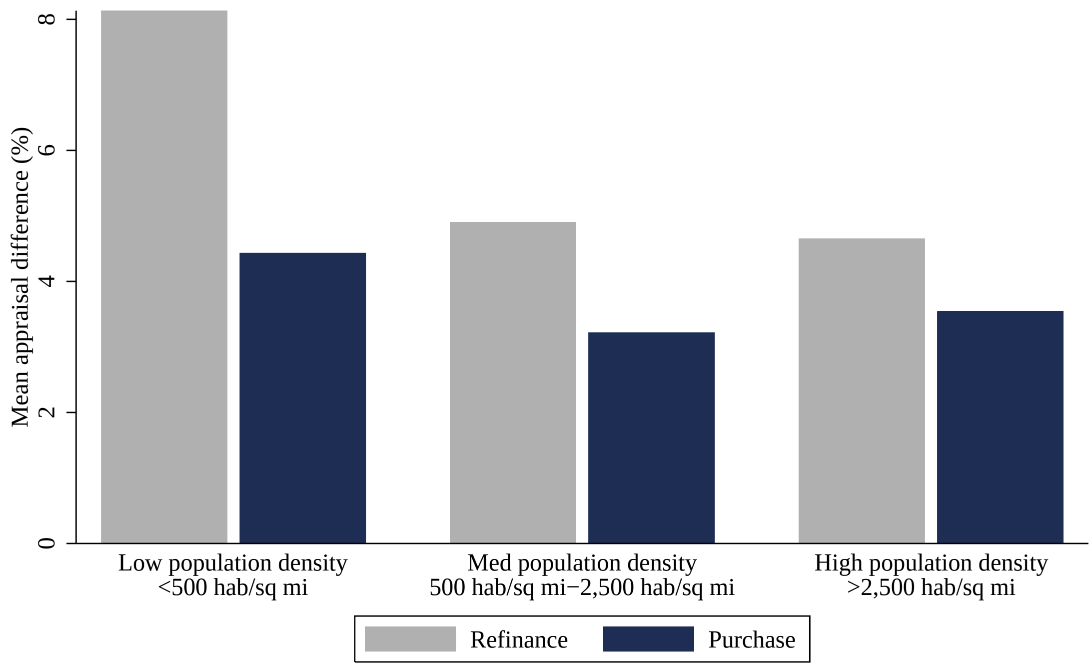


Figure IA.3 (continued). Appraisal difference by loan characteristics

Panel E: Population density



Panel F: House market liquidity

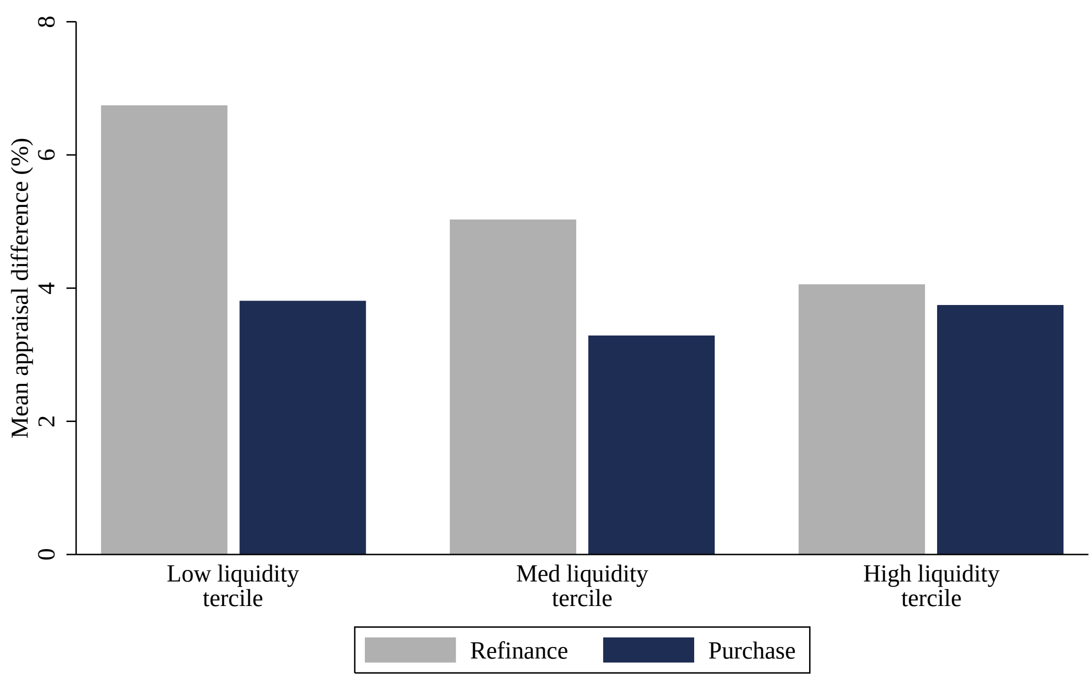
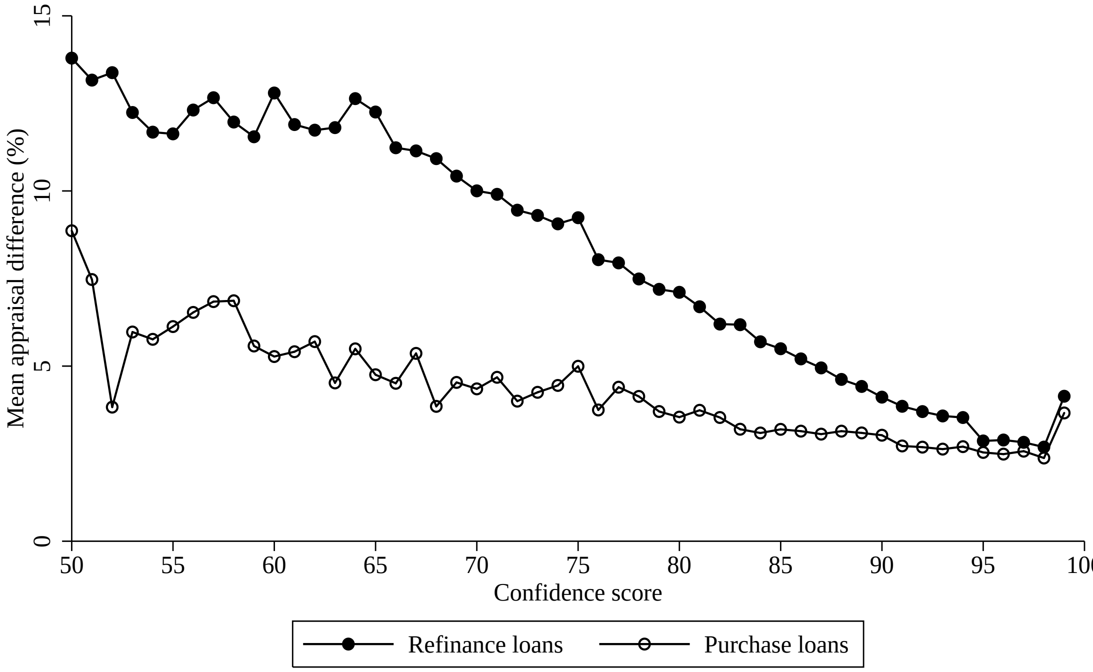


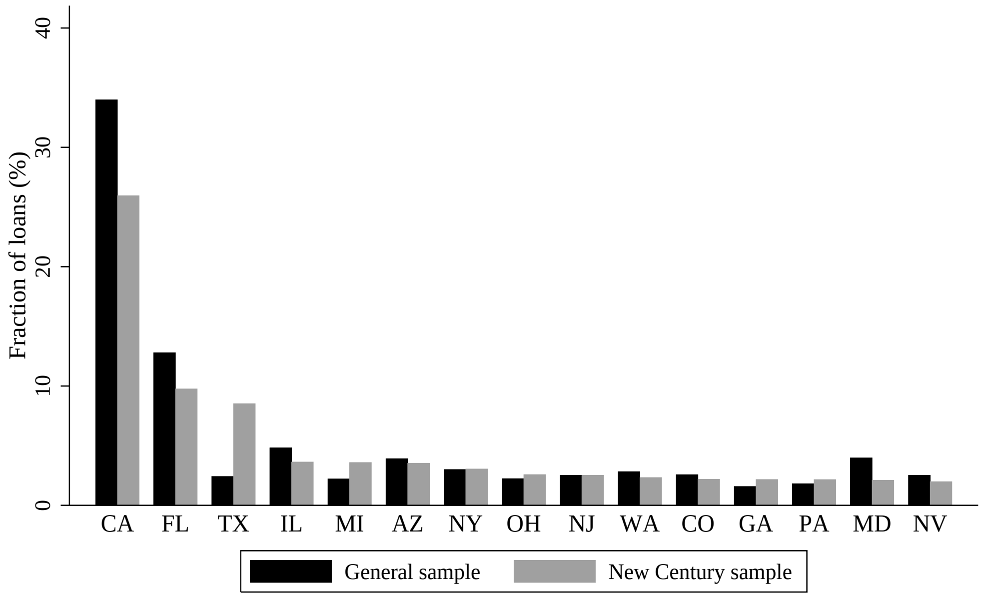
Figure IA.4. Appraisal difference by confidence score



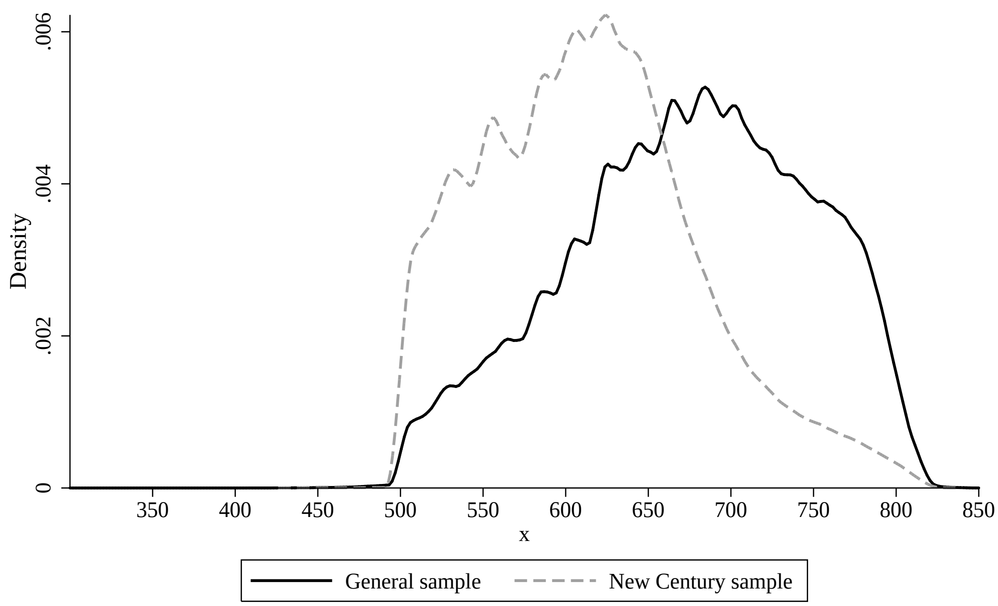
This figure plots the mean appraisal difference for refinance loans and purchase loans by AVM confidence score. Appraisal difference is the difference between appraised value and AVM value, divided by the average of both values.

Figure IA.5. Comparison of New Century and general sample loans

Panel A: Geographic distribution

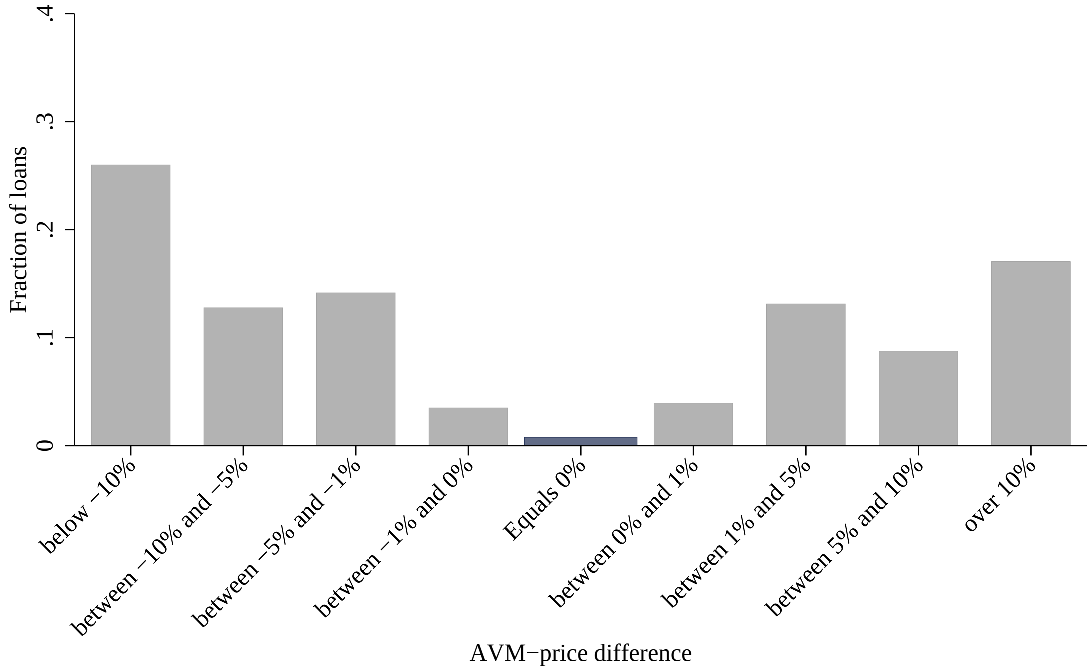


Panel B: FICO score distribution



This figure compares the geographic distributions (Panel A) and the FICO score distributions (Panel B) of New Century loans and the loans in the general sample.

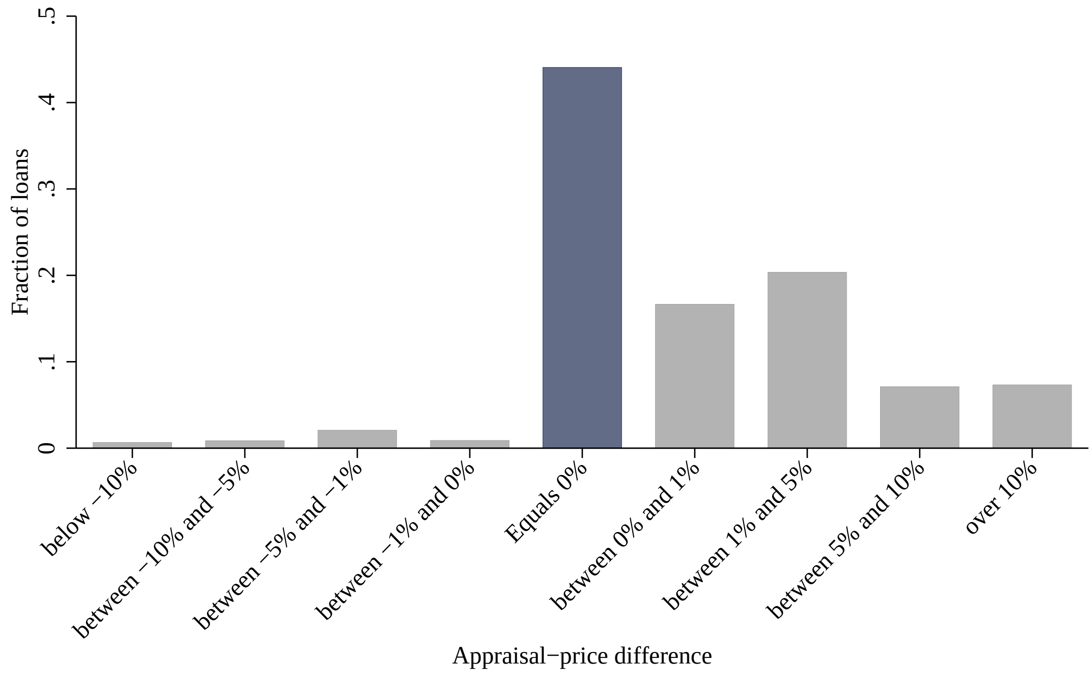
Figure IA.6. AVM relative to New Century purchase price



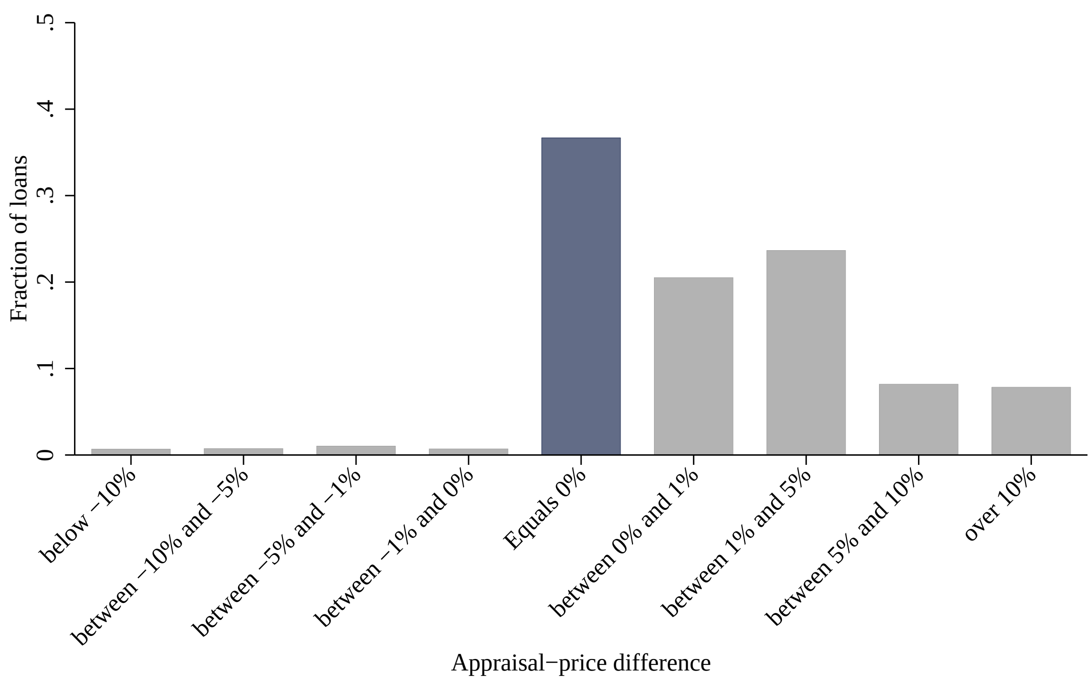
This figure plots the fraction of purchase loans in the merged New Century data by AVM value relative to purchase price. The dark blue bar highlights AVM values that are equal to purchase prices. AVM-price difference is the difference between ABSNet's AVM value and the property's purchase price divided by the purchase price.

Figure IA.7. **Appraisal values of New Century unfunded purchase loan applications, additional robustness**

Panel A: Application date preceding appraisal date



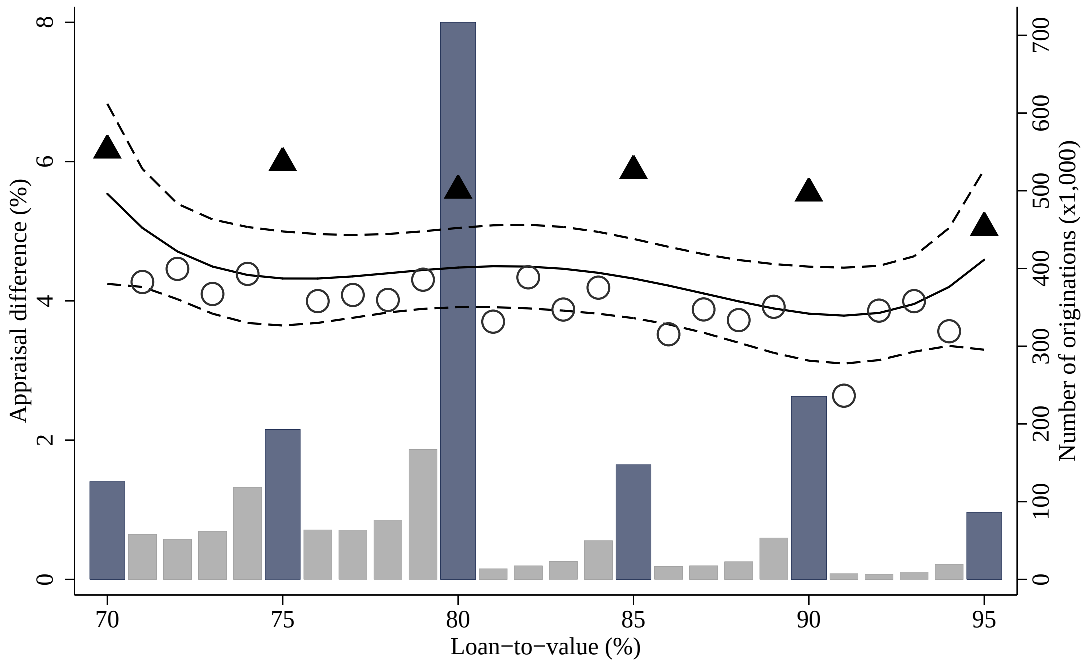
Panel B: Application date preceding appraisal date and retail loan



This figure plots the fraction of New Century purchase loans by appraisal value relative to purchase price. The dark blue bar highlights appraisals that are equal to purchase prices. Data comes from New Century's internal records. Appraisal-price difference is the difference between New Century's (internal data) appraisal and the property's purchase price divided by the purchase price. In Panel A, we extend the sample selection requirements to only consider unfunded loan applications with dates preceding those of appraisals. In Panel B, we further restrict the sample to include only retail loans.

Figure IA.8. LTV ratio clustering of refinance loans

Panel A: All refinance loans



Panels A and B plot number of observations and the mean appraisal difference for refinance loans by LTV ratio using the full sample of ABSNet loans and the subsample comprised by those loans originated by New Century, respectively. Loans at five-unit LTV ratios are required to have LTV ratios exactly equal to those values. The bars show the number of loan originations by LTV ratio. Dark blue bars highlight originations at five-unit LTV ratios. The circles and triangles show mean appraisal differences. Triangles highlight mean appraisal differences at five-unit LTV ratios. The black line fits a fourth-order polynomial for appraisal difference and the dashed lines delimit the 95% confidence interval.

Figure IA.8 (continued). LTV ratio clustering of refinance loans

Panel B: New Century refinance loans

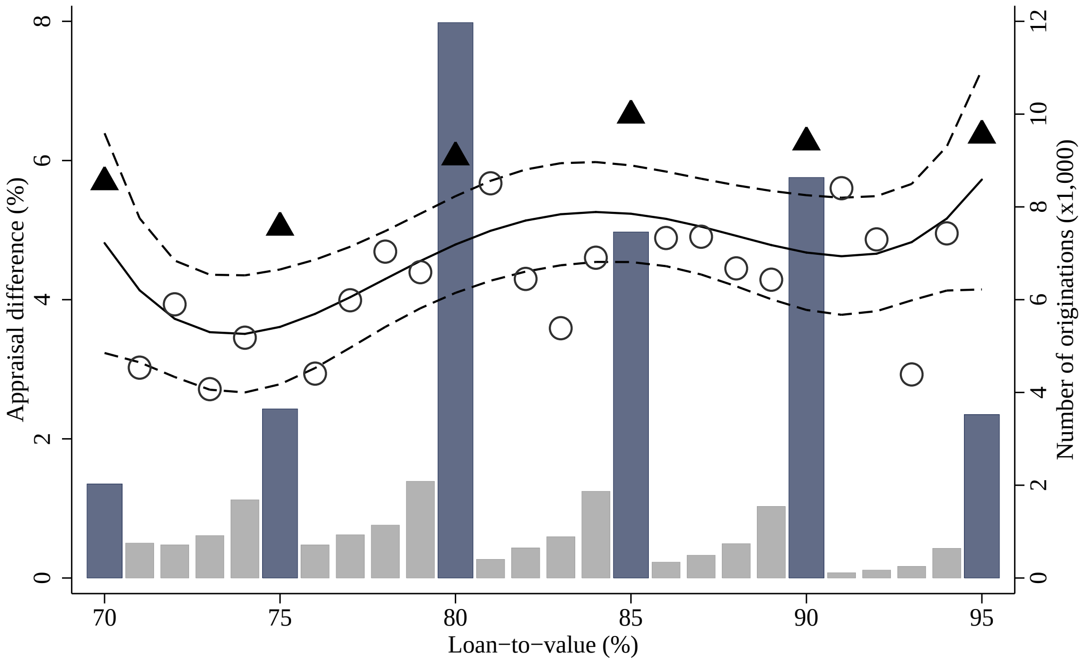
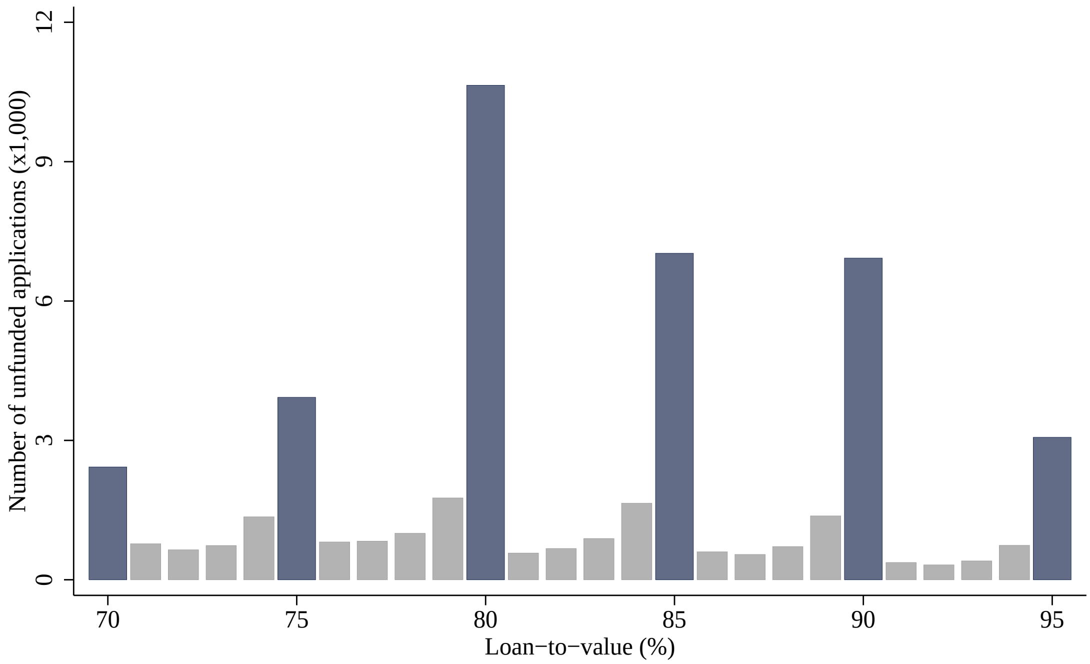
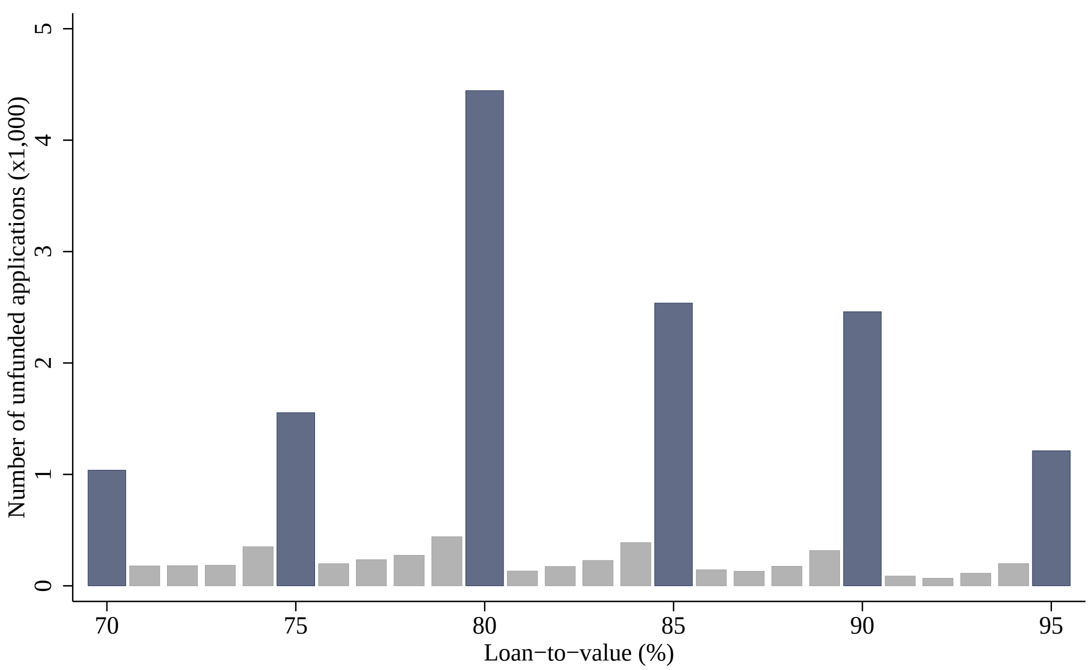


Figure IA.9. **LTV ratio clustering of unfunded refinance applications, additional robustness**

Panel A: Application date preceding appraisal date

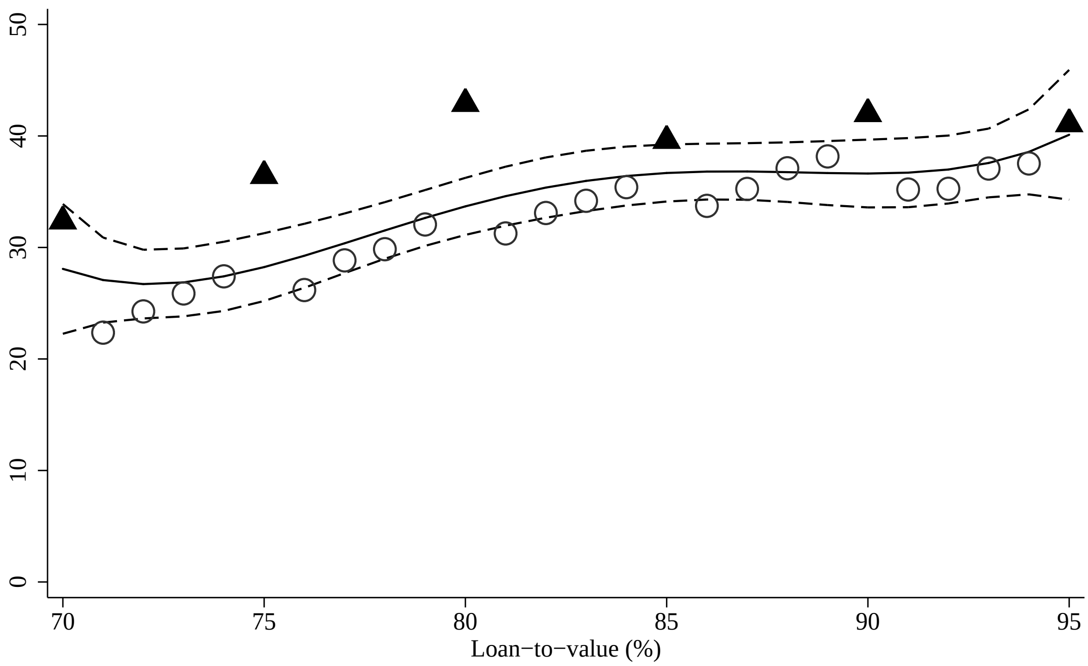


Panel B: Application date preceding appraisal date and retail loan



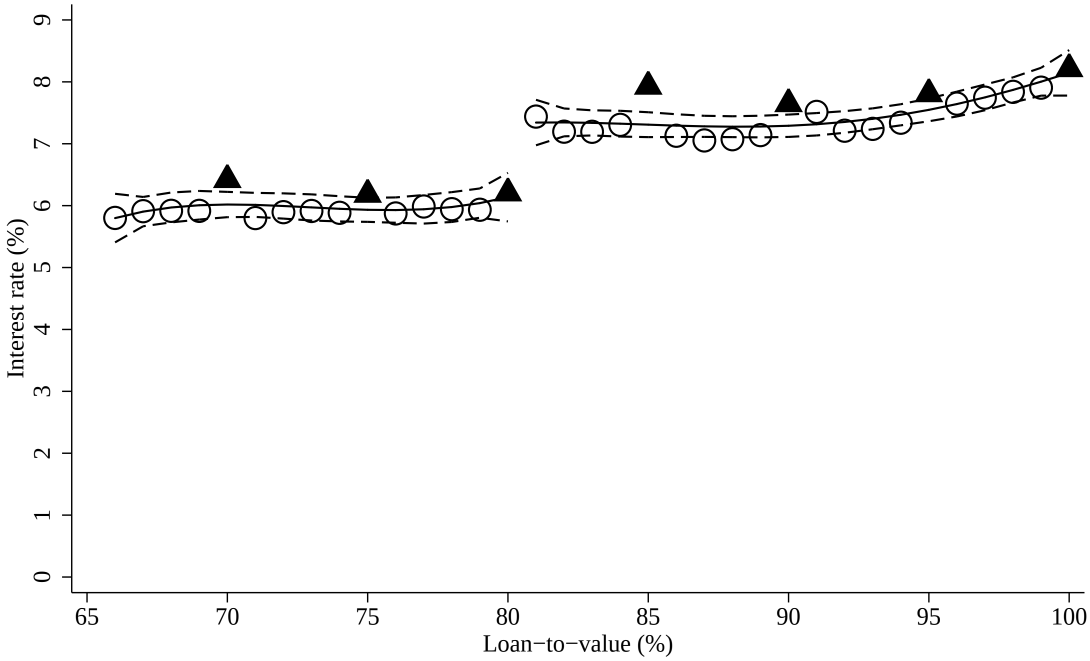
This figure plots the number of unfunded refinance loan applications by LTV ratio in New Century's internal records. Loans at five-unit LTV ratios are required to have LTV ratios exactly equal to those values. Dark blue bars highlight originations at five-unit LTV ratios. In Panel A, we extend the sample selection requirements to only consider unfunded loan applications with dates preceding those of appraisals. In Panel B, we further restrict the sample to include only retail loans.

Figure IA.10. **Delinquency rates of refinance loans**



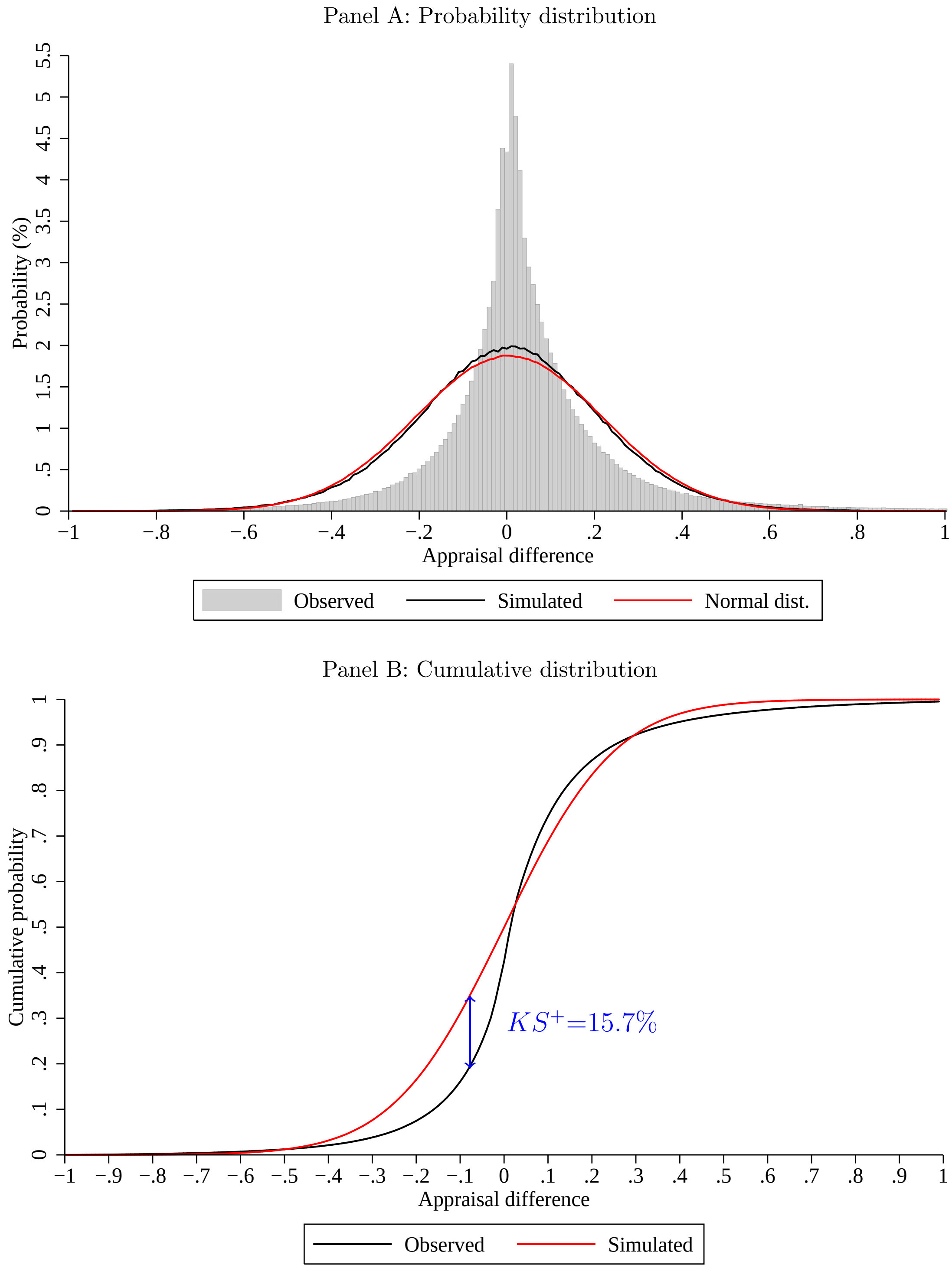
This figure plots delinquency rates for refinance loans by LTV ratio. Delinquency rates are based on a dummy variable that takes the value of one if the loan became more than 90 days delinquent at any point in time between origination and September 2012, and zero otherwise. Loans at five-unit LTV ratios are required to have LTV ratios exactly equal to those values. Triangles highlight mean delinquency rates at five-unit LTV ratios. The black line fits a fourth-order polynomial and the dashed lines delimit the 95% confidence interval.

Figure IA.11. Interest rates of refinance loans



This figure plots interest rates at origination for refinance loans by LTV ratio. Loans at five-unit LTV ratios are required to have LTV ratios exactly equal to those values. Triangles highlight mean interest rates at five-unit LTV ratios. The black line fits a fourth-order polynomial and the dashed lines delimit the 95% confidence interval.

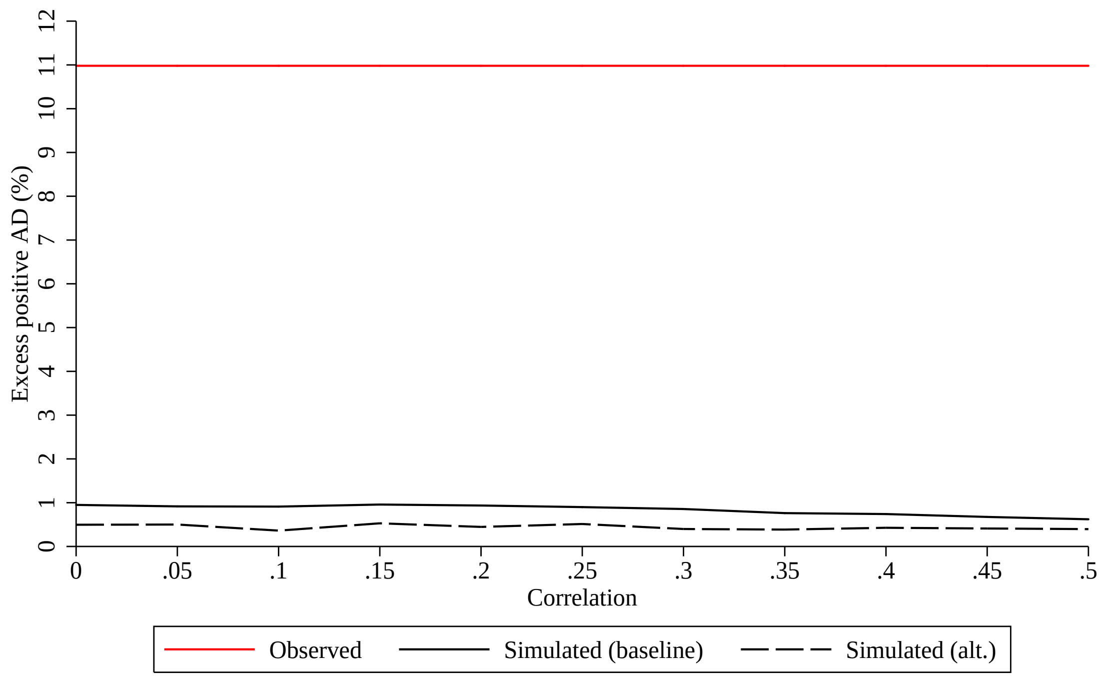
Figure IA.12. Distribution of appraisal differences for purchase loans



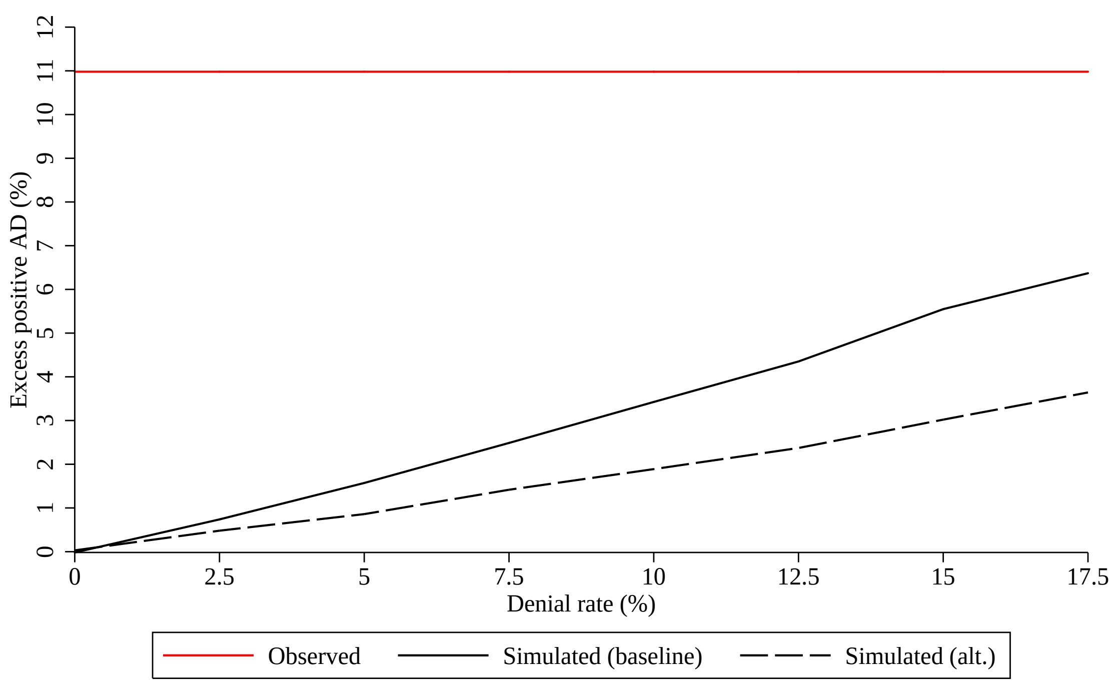
This figure plots probability and cumulative distributions of appraisal differences for purchase loans. In Panel A, the observed frequencies are compared to bias-free simulated appraisal difference probability distribution functions and to normal distributions with means of zero and standard deviations equal to those of the data. Panel B plots empirical and bias-free simulated cumulative distribution functions of KS^{+}. Appraisal and AVM values are modeled as bivariate normal random variables with means of zero and correlation of 0.5. We calibrate the standard deviations of Appraisal and AVM such that the simulated appraisal difference standard deviation matches its empirical counterpart. KS^{+} measures the maximum difference between the distributions.

Figure IA.13. Simulation sensitivity analysis for refinance loans

Panel A: Sensitivity with respect to error correlations



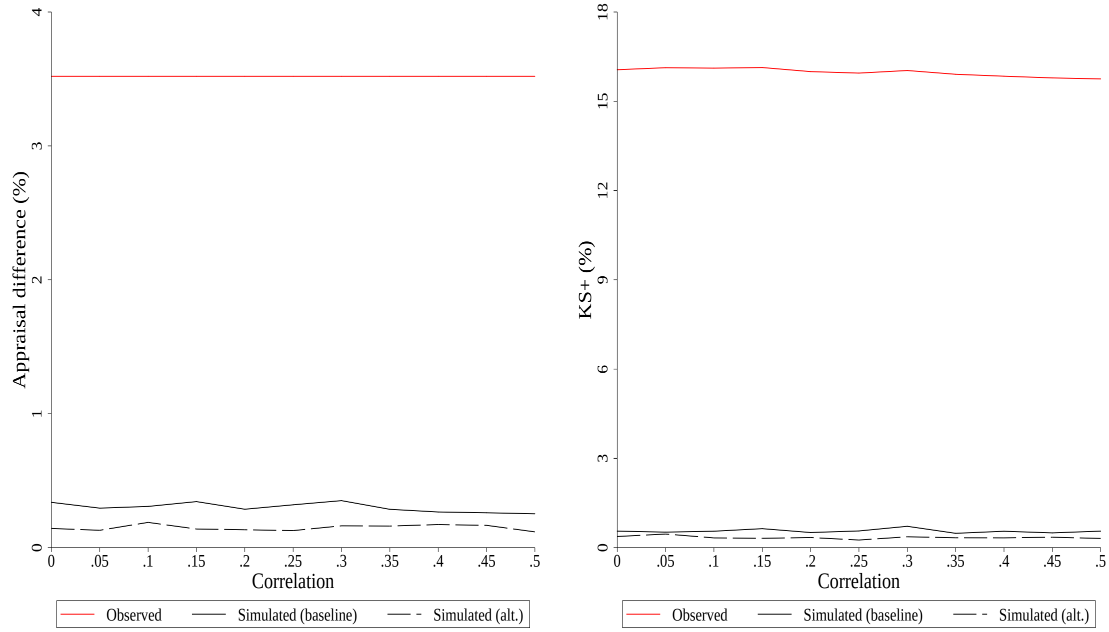
Panel B: Sensitivity with respect to denial rates



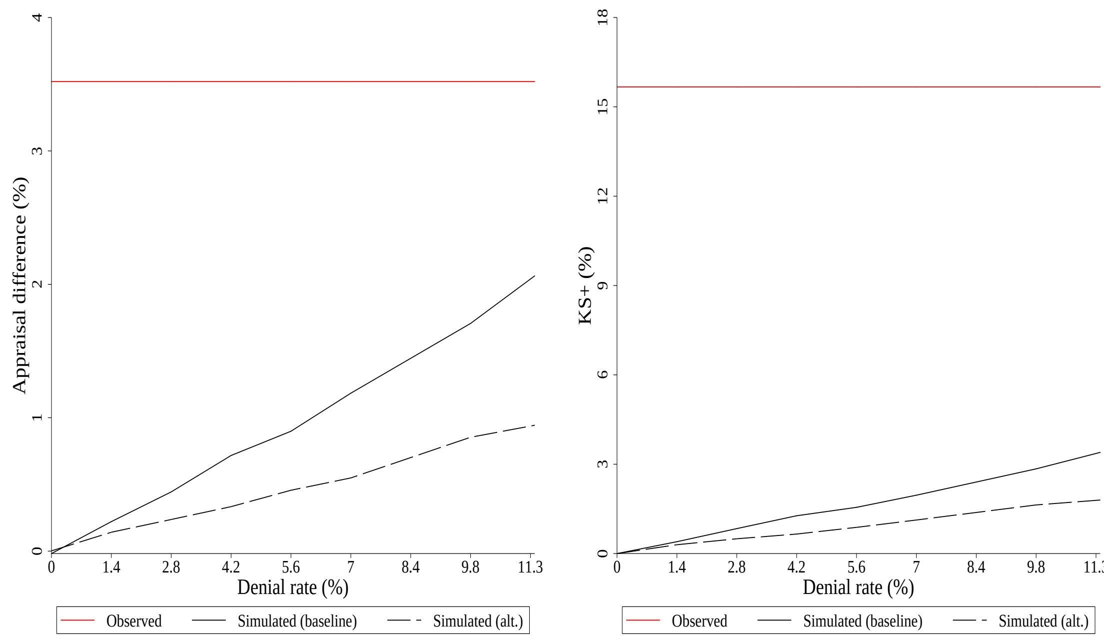
This figure plots refinance simulation results for excess positive AD under different assumptions regarding error correlations and denial rates. In the alternative simulations, we change the threshold for 100% origination probability from $A \geq V$ to $A \geq 1.25V$ while keeping the same linear structure for loan completion probability when appraisals are below the $1.25V$ threshold. Excess positive appraisal difference measures the amount of appraisals that are higher than the AVM in excess of 50%.

Figure IA.14. Simulation sensitivity analysis for purchase loans

Panel A: Sensitivity with respect to error correlations



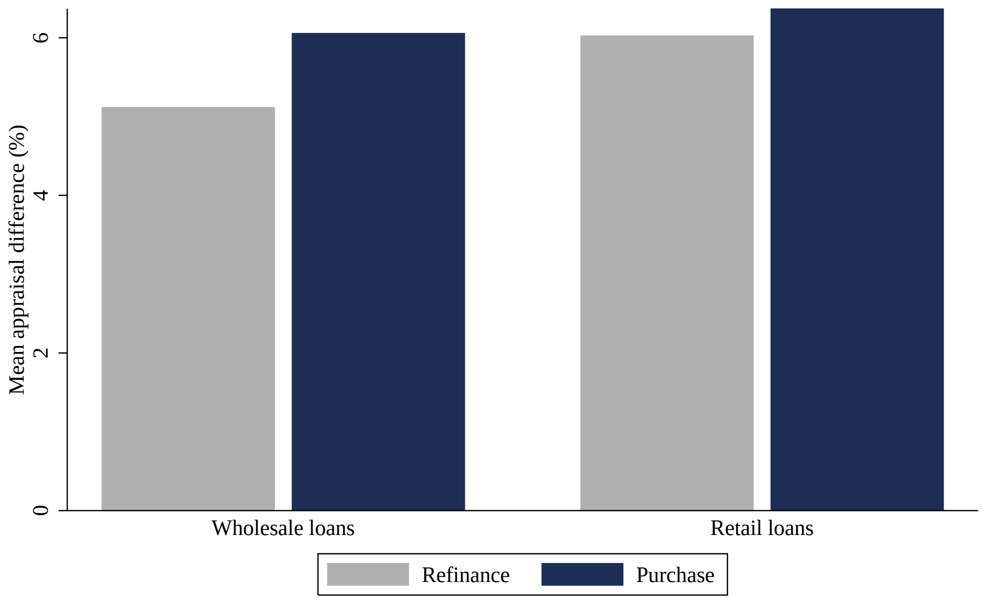
Panel B: Sensitivity with respect to denial rates



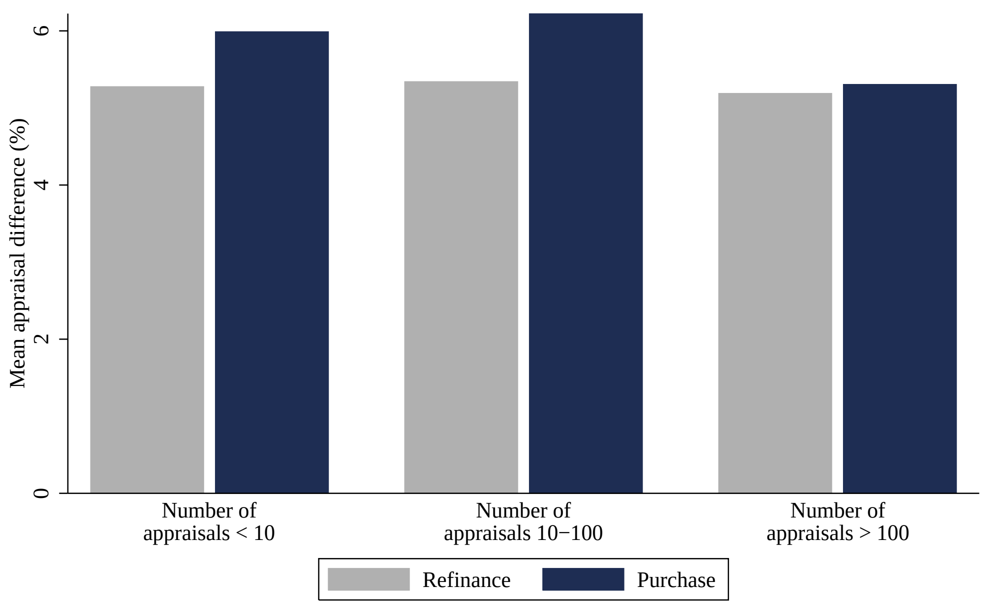
This figure plots purchase simulation results under different assumptions regarding error correlations and denial rates. In the alternative simulations, we change the threshold for 100% origination probability from $A \geq V$ to $A \geq 1.25V$ while keeping the same linear structure for loan completion probability when appraisals are below the $1.25V$ threshold. Appraisal difference is defined as the difference between appraised value and AVM value, divided by the average of both values. KS^+ measures maximum difference from the bias-free simulated distributions. Because KS^+ is computed relative to the bias-free simulation, observed KS^+ changes slightly across the correlation scenarios in Panel A.

Figure IA.15. Appraisal difference by origination channel and appraiser experience

Panel A: Origination channel



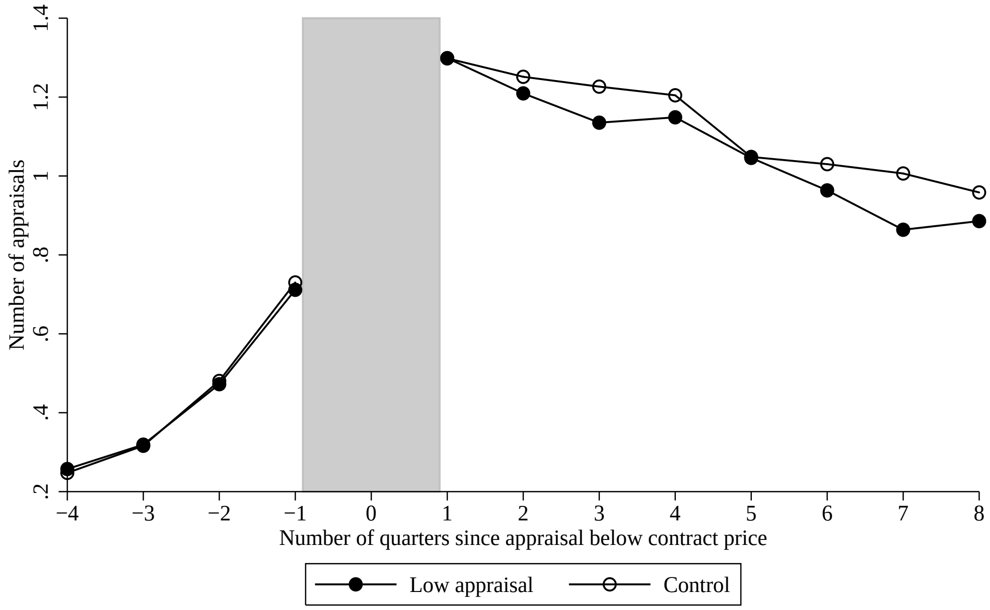
Panel B: Appraiser experience



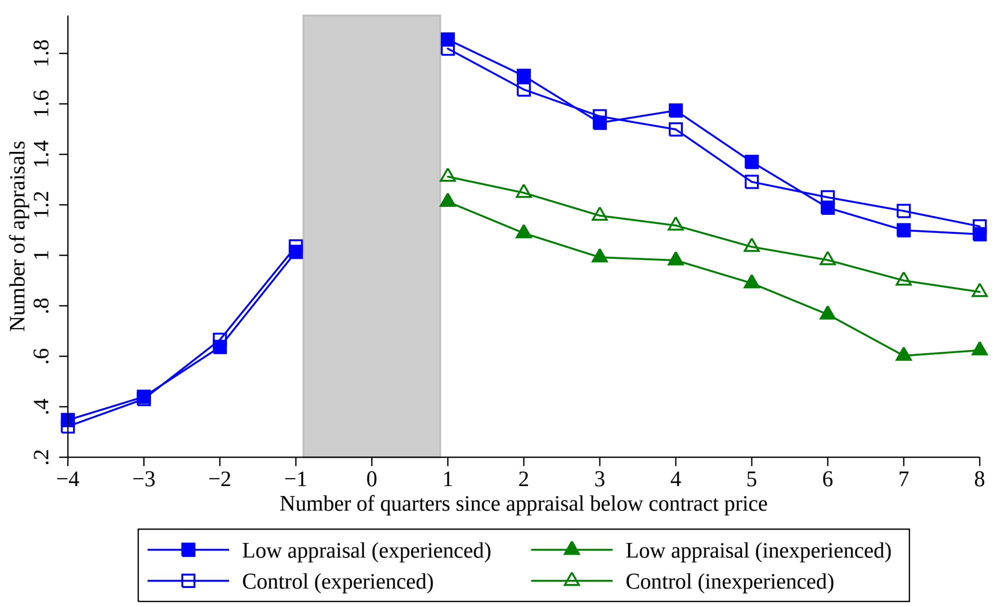
This figure plots the average appraisal difference by origination channel (i.e., broker loan vs. retail loan) and appraiser experience. Appraiser experience is defined as the number of appraisals performed by the appraiser in the New Century data. Appraisal difference is the difference between appraised value and AVM value, divided by the average of both values.

Figure IA.16. Appraisal business after below-price appraisals

Panel A: Full sample



Panel B: Experience vs. inexperienced appraisers



This figure plots subsequent business after producing a below-price appraisal. We match below price appraisals to at-or-above-price appraisals in the same quarter, in the same CBSA, by appraisers with the same number of appraisals in that quarter and the same number of past appraisals. We then track subsequent appraisal business for the low appraisal and matched control appraisers over the next eight quarters. In Panel A, the analysis includes all first lien purchase loan appraisals in the full New Century data, including appraisals for unfunded loan applications. In Panel B, we decompose appraisals based on appraisal experience. We define inexperienced appraisers as those with no New Century appraisals during any previous quarter.

Table IA.1. New Century-ABSNet merged data summary statistics

	All loans N = 70,325		Refinance loans N = 53,330		Purchase loans N = 16,995	
Variables	Mean	SD	Mean	SD	Mean	SD
Appraisal measures						
Appraisal difference (AD) (%)	5.46	22.3	5.26	22.6	6.06	21.3
AD>0 (d,%)	62.7	-	62.8	-	62.5	-
Loan/borrower characteristics						
Purchase loan (d,%)	24.2	-	-	-	-	-
Loan amount ($000s)	223.3	130.8	217.7	125.9	240.8	143.6
FICO score	608.8	59	598.5	56.3	641.3	56.6
LTV (%)	78.8	11.9	77.5	12.8	82.5	7.2
ARM (d,%)	74.5	-	70.5	-	87	-
Full documentation (d,%)	58.7	-	63.3	-	44.1	-
Prepayment penalty (d,%)	58	-	56.3	-	63.5	-
Owner occupied (d,%)	92.7	-	94.4	-	87.6	-
Complex (d,%)	0.003	-	0.000	-	0.012	-
Interest rate (%)	7.8	1.2	7.8	1.2	7.9	1.2
Loan performance						
Delinquent 90+ before Sep. 2012 (d,%)	48.9	-	44.6	-	62.5	-

This table reports summary statistics for the sample of New Century-ABSnet matched loans. We match the loans in the two datasets based on their zip code, loan size, first payment date, purpose, type of interest rate (fixed or floating), and credit score, and we require matches to be unique. A more detailed description of the matching is available in Internet Appendix A. Appraisal differences are based on New Century's (internal data) appraisals.

Table IA.2. New Century unfunded loan application summary statistics

	Refinance loans N = 297,799		Purchase loans N = 132,566	
Variables	Mean	SD	Mean	SD
Appraisal measures				
Appraisal-price difference (%)	-	-	2.8	16.0
Appraisal-price difference≥0 (d,%)	-	-	96.7	-
Loan/borrower characteristics				
Loan amount ($000)	201.9	137.4	215.0	149.6
FICO score	596.4	61.8	636.5	63.6
LTV (%)	78.3	13.7	83.4	8.5
ARM (d,%)	72.7	-	84.5	-
Prepayment penalty (d,%)	76.0	-	75.6	-
Owner occupied (d,%)	92.7	-	84.2	-
Interest rate (%)	8.2	1.5	8.0	1.3

This table reports summary statistics for the sample of unfunded loan applications from New Century internal records. The sample consists of first-lien loan applications submitted between 2001 and 2007 for purchase or refinancing with original loan balances between $30k and $1 million. Loans with original LTV ratios over 103% or with CLTV ratios below 25%, as well as loans reported as being for homes of over one unit are excluded. FHA and VA loans are also dropped. Appraisal-price difference is the difference between appraisal and the property's purchase price divided by the purchase price.

Table IA.3. Appraisal differences and round LTV ratios

	Appraisal Difference				Round LTV
	(1)	(2)	(3)	(4)	(5)
Mean (%)	5.4	5.4	5.4	5.4	45.2
Round LTV	1.518***		1.435***	1.155***	
	(0.103)		(0.098)	(0.121)	
Cashout		1.319***	1.208***	1.057***	7.689***
		(0.126)	(0.124)	(0.163)	(0.430)
Round LTV×Cashout				0.373**	
				(0.161)	
Controls	yes	yes	yes	yes	yes
CBSA×Quarter FE	yes	yes	yes	yes	yes
N	3,662,156	3,662,156	3,662,156	3,662,156	3,662,156
R^2	0.11	0.11	0.11	0.11	0.25

This table estimates OLS regressions of the form:

$$y_{ijt} = \alpha + \beta RoundLTV_{ijt} + X_{ijt}^{'}\Gamma + \phi_{jt} + \varepsilon_{ijt},$$

where the subscripts i, j, and t index the mortgage, the CBSA where the underlying property is located, and the quarter of origination, respectively. Columns (1) to (4) report results where the dependent variable (y) is the loan's appraisal difference. The explanatory variables of interest are indicator for round LTV, an indicator for cash-out refinance, and the interaction of both. Control variables (X) include indicators for full-doc loans, the presence of a prepayment penalty, owner occupied properties, complex loans, adjustable-rate loans, as well as credit score, loan amount, LTV, interest rate at origination, and an interaction term between interest rate and the adjustable rate indicator. Column (5) reports the result where the dependent variable the indicator for round LTV. All regressions include CBSA×quarter of origination fixed effects (ϕ_{jt}). Reported standard errors (in parentheses) are heteroscedasticity-robust and clustered by CBSA. ***p <0.01, **p <0.05, *p <0.1. *p <0.1.

Table IA.4. Loan performance and pricing of New Century purchase loans

	Delinquent			Interest rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Mean (%)	48.9	48.9	48.9	7.8	7.8	7.8
AD	6.795***		5.788***	-0.029		-0.029
	(0.972)		(1.037)	(0.022)		(0.022)
A=Price		15.341***	14.040***		0.219***	0.221***
		(0.743)	(0.781)		(0.015)	(0.017)
AD×A=Price			8.456***			-0.017
			(3.074)			(0.054)
Controls	yes	yes	yes	yes	yes	yes
CBSA×Quarter FE	yes	yes	yes	yes	yes	yes
N	70,325	70,325	70,325	70,325	70,325	70,325
R^2	0.282	0.274	0.289	0.595	0.598	0.598

This table reports results analogous to Table 4, for New Century purchase loans as opposed to the overall sample of refinance loans. Columns (1) to (3) report results from OLS regressions where the dependent variable is a dummy variable that takes the value of one if the loan became more than 90 days delinquent at any point in time between origination and September 2012, and zero otherwise. The explanatory variables of interest are the loan's appraisal difference and an indicator for appraisal being equal to purchase price (both variables are based on New Century's internal data appraisals). Control variables include indicators for full-doc loans, the presence of a prepayment penalty, owner occupied properties, complex loans, adjustable-rate loans, as well as credit score, loan amount, LTV, interest rate at origination, and an interaction term between interest rate and the adjustable rate indicator. Columns (4) to (6) report results from OLS regressions where the dependent variable is the loan interest rates at origination. The regression specifications are the same as in columns (1) to (3) except that interest rate is not a control variable (because it is the dependent variable) and an additional control variable indicator for LTV ratios above 80 is included. Reported standard errors (in parentheses) are heteroscedasticity-robust and clustered by CBSA. ***p <0.01, **p <0.05, *p <0.1. *p <0.1.

Table IA.5. **Loan performance and pricing after dropping loans with LTV ratios of 78-82**

	Delinquent			Interest rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Mean (%)	26.7	26.7	26.7	6.5	6.5	6.5
AD	4.751***		3.172***	-0.001		-0.028**
	(0.307)		(0.314)	(0.013)		(0.014)
Round LTV		7.232***	2.010***		0.224***	0.222***
		(0.193)	(0.121)		(0.011)	(0.011)
AD×Round LTV			4.417***			0.047**
			(0.487)			(0.022)
Controls	yes	yes	yes	yes	yes	yes
CBSA×Quarter FE	yes	yes	yes	yes	yes	yes
N	2,710,323	2,710,323	2,710,323	2,710,323	2,710,323	2,710,323
R^2	0.26	0.24	0.26	0.68	0.68	0.68

This table reports the results of estimates of the same specifications as in Table 4, after excluding loans with LTVs at origination between 78 and 82. Columns (1) to (3) report results from OLS regressions where the dependent variable is a dummy variable that takes the value of one if the loan became more than 90 days delinquent at any point in time between origination and September 2012, and zero otherwise. The explanatory variables of interest are the loan's appraisal difference and an indicator for round LTV. Control variables include indicators for full-doc loans, the presence of a prepayment penalty, owner occupied properties, complex loans, adjustable-rate loans, as well as credit score, loan amount, LTV, interest rate at origination, and an interaction term between interest rate and the adjustable rate indicator. Columns (4) to (6) report results from OLS regressions where the dependent variable is the loan interest rates at origination. The regression specifications are the same as in columns (1) to (3) except that interest rate is not a control variable (because it is the dependent variable) and an additional control variable indicator for LTV ratios above 80 is included. Reported standard errors (in parentheses) are heteroscedasticity-robust and clustered by CBSA. ***p <0.01, **p <0.05, *p <0.1. *p <0.1.

Table IA.6. Baseline simulation calibration parameters and appraisal difference moments

Panel A: Refinance loans

	Data	Bias free simulation	Selection bias simulation
Calibration parameters			
σ_A	-	19.10	19.30
σ_{AVM}	-	19.10	19.30
β	-	0	0.33
Appraisal difference moments			
σ_{AD}	24.26	24.28	24.35
d	2.50	0	2.54
Mean AD	5.36	-0.04	0.57
AD>0−0.5	10.98	-0.05	0.79
KS^+	15.59	-	0.87
Mean (A-AVM)/AVM	9.28	3.07	3.74
(A-AVM)/AVM>0.20	21.28	21.96	22.70
(A-AVM)/AVM<-0.20	8.02	17.37	16.77

Panel B: Purchase loans

	Data	Bias free simulation	Selection bias simulation
Calibration parameters			
σ_A	-	20.30	20.30
σ_{AVM}	-	20.30	20.30
β	-	0	0.21
Appraisal difference moments			
σ_{AD}	21.27	21.39	21.29
d	1.70	0.00	1.70
Mean AD	3.62	0.01	0.27
AD>0−0.5	7.56	0.08	0.47
KS^+	15.67	-	0.74
Mean (A-AVM)/AVM	6.69	2.41	2.65
(A-AVM)/AVM>0.20	14.95	18.80	19.06
(A-AVM)/AVM<-0.20	6.41	14.06	13.72

This table reports the parameter values and appraisal difference moments from the baseline simulations. Appraisal and AVM values are modeled as bivariate normal random variables with means of zero, equal error standard deviations, and correlations of 0.25 and 0.5 respectively for refinance and purchase loans. We calibrate error standard deviations for Appraisal and AVM such that the simulated appraisal difference (AD) standard deviations for refinance and purchase loans match their empirical counterparts. To model selection, we assume that loan completion probability is one if an appraisal is above the property's true value and is otherwise $max(0, 1 - \beta(V - max(0, A))/V)$, where V represents the property's true value and can be normalized to one. The parameter β is calibrated such that the simulation generates targeted denial rates of 2.5% for refinance loans and 1.7% for purchase loans, which are based on observed HMDA collateral denial rates. Excess positive appraisal difference measures the amount of appraisals that are higher than the AVM in excess of 50% and KS^+ measures the maximum differences from the bias-free simulated distributions.

Table IA.7. Simulation sensitivity analysis

Panel A: A≥V threshold for 100% loan completion probability

		Refinances			Purchases			
		Mean AD	Excess positive AD	KS^+		Mean AD	Excess positive AD	KS^+
$\rho = 0$	d = 0	-0.01	0.03	0	d = 0	0.01	-0.01	0
	d = 2.5	0.57	0.89	0.89	d = 1.7	0.34	0.62	0.64
	d = 7.5	1.93	2.87	2.85	d = 4.9	1.04	1.83	1.86
	d = 12.5	3.50	5.08	5.05	d = 8.1	1.88	3.19	3.23
	d = 17.5	5.31	7.47	7.53	d = 11.3	2.72	4.56	4.58
$\rho = 0.25$	d = 0	-0.04	-0.05	0	d = 0	0.01	0.03	0
	d = 2.5	0.57	0.79	0.87	d = 1.7	0.32	0.53	0.52
	d = 7.5	1.67	2.48	2.54	d = 4.9	0.93	1.58	1.55
	d = 12.5	3.09	4.39	4.47	d = 8.1	1.62	2.71	2.71
	d = 17.5	4.67	6.47	6.58	d = 11.3	2.40	3.98	3.96
$\rho = 0.5$	d = 0	-0.06	-0.12	0	d = 0	0.01	0.08	0
	d = 2.5	0.44	0.60	0.74	d = 1.7	0.27	0.47	0.74
	d = 7.5	1.42	2.00	2.14	d = 4.9	0.78	1.29	2.14
	d = 12.5	2.62	3.57	3.70	d = 8.1	1.36	2.21	3.70
	d = 17.5	3.94	5.27	5.51	d = 11.3	2.03	3.17	5.51

Panel B: A≥1.25V threshold for 100% loan completion probability

		Refinances			Purchases			
		Mean AD	Excess positive AD	KS^+		Mean AD	Excess positive AD	KS^+
$\rho = 0$	d = 0	0.02	0.05	0	d = 0	-0.04	-0.07	0
	d = 2.5	0.26	0.47	0.46	d = 1.7	0.12	0.18	0.42
	d = 7.5	0.88	1.50	1.50	d = 4.9	0.44	0.84	0.95
	d = 12.5	1.60	2.67	2.66	d = 8.1	0.80	1.47	1.59
	d = 17.5	2.38	3.91	3.90	d = 11.3	1.11	2.07	2.16
$\rho = 0.25$	d = 0	0.00	0.01	0	d = 0	-0.02	-0.04	0
	d = 2.5	0.26	0.43	0.49	d = 1.7	0.15	0.28	0.40
	d = 7.5	0.80	1.31	1.34	d = 4.9	0.41	0.77	0.83
	d = 12.5	1.47	2.40	2.41	d = 8.1	0.77	1.47	1.51
	d = 17.5	2.28	3.69	3.68	d = 11.3	1.08	2.02	2.07
$\rho = 0.5$	d = 0	0.02	0.00	0	d = 0	0.04	0.06	0
	d = 2.5	0.29	0.52	0.53	d = 1.7	0.14	0.27	0.53
	d = 7.5	0.79	1.23	1.24	d = 4.9	0.36	0.69	1.24
	d = 12.5	1.30	2.10	2.10	d = 8.1	0.67	1.24	2.10
	d = 17.5	2.12	3.40	3.40	d = 11.3	0.98	1.77	3.40

This table reports sensitivity analysis for the correlation, denial rate, and appraisal thresholds assumptions discussed in Section 3.1. In total, we consider 15 permutations under both baseline and alternative appraisal thresholds. Appraisal and AVM values are modeled as bivariate normal random variables with means of zero and equal error standard deviations. We calibrate error standard deviations for Appraisal and AVM such that the simulated appraisal difference (AD) standard deviations for refinance and purchase loans match their empirical counterparts. To model selection, we assume that loan completion probability is one if an appraisal is above the property's true value and is otherwise $max(0, 1 - \beta(V - max(0, A))/V)$, where V represents the property's true value and can be normalized to one. The parameter β is calibrated such that the simulation generates a targeted denial rate. Excess positive appraisal difference measures the amount of appraisals that are higher than the AVM in excess of 50% and KS^+ measures the maximum differences from the bias-free simulated distributions.