Appraisal Inflation and Private Mortgage Securitization

Moussa Diop* Abdullah Yavas† Shuang Zhu‡

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Abstract

This paper examines adverse selection based on appraisal inflation in private securitization using jumbo refinance loans as a laboratory. Combining a nationwide mortgage data set with real estate transaction data, we find that at key LTV notches mortgages with higher appraisal inflation have a higher probability of being securitized. As confirming evidence, securitized notch loans have more than 3% higher appraisal inflation than similar portfolio loans, which is statistically and economically significant. Even though these securitized mortgages with inflated appraisals are associated with higher default probabilities, the additional credit risk is not priced in mortgage rates. We provide evidence that lenders exploit their informational advantage about appraisal quality to benefit themselves or affiliated parties in the secondary market. These findings are robust to various model specifications and suggest the existence of adverse selection in private securitization based on property appraisal quality.

JEL Classifications: G21, G24, R3

Keywords: Appraisal Inflation, Securitization, Non-Agency Market, Adverse Selection, Information Asymmetry

*University of Southern California, Los Angeles, CA 90089, *diop@price.usc.edu*

†University of Wisconsin-Madison, Madison, WI 53706, *yavas@wisc.edu*

‡Kansas State University, Manhattan, KS 66506, *shuangzhu@ksu.edu*

1 Introduction

The bust of the housing market bubble at the end of 2007 and the ensuing Great Recession have highlighted the importance of sound housing finance in maintaining a healthy financial system. Apart from lax mortgage underwriting standards that are characteristic of mortgage credit expansions, widespread appraisal inflation, the overvaluation of properties used as collateral, contributed to deteriorating mortgage originations during that period (Nakamura et al., 2010; Calem, Lambie-Hanson, and Nakamura, 2015; Piskorski, Seru, and Witkin, 2015; Shi and Zhang, 2015; Ding and Nakamura, 2016; Agarwal, Ben-David, and Yao, 2015; Griffin and Maturana, 2016; Eriksen et al., 2019; Kruger and Maturana, 2020; Conklin et al., 2020).[1,2] Appraisal inflation leads to excessive lending and/or more favorable borrowing terms than warranted by the true value of the property. Thus, loans backed by inflated appraisals are more likely to default with mortgage investors experiencing higher losses after foreclosure (e.g., Nakamura et al. (2010); Agarwal, Ben-David, and Yao (2015); Griffin and Maturana (2016)).

Non-agency (private-label) mortgage securitization had a compounding effect on the deterioration in loan quality during the mortgage credit expansion (e.g., Mayer, Pence, and Sherlund (2009); Keys et al. (2010); Keys, Seru, and Vig (2012)). Previous studies of adverse selection in securitization typically examine loan performance (default) after origination and sometimes attribute significant differences between portfolio and observably similar sold loans to unobservable loan characteristics (e.g., Elul (2016); Agarwal, Chang, and Yavas (2012)).[3] However, it is often unclear what unobservables caused the observed difference in loan performance. As appraisal inflation is an important unobservable determinant of credit risk, this paper explores the interlink between appraisal inflation and private mortgage securitization. More specifically, we investigate whether lenders sold mortgages with more pronounced appraisal inflation to less-informed investors in the secondary market and which mortgages they targeted. This study contributes to the literature by unveiling the relationship between appraisal inflation, a key determinant of credit risk that is "unobservable" by secondary market investors, and securitization during the mortgage credit expansion that preceded the mortgage market crash.

The purpose of appraisal is to provide an independent assessment of the fair market value of a

[1] Collateral valuation is a key feature of housing finance determining loan amount, loan-to-value ratio, and pricing. Even though appraisal inflation was widespread and probably more pronounced during the housing boom, it was not a new phenomenon in housing finance, as Cho and Megbolugbe (1996) and Chinloy, Cho, and Megbolugbe (1997) attest.

[2] For example, Griffin and Maturana (2016) document that 45% of appraisals conducted during the mortgage credit expansion were at least 5% higher than unbiased automated valuation model (AVM) value estimates. In contrast to appraisals, which are subject to interference by lenders, mortgage brokers, real estate brokers, and borrowers, AVM home value estimates are from hedonic regression models based on home characteristics, property location, and transaction characteristics. In addition, the selection of comparable properties used in the appraisal and the appraiser's subjective price adjustments may further bias appraisals (Eriksen et al., 2019). We discuss later various incentive problems that may lead to appraisal inflation.

[3] The term *"sold"* loans designates loans sold by lenders to non-agency mortgage-backed security issuers. We interchangeably refer to these loans as *"securitized"* loans throughout the paper.

property. Appraisals are typically required in home mortgage underwriting and used by mortgage lenders to determine the amount to lend against the property, the mortgage interest rate, and the need for private mortgage insurance (PMI) premia.[4] As noted earlier, appraisal inflation increases the likelihood of mortgage default and loss severity by understating the true value of the mortgage's loan-to-value (LTV) ratio. But more importantly for the purposes of this study, appraisal quality is a potential source of information asymmetry that could lead to adverse selection in the secondary market. Relative to mortgage security investors, mortgage lenders have an information advantage about the quality of appraisals because they receive appraisal reports describing the subject property, the comparable properties used in the appraisal, local market conditions, and price adjustments made by the appraiser, which allow them to gauge the quality of the appraisal. Furthermore, lenders with local presence are likely to know more about mortgaged properties, the comparables used in the appraisal, and local market trends and conditions than mortgage-backed security (MBS) investors. Finally, with the desintegration of housing finance brought about by securitization, shortsighted lenders may have strong incentives to seek or tolerate inflated appraisals for loans meant for securitization to boost short-term profits by growing origination volumes because for the same amount of down payment by a borrower, an inflated appraisal will increase the chance of the loan being approved due to the resulting lower LTV ratio.[5]

Appraisal inflation presents mortgage lenders with an opportunity to take advantage of their privileged position relative to mortgage security investors in the secondary market.[6,7] Among the incentive problems documented in the literature, appraisal inflation has been identified as one of the most consequential because of the critical role of appraisal in housing finance, particularly for refinance loans. But despite the accumulation of extensive evidence of appraisal inflation in securitized loans, the relation between securitization and appraisal inflation remains unclear because higher appraisal inflation in securitized loans does not necessarily represent evidence of adverse selection or suggest a causal relationship between appraisal inflation and securitization.

To investigate the relation between appraisal inflation and securitization in the non-agency market, we use refinance jumbo mortgages as a laboratory.[8] By focusing on jumbo mortgages, we avoid potential

[4] Appraisal waivers, as currently allowed in some agency lending, were far less common during the period of this study and would not enter our data.

[5] Furthermore, it was not uncommon for lenders or borrowers to request a second appraisal if the first appraisal is too low, a practice not observable to MBS investors (Conklin et al., 2020)

[6] Several narratives, including private mortgage securitization, have been proposed as potential explanations of the housing bubble that preceded the Great Recession – other proposed explanations include lax monetary policies, and government policies aimed at increasing homeownership, among others (Obstfeld and Rogoff, 2009; Campbell, 2013; Moulton, 2014). Proponents of the securitization narrative argue that the originate-to-distribute mortgage lending business model skewed the incentives of lenders toward the origination of risky loans that were then repackaged and sold to unsuspecting MBS investors (Mian and Sufi, 2009; Keys et al., 2010; Demyanyk and Van Hemert, 2011; Keys, Seru, and Vig, 2012; Nadauld and Sherlund, 2013; Elul, 2016; Griffin, Kruger, and Maturana, 2020; Ding and Nakamura, 2016).

[7] This could be especially true during our sample period because as the housing market boomed, lenders underestimated default risk and were less concerned about reputational risk.

[8] Jumbo mortgage loans are conventional mortgages that exceed the maximum loan amount set by the government-

econometric issues related to the choice of securitization channel (agency or private-label securitization) because jumbo loans do not qualify for purchase by the government-sponsored enterprises (GSEs). We specifically target refinance loans because appraisal quality is more critical for the underwriting of these loans than purchase loans.[9] Furthermore, the incidence of appraisal inflation is likely to be more pronounced on refinance mortgages because the absence of a transaction price leaves more room for subjective value adjustments by appraisers.

We employ two complementary approaches in our investigation of the relationship between securitization and appraisal inflation. First, we estimate a mortgage securitization model that controls for reverse causality between appraisal inflation and the securitization decision. This methodology takes an ex-ante approach to the securitization decision by turning off potential reverse causality channels linking appraisal inflation to securitization. We also control for potential errors in the measurement of appraisal inflation on sold and portfolio loans. Our second approach uses a cross-sectional difference-in-differences (DID) design comparing the appraisal values of portfolio and sold *refinance loans* relative to the valuation of properties securing portfolio and sold *purchase loans*. We use purchase mortgages as a *"control group"* to enhance identification of the ex post difference in appraisal inflation between portfolio and sold refinance loans by controlling for potential difference in market valuation of properties backing portfolio and sold refinance loans. In addition to documenting the average effect of appraisal inflation on securitization, we also do the analysis at specific LTV notches (i.e., 80, 85, 90, 95, and 97% LTV ratios) where appraisal overstatement is likely to have a stronger impact on mortgage underwriting and pricing. For example, mortgages with LTV greater than 80% generally require PMI coverage and/or carry higher interest rates. Therefore, appraisal inflation at LTV notches likely benefit borrowers in the form of lower financing costs, and lenders by improving the chance of loan approval.

We implement our empirical strategies using mortgage origination and performance data from McDash, and property transaction and characteristics data from RealtyTrac. We calculate appraisal inflation on refinance loans as the ratio of the property's appraised value to its fair market valuation at loan origination – thus, we also refer to appraisal inflation as valuation ratio in the paper. We estimate fair market value at loan origination as the adjusted subsequent sale price of the same property using the local market home price index (HPI). Realizing that individual properties may appreciate at a different rate than the local market's HPI, we use property appreciation information from purchase loans to address this potential issue and also perform robustness checks using hedonic price estimates as an

sponsored enterprises Fannie Mae and Freddie Mac and are therefore kept by the lenders or securitized in the non-agency market.

[9]Refinance loan amounts are based on appraisal values. In contrast, lenders use the smaller of the appraised value and the transaction price for purchase loans. Thus, an appraisal impacts a purchase loan's terms only if it is less than the purchase price, which is a rare occurrence (Conklin et al., 2020).

alternative measure of fair market value.

Our ex-ante analysis suggests that appraisal inflation is not a significant determinant of securitization, except at key LTV notches where appraisal inflation is more consequential. A one standard deviation increase in appraisal inflation increases the likelihood of securitization by 1.8 to 3.6% depending on the model specification used. Our ex-post DID analysis confirms this finding with appraisal inflation on properties securing sold notch loans being 3.1 percentage points (pp) higher than on similar notch portfolio loans. This finding remains when we restrict our sample to loans with non-distressed subsequent sales to avoid the potential effect of subsequent foreclosure sales on our appraisal inflation measure. Furthermore, we find that the effect comes largely from cash-out refinance mortgages. While cash-out refinance mortgages show a large and significant securitization effect, securitization has no effect on appraisal inflation for rate and term refinance mortgages. This supports our hypothesis that equity extraction was likely a determining factor of appraisal inflation during the study period.

Next, we show that notch securitized refinance mortgages are significantly more likely to default compared to portfolio refinance mortgages, which establishes a direct link between appraisal overstatement and the poor performance of sold mortgages. Furthermore, we find no evidence indicating that the pricing of (interest rate on) securitized at-notch mortgages reflects the additional credit risk associated with the higher appraisal inflation at those LTV thresholds.[10] We also show that the cherry picking behavior centers on small lenders who are likely to have more presence in local market and have more private information regarding appraisal quality. In addition, the adverse selection is more severe when a lender is not affiliated with the MBS issuer. Our main results remain when we control for lender effects, compare appraisals within the same metropolitan statistical area (MSA), the same origination quarter, and the same subsequent sale quarter, or use hedonic home value estimates as an alternative measure of fair market value in our appraisal inflation measure. Overall, our results point to the existence of adverse seletion in private securitization based on appraisal inflation.

This study makes several contributions. First, we contribute to the private securitization literature by connecting appraisal inflation to adverse selection in securitization. To re-establish investors' confidence in private home mortgage securitization, it is important that the root causes of the recent failure of private securitization be properly diagnosed and addressed. Both loan quality at origination and default events experienced by borrowers, such as income shocks, affect loan performance. Studies investigating adverse selection in securitization that focus primarily on differences in loan performance between securitized and portfolio loans suffer from unobservable borrower circumstances affecting de-

[10]We are unable to confirm that lenders were not compensated for the additional risk by other means (points and other fees) because we only observe interest rates in our data. Nonetheless, we can safely state that any such compensation would likely be kept by lenders, rather than passed through to MBS investors who bear the additional credit risk.

fault decision that are generally difficult to control away. Our focus on appraisal inflation at origination alleviates this problem, thus providing a cleaner setting to investigate adverse selection in home mortgage securitization. Second, we show that adverse selection based on appraisal inflation does not apply to all loans but is rather limited to riskier mortgages such as those at key LTV notches, where appraisal inflation matters most on loan performance and mortgage pricing. Therefore, regulations or security design aimed at reducing appraisal inflation and related adverse selection should target those loans because it is where the problem in more acute.[11] Third, from property valuation perspective, if lenders are able to sell loans with worse appraisal quality, this study indicates that securtization could be an additional factor leading to inflated appraisal. Finally, we add to the mortgage literature examining home equity extraction by showing that the impact of securitization on appraisal inflation predominantly affects cash-out refinancing mortgages, and to the mortgage performance literature by confirming the link between appraisal overstatement and mortgage default.

Related literature include studies documenting substantial appraisal overstatement in the residential mortgage market (Cho and Megbolugbe, 1996; Chinloy, Cho, and Megbolugbe, 1997; Calem, Lambie-Hanson, and Nakamura, 2015; Kruger and Maturana, 2020; Eriksen et al., 2019; Conklin et al., 2020), relating between default and appraisal inflation (Ben-David, 2011; LaCour-Little and Malpezzi, 2003; Piskorski, Seru, and Witkin, 2015; Calem, Lambie-Hanson, and Nakamura, 2021; Kruger and Maturana, 2020), home equity extraction (Mian and Sufi, 2011; Bhutta and Keys, 2016; Goodman and Zhu, 2018; Laufer, 2018; Kumar, 2018), appraisal inflation and the recent financial crisis (Ben-David, 2011; Kruger and Maturana, 2020), the surge in private label mortgage securitization prior to the financial crisis fueled a large expansion in mortgage credit supply (Mian and Sufi, 2009), and the mortgage misrepresentation literature (e.g., Griffin and Maturana (2016)).

The paper proceeds as follows. The next section describes our empirical methodologies. Section 3 discusses data used in this study and describes our sample. Section 4 discusses our empirical findings and robustness checks. Finally, Section 5 concludes.

2 Empirical Methodologies

2.1 Focusing on Refinance Jumbo Loans

The main focus of this study is on assessing appraisal inflation on properties securing jumbo refinance loans, determining whether portfolio refinance loans carry significantly different appraisal inflation than

[11] Appraisal inflation is hard to detect and difficult to address. But the importance of this problem and the perverse incentives created by securitization require the development of innovative tools to improve appraisal quality.

privately securitized refinance loans, and exploring for potential explanations. One reason why we focus on refinance mortgages is that appraisal plays a more important role in mortgage refinancing than home purchase financing because the underwriting of refinance loans is solely based on appraised values whereas purchase loans are based on the lower of appraised values and transaction prices.More importantly, the lack of transaction price makes it more difficult for outside parties to detect appraisal inflation on refinancing loans, which could lead to more severe information asymmetry in the secondary mortgage market – for purchase loans, the availability of sale prices limits the incidence and, likely, the severity of appraisal inflation. We further limit our analysis to refinance jumbo loans because, unlike conforming home loans, jumbo loans are either retained by lenders or sold to the private securitization market. In contrast, conforming loans can either be sold to the GSEs and securitized in the agency MBS market or sold to private MBS issuers. Therefore, jumbo loans provide a cleaner platform for the investigation of the impact of appraisal inflation on private mortgage securitization.[12] The next sections discuss our main measure of appraisal inflation and the two empirical approaches we develop to gauge the impact of appraisal inflation on securitization.

2.2 Measuring Appraisal Inflation

To measure appraisal inflation, we need to relate a property's appraised value at loan origination to its fair market value at that date. For the purposes of this study, we define appraisal inflation as a valuation ratio, the ratio of a property's appraisal value to its market value.[13] Even though we observe appraised values at loans origination, property values are not directly observable since refinance loans do not involve a transfer of property rights (thus no transaction prices). Since we do not directly observe property values for refinance loans to serve as an anchor to gauge the severity of appraisal inflation, we adopt a "repeat-sale" approach.

To estimate property values at the origination of the refinance loans ($Time_0$), we identify the subsequent sale of the same property ($Time_1$) and then adjust the subsequent sale price, which we refer to as $Price_1$, back to the preceding refinancing date ($Time_0$) using the change in local HPI between $Time_0$ and $Time_1$. This HPI-adjusted price from $Time_1$ back to $Time_0$ (Adj_Price_{10}) is computed as follows: $Adj\_Price_{01} = Price_1 \times HPI_0/HPI_1$, where HPI_0 and HPI_1 are the values of the local house price index at $Time_0$ and $Time_1$, respectively. We use this HPI-adjusted subsequent sale price as our

[12]The relationship between appraisal inflation and securitization is complex because appraisal inflation is not necessarily exogenous to the decision to securitize the associated loan. Although appraisal inflation may affect lenders' choice of which loans to securitize, the reverse could also be true because lenders may tolerate or initiate appraisal inflation if those loans will be securitized. To the best of our ability, we try to shut down the reverse causation in order to accurately estimate the effect of appraisal inflation on securitization. This is the one of the main contributions of this study.

[13]We interchangeably use the terms appraisal inflation, appraisal quality, and appraisal overstatement in this paper.

measure of the property's fair market value at the origination of the associated refinance loan. Finally, we compute appraisal inflation on that property ($AppraisInfl$) as the ratio of the property's observed appraisal value at $Time_0$ ($Appraisal_0$) to the HPI-adjusted subsequent sale price (Adj_Price_{01}).[14]

The intensity of appraisal inflation likely varies across mortgages such as notch versus non-notch loans (Calem, Lambie-Hanson, and Nakamura, 2021). We expect adverse selection is more prominent where intensity of appraisal inflation is high. In addition to exploring adverse selection according to the average appraisal inflation, we also examine the effect at critical LTV cutoffs (notches) above which mortgage pricing and private mortgage insurance (PMI) premiums go up.[15] Inflating an appraisal in order to lower the LTV ratio to the notch or below would reduce financing costs, i.e., PMI premium and mortgage pricing. Therefore, the incidence of appraisal overstatement at LTV notches is likely to be more severe than at non-notches. Lenders are likely aware of lower appraisal quality at LTV notches and may use that to their advantage by selling loans with worse appraisal quality to secondary market and keeping on their books loans with lower appraisal inflation.

2.3 Ex-Ante Analysis of the Securitization Decision

We first explore the potential effect of appraisal inflation on lenders' decision to securitize loans using the following model:

$$\begin{aligned} Pr(Sec_i = 1) &= \alpha + \beta_1 \times AppraisInfl_i + \beta_2 \times LoanChars_i + \beta_3 \times PropChars_i \\ &\quad + \beta_4 \times Lender + \beta_5 \times MSA * OrigQuarter + \varepsilon_i \,. \end{aligned} \tag{1}$$

The dependent variable, Sec_i is a 1/0 variable that takes the value 1 if loan i is securitized and 0 if it is kept in the lender's loan portfolio. The estimated value of β_1, the slope of our variable of interest ($AppraisInf_i$), normally gives the average effect of appraisal inflation on the securitization decision if the relationship is well identified. To isolate the effect of appraisal inflation, our model includes loan characteristics ($LoanChars_i$), property characteristics ($PropChars_i$), lender fixed effects to control for

[14] $AppraisInfl = Appraisal_0/Adj\_Price_{01} = Appraisal_0/(Price_1 \times HPI_0/HPI_1)$. Treating the subsequent sale price of the same property as its fair market value when the property was refinanced is a reasonable assumption as long as the subsequent sale was an arm-length transaction. However, we recognize that Adj_Price_{01} is potentially a noisy measure of property value at the refinancing of the property because changes in market conditions may not be fully reflected in the HPI. Furthermore, this adjustment process does not take care of property-specific price changes. We address these potential identification challenges in our empirical analyses that follow and later test the robustness of our results using hedonic price estimates.

[15] For example, Fannie Mae loan-level pricing adjustment matrix shows that the required minimum mortgage insurance coverage for a borrower with a credit score more than 740 is 0.125%, 0.375%, 0.5% and 1% for mortgages with LTV ratio equaling 80.01% to 85.00%, 85.01% to 90.00%, 90.01% to 95.00%, and 95.01% to 97.00%, correspondingly. Calem et. al., (2017) presents an informative graph in Figure 4 illustrating how private mortgage insurance changes to a higher category right above those LTV notches. These LTV notches are also critical cutoff points for mortgage pricing purposes. For example, Fannie Mae uses the same LTV categories mentioned above to price individual mortgages.

lender heterogeneity, and MSA*Orig Quarter fixed effects to draw within MSA and loan origination quarter inference. As common in the mortgage literature, we use OLS to estimate equation (1), which produces linear probability estimates.[16]

As we alluded to earlier, a straight estimation of Equation (1) would not yield the true effect of appraisal inflation on the likelihood of securitization for the following two reasons. The first challenge is endogeneity due to reverse causality. This ex ante examination of the impact of appraisal inflation on lenders' decisions to securitize originated loans requires that the appraisal occur prior to the securitization decision. Unfortunately, the timing of these decisions is not observable by the econometrician who makes identificationing, because a lender's intention to securitize a loan might affect the appraisal. Secondly, errors in our measure of appraisal inflation could affect $\hat{\beta}_1$, the estimated value of β_1, because our adjustment of subsequent sale prices using changes in local HPIs may not fully account for price changes at the property level. Property-specific market valuation changes will likely be missed by the HPI adjustment process, causing measurement errors.

We develop two empirical techniques that allow us to generate two variants of our appraisal inflation measure to address these potential estimation problems. First, we refine our appraisal inflation measure to account for potential measurement errors due to property-level price appreciations missed by our HPI price adjustment as follows. We calibrate a property-level price appreciation model using purchase transactions and then use our calibrated model to estimate property-specific price appreciations on properties securing refinance loans – since it is possible that properties backing securitized loans do not appreciate at the same rate as properties backing portfolio loans, we control for securitization status in our price appreciation model.[17] We then use our calibrated price appreciation model to estimate price appreciations ($\widehat{Appreciation}$) on refinance loan properties and then adjust our original appraisal inflation measure on refinance loans. This new adjusted appraisal inflation measure, referred to as $Adj\_AppraisInfl$, normally takes care of property-specific price appreciations affecting our estimation results.[18]

We also produce a second variant of our original appraisal inflation measure that mitigates potential endogeneity from reverse causality and also adjusts for property-specific price appreciations. This is accomplished by first predicting appraisal inflation that is independent of the securitization status and then adjusting our predictions for property-specific price appreciations in a manner almost similar to

[16]OLS has a significant advantage over nonlinear models (probit and logit models) because it produces consistent coefficient estimates when the model includes a large number of fixed effects (Wooldridge, 2010).

[17]Table A.2 of the appendix reproduces our property appreciation model. The dependent variable is price appreciation ($Price_0/Adj\_Price_{01}$) on properties backing purchase loans.

[18]For refinance loans, $Adj\_AppraisInfl = Appraisal_0/Adj\_Price_{01} - \widehat{Appreciation}$, where $Adj\_Price_{01} = Price_1 \times HPI_0/HPI_1$

the method described earlier. To predict appraisal inflation, we randomly split our sample into two. We calibrate an appraisal inflation model using one of the sub-samples and then use the calibrated model to generate out-of-sample appraisal inflation predictions for the loans in the other sub-sample.[19] Since the appraisal inflation data used to form predictions only account for local house price changes, as previously, we estimate property-specific price appreciations using a model calibrated on observed sale prices of properties backing purchase loans. But unlike in our previous price appreciation model, this one does not control for securitization status – nor does our appraisal prediction model – to ensure that securitization status has no direct effect on predicted appraisal inflation on refinance loans. The resulting expected appraisal inflation measure ($E[ApppraisInfl]$) thus mitigates endogeneity from reverse causality and also takes care of property-specific price deviations affecting our original appraisal inflation measure, $AppraisInfl$, the ratio of $Appraisal_0$ to Adj_Price_{01}.

Due to the econometric issues discussed above, it would be difficult to draw any conclusive evidence regarding the impact of appraisal inflation on securitization by estimating Equation (1) with our original appraisal inflation measure. Our ex-ante analysis will rely on our two improved measures of appraisal inflation, namely, $Adj\_AppraisInfl$ and $E[ApppraisInfl]$, that are likely to be informative about the effect of appraisal overstatement on securitization. But despite these improvements to our appraisal inflation measure and the numerous controls included in Equation (1), our ex-ante analysis is not immune to potential model misspecification due to omitted variables. In the next section, we propose a cross-sectional difference-in-differences design relying our original appraisal inflation measure that will allow us to confirm our ex-ante analysis and further investigate the complicated relationship between appraisal inflation and securitization in the private mortgage space.

2.4 Ex Post Difference in Appraisal Inflation: Difference-in-Differences Design

To complement our ex-ante analysis of the effect of appraisal inflation on securitization decisions, we examine whether ex post portfolio and securitized loans show significantly different levels of appraisal inflation after controlling for observable differences between the two groups of loans and unobservable factors contributing to our appraisal inflation measure but not related to the difference in appraisal inflation due to securitization. To identify whether securitized refinance loans and portfolio refinance loans have different appraisal inflation, we utilize new purchase loans as a control group to capture the potential difference in price appreciation between portfolio and securitized loans. We contrast the

[19]Table A.3 of the appendix reports our appraisal prediction model.

difference between sold refinance loans and sold portfolio loans to the difference between sold purchase loans and portfolio purchase loans. Since we have pooled cross-sectional data instead of panel data, the empirical design is not intended to draw causal effect but rather to compare the ex post appraisal inflation between sold and portfolio loans. Our DID model specification is as follows:

$$\begin{aligned} ValuationRatio_i \;=\;& \alpha + \beta_1 \times Sec_i + \beta_2 \times Refi_i + \beta_3 \times Sec_i \times Refi_i \\ & + \beta_4 \times LoanChars_i + \beta_6 \times PropChars_i \\ & + \beta_7 \times MSA * OrigQuarter + \beta_8 \times MSA * LaterSaleQuarter + \omega_i \,. \end{aligned} \quad (2)$$

The dependent variable ($ValuationRratio$) is the ratio of property value (that is used to calculate LTV ratio) at origination to the HPI-adjusted subsequent sale price of the same property. For refinance loans, it takes the value of our original appraisal inflation measure, the ratio of appraisal value at $Time_0$ ($Appraisal_0$) to the HPI-adjusted $Time_1$ subsequent sale price of the same property (Adj_Price_{01}). For loans belonging to our control group of purchase loans, our dependent variable is the ratio of the transaction price of the property at origination ($Price_0$) to its HPI-adjusted subsequent sale price (Adj_Price_{01}). Thus, for refinance loans, our dependent variable captures both actual appraisal inflation and property-specific price appreciations not removed through our HPI adjustment process. Our DID design using purchase loans as a control group thus allows us to remove price appreciations on refinanced properties captured in our appraisal inflation measure in a manner similar to the method used in the previous ex-ante analysis. The validity of our DID design relies on the assumption that differences in price appreciation between refinance and purchase portfolio loans are on average similar to differences in price appreciation between refinance and purchase securitized loans. This should be a reasonable assumption.

In Equation (2), Sec identifies securitization status and is set to 1 for securitized loans and 0 for portfolio loans. $Refi$ is also a binary variable indicating loan purpose that is equal to 1 for refinance loans and 0 for purchase loans. The interaction of these two variables, $Sec \times Refi$, is our variable of interest. Its coefficient (β_3) measures the average appraisal inflation on securitized over portfolio refinance loans. Again, the inclusion of portfolio and securitized purchase loans in our DID estimation as a control group allows us to directly estimate average appraisal inflation on portfolio and securitized refinance loans by controlling for average price appreciations clouding our appraisal inflation measure. Since loan characteristics and property characteristics might differ between sold and portfolio loans, we control for $LoanChars$ and $PropChars$ in Equation (2), as in our ex-ante analysis. Our model also include MSA*Origination Quarter and MSA*Later Sale Quarter fixed effects to make inferences for mortgages within the same MSA, the same origination quarter, and the same subsequent sale quarter.

3 Data

This section discusses the various data sources we use in this study and how we construct our sample. We also discuss the main variables used in our analysis and relevant descriptive statistics.

3.1 Sample Construction

This study combines two data sets: McDash and RealtyTrac. The McDash data set is from Black Knight Financial Service (BKFS), a Fidelity National Financial company.[20] The McDash data set contains U.S. home mortgages serviced by nine of the ten largest mortgage servicers and covers more than 60% of home mortgages. The data include mortgages kept by lenders as investment assets (portfolio loans) and those sold to non-agency secondary mortgage market investors (privately securitized mortgages). The data contain detailed loan origination information, such as borrower credit scores, property values, LTV ratios, and subsequent loan performance data, including payments and delinquency records. RealtyTrac collects U.S. residential real estate transaction (lien) data from county recorder offices (recorder data) and real estate property information from county assessors (assessor data). The recorder data include transaction types (e.g., loan refinance or home purchase), transaction dates, transferred values, and associated mortgage information. In addition to assessed property values used for tax purposes, the assessor data record property characteristics, such as property type, total square footage, number of rooms and bathrooms, and property age, etc. We also use FHFA quarterly MSA-level house price index (HPI) data.

To construct the study sample, we first match the McDash data to the RealtyTrac recorder data. To ensure high quality matching, a critical requirement for the accuracy of our analysis, we match the two data sets along property type (e.g., single family), property zip code, transaction year and month, loan amount (in thousands of dollars), transaction purpose (refinance or purchase loan), and interest rate type (fixed or adjustable rate mortgage).[21] We only keep unique matches, which yields a match rate of 30.3%. Next, for each mortgage in our McDash-RealtyTrac matched sample, we track the RealtyTrac recorder data after loan origination to identify the first subsequent sale of the same property up to 2014 when our recorder data end. Our initial sample includes mortgages with recordered subsequent sale of

[20] The data set was previously called LPS data. Fidelity National Financial acquired LPS Applied Analytics, the previous owner of the data, and established BKFS in 2014.

[21] Unlike RealtyTrac, McDash reports loan amounts in \$'000s, and reports transaction year and month, instead of specific transaction dates.

the property are included in our initial sample.

Mortgages are heterogeneous products and underwriting standards evolve over time, particularly during prolonged lending expansions. To maintain a homogeneous data set in order to improve identification, we restrict our sample to conventional, single-family, first lien, jumbo loans originated in 2005 and 2006 on properties located in MSAs.[22] We restrict the study to jumbo loans because, unlike conforming loans, they are either kept by lenders as investment assets or sold to private (non-agency) securitization shops. Conforming loans, on the other hand, can be retained by lenders, sold to government-sponsored enterprises (GSEs) and put into agency securitization deals (the most likely outcome), or sold to the private securitization market. By focusing on jumbo loans, we are able to shut off the agency securitization outlet, which allows us to compare and contrast lenders' portfolio and private securitization decisions. Therefore, jumbo loans provide a cleaner setting to investigate the effect of securitization, more specifically private market securitization, on property appraisal. To further clean our sample, we exclude observations with missing values and, to avoid potential data error and ensure that only residential properties are included in the study, we limit loan amounts to $1.5 million and restrict LTVs between 0.3 and 1.05. Finally, we require that the loans entered into the McDash data within four months of their origination month to limit survival bias.

Both equations (1) and (2) require that we accurately identify each loan's securitization status. We use the investor status variable in McDash to identify securitization status. A mortgage may enter the McDash data as a portfolio loan and later switch to securitized loan because it may take a few months before the lender has amassed enough loans for securitization. Higgins, Yavas, and Zhu (2020) show that over seventy-five percent of securitized mortgages are sold within six months after origination. Therefore, we identify a mortgage's securitization status as its investor status six months after origination – we check that our results are unchanged when securitization status identification is identified nine or twelve months after origination. In order to accurately capture lenders' initial intention to securitize originated loans, we make two additional adjustments to our sample. Mortgages that default soon after origination cannot be securitized. Lenders may also be forced to purchase back securitized loans due to misrepresentation and/or violation of warranty clauses. Neither early-default loans, nor repurchased loans were initially destined to be kept as portfolio loans. Therefore, to better capture lenders' securitization decisions, we drop early-default loans and repurchased mortgages from our sample. After these various data selection and cleaning steps, we end with a final sample of 21,106

[22]The McDash data poorly cover the period pre 2005. Variables key to this study, such as combined LTV (CLTV), documentation status, and debt-to-income (DTI) ratio, are missing for that period. We exclude 2007 from the study due to structural changes of the private mortgage securitization market. Following the mortgage crisis, lenders were no longer able to offload loans they initially intended to securitize, which may complicate identification.

loans, consisting of 13,298 refinance loans, the main focus of this study, and 7,808 purchase loans.[23]

3.2 Summary Statistics

Table 1 presents the summary statistics of refinance loans, the focus of this study – Table A.1 in Appendix reports the same information on purchase loans, for comparison purpose. At loan origination, the appraisals of properties securing portfolio refinance loans ($Appraisal_0$) were on average 4% higher than those securing securitized loans, despite having similar average property size, with the average difference in value widening to 9% following the housing market meltdown ($Price_1$). As far as appraisal inflation is concerned, on average, the two groups look very similar, with securitized loans showing a slightly higher level of appraisal inflation. Furthermore, sold loans have lower average borrower credit score, higher CLTV ratio, higher DTI ratio, a higher percentage of mortgages with exotic features, and higher mortgage rates, which together suggests that they are of lower quality than loans kept by lenders, as evidenced by their higher default rates and level of distressed sales.[24] However, the percentage of loans with fixed interest is higher for sold loans. The descriptive statistics of purchase loans in Table A.1 show similar differences in property characteristics between securitized and portfolio purchase loans.

Table 1 shows no significant difference in appraisal inflation between securitized and portfolio refinance loans. But as noted earlier, appraisal inflation is likely to be more pronounced at LTV notches. Table 2 compares the descriptive statistics of notch and non-notch portfolio and securitized refinance loans.[25] As predicted, portfolio and securitized notch loans show significantly higher appraisal inflation than corresponding non-notch loans. The difference in appraisal inflation between notch and non-notch loans is 4.95% for portfolio loans and 8.77% for securitized loans. More importantly in the context of this study, Table 2 shows significantly higher appraisal inflation on securitized notch loans than on portfolio notch loans, with could be indicative of adverse selection in securitization based on appraisal quality. Whereas non-notch portfolio and securitized loans have similar levels of appraisal inflation, the level of appraisal inflation on notch securitized loans is 3.13% higher than that on portfolio notch loans. Furthermore, this difference in appraisal inflation is economically meaningful because securitized notch loans subsequently defaulted at a much higher rate than notch portfolio loans – 3.62% and 8.41% more within 12 and 24 months after origination, respectively.

[23]The relative small sample is due to inclusion of only jumbo loans with a subsequent sale by 2014.

[24]Exotic loans features include teaser rate, interest only, and balloon structure.

[25]As noted earlier, appraisal inflation at LTV notches is likely to be more severe than at non-notches. Again, notches are the cutoff points above which PMI premiums increase. They are also critical cutoff points for mortgage pricing – Fannie Mae uses the same LTV thresholds to price individual mortgages. Lenders most likely are aware of the lower appraisal quality at LTV notches and may choose to sell worse appraisal quality notch loans to the private market, while keep better appraisal quality notch loans on their books. Notch equals one if LTV ratio equals 80%, 85%, 90%, 95% or 97% or zero, otherwise.

It is possible that servicers approach differently the servicing of securitized and portfolio loans during default and loss mitigation, which could differently affect subsequent transaction prices of distressed securitized and portfolio loans. Therefore, excluding distressed sales from our DID analysis removes potential valuation differences between sold and portfolio loans due to servicing differences. Our previous findings obtain when we exclude distressed loans, with appraisal inflation being 3.2% higher on notch securitized loans than on notch portfolio loans.

These observations provide initial evidence that securitized loans might carry higher valuation inflation than portfolio loans at notches. However, these valuation differences between portfolio and sold loans may be due to differences in loan and housing characteristics. The next section explores differences in appraisal inflation between sold and portfolio loans in a regression setting.

4 Empirical Evidence

4.1 Ex-Ante Analysis: Appraisal Inflation on Lenders' Decision to Securitize

The most direct approach to examining how appraisal inflation affects lenders' decision to securitize is from an ex-ante perspective.[26] However, as discussed in Section 2.2, an estimation of Equation (1) using our original appraisal measure ($AppraisInf$) could yield inconsistent results because of potential measurement errors and reverse causality. To overcome these challenges, we develop two more robust measures of appraisal inflation, $Adj\_AppraisInfl$ and $E\{AppprraisInfl\}$, to reduce measurement errors and turn off reverse causality. Table 3 reports linear probability model (LPM) estimations of Equation (1) using our revised appraisal inflation measures. Our dependent variable captures the loans' securitization status six months after origination.[27] Our measure of appraisal inflation in Model (A) is $Adj\_AppraisInfl$, the ratio of appraisal value to the HPI-adjusted subsequent sale price minus the predicted property appreciation based on the model in Table A.2. As the descriptive statistics in Table 1 suggest, column (1) shows no statistically significant relationship between appraisal inflation and securitization for the full sample. This finding is not surprising because appraisal inflation is unlikely to have a significant effect on average because it normally only matters at specific LTV thresholds. To confirm this intuition, we divide our sample into notch and non-notch loans and re-estimate our model on each sub-sample. As expected, column (2) shows that appraisal inflation has no effect on securitiza-

[26]It is reasonable to assume that lenders are aware of appraisal quality when making securitization decision.

[27]For the sake of brevity, Table 3 only shows our main variable of interest, *Appraisal Inflation*. The full table is available at request.

tion decision on non-notch loans since appraisal inflation is unlikely to have a significant pricing effect on those loans. In contrast, we find in column (3) that appraisal inflation has a strong effect on lenders' decision to securitize those loans, despite the relatively small number of notch loans. A one standard deviation increase in appraisal inflation on notch loans increases the likelihood of a notch loan being securitized by 1.8%, or 2.3% in relative terms.[28] This effect is not only statistically significant, but also of economically meaningful. Though not reported in Table 3 to save space, the explanatory variables included in our model behave appropriately (Table A.4).

As noted earlier, our previous measure of appraisal inflation in Model (A) could be marred by potential reverse causality. To address this concern, Model (B) uses our second measure of appraisal inflation, the expected appraisal inflation that is computed as discussed in the methodology section without controlling for securitization status. Columns (1'), (2'), and (3') report our ex-ante examination of the effect of expected appraisal inflation on securitization for the full sample, and non-notch and notch loans, respectively – the smaller number of observations compared to columns (1), (2), and (3) is due to the splitting of our sample into an estimation subsample and a prediction subsample. Again, we find no significant effect of expected appraisal inflation on securitization for the full sample and non-notch loans. However, lenders' decisions to securitize notch loans appear to be partly driven by the level of appraisal inflation on those loans. Based on the coefficient estimate in column (3'), a one standard deviation increase in appraisal inflation increases the likelihood of a notch loan being securitized by 2.7%, or 3.5% in relative terms.[29] Again, unreported explanatory variables show no inconsistency.

The fact that Model (A) and Model (B) give similar results suggests that reverse causality might not be a serious concern in this situation. Given the prevalence of appraisal inflation during the study period (Kruger and Maturana, 2020), these findings are suggestive of adverse selection based on information asymmetry about mortgage quality as documented in the literature (e.g., Agarwal, Chang, and Yavas (2012)).

4.2 Ex Post Difference in Appraisal Inflation: Difference-In-Differences Analysis

The previous section documents that lenders consider appraisal inflation when securitizing loans. This section investigates whether ex post differences in appraisal inflation between securitized and portfolio loans are statistically and economically significant. We present results based on the DID

[28] 0.0627*0.284(not tabulated)= 1.8% or 1.8%/(10,242/13,298)=2.3% in relative terms. The standard deviation of refinance notch loans is 0.284.

[29] 0.1516*0.175(not tabulated)= 2.7% or 2.7%/(10,242/13,298)=3.6% in relative terms

methodology described in Section 2.4. Our DID analysis uses purchase loans to control for potential differences in property appreciation (or changes in market valuations not removed by HPI adjustments) between portfolio and securitized loans. Differencing out average property appreciation of properties backing purchase loans enables us to accurately measure the difference in appraisal quality between portfolio and securitized refinance loans. Again, the dependent variable, valuation ratio, is the ratio of property valuation at origination (appraised value for refinance loans or transaction price for purchase loans) to the HPI-adjusted subsequent sale price of the same property. The variable of interest in Equation (2) is the interaction of our binary securitization variable (*Sec*) and refinancing variable (*Refi*). Its coefficient estimate, β_3, captures the difference in appraisal inflation between sold and portfolio refinance loans. The explanatory variables include a battery of loan and borrower characteristics to account for other differences between portfolio and securitized loans among refinancing and purchase loans. We also add house tenure and housing characteristics to increase the statistical power of the regression. Lending standards and real estate market conditions change over time and over space. We include MSA times loan origination quarter and MSA times subsequent sale quarter fixed effects to make within the same MSA, the same origination quarter and the same later sale quarter comparisons. If a subsequent sale is a distressed sale, the mortgaged property may be sold at below market value. Thus, we control for distressed sale in the regressions.

Table 4 reports DID regression results following Equation (2).[30] Column (1) reports DID results for the full sample. As in the corresponding ex-ante estimation, $\widehat{\beta}_3$ is positive but insignificant (0.2%), which indicates that there is no discernible difference in appraisal inflation between portfolio and securitized refinancing loans, but the level of appraisal inflation on portfolio refinance loans is significant at 6.1%. Similarly, the insignificant coefficient of *Sec* suggests that properties backing portfolio purchase loans and those backing securitized purchase loans appreciated at similar rate. We find similar results when we restrict our sample to non-notch loans in column (2). In line with our previous ex-ante analysis results, column (3) shows, at the key LTV notches, the level of appraisal inflation on securitized refinancing loans is 3.1% higher than on corresponding loans kept by lenders. In fact, the level of appraisal overstatement on securitized refinancing loans is almost 2.7 times as large as on similar portfolio loans (4.9% vs. 1.8%). Interestingly, the negative coefficient of *Sec* indicates that properties backing securitized purchase loans experienced smaller value appreciation than those securing portfolio purchase loans, which suggests another potential source of adverse selection.

As discussed, the dependent variable used in the above analysis compares property valuation at loan

[30] Table 4 omits the coefficient estimates of the explanatory variables since we do not any strong basis to make predictions on how they should affect the incidence and/or intensity of appraisal inflation.

origination to the HPI-adjusted subsequent sale price; we control for whether the subsequent sale is a distressed sale using a distressed sale dummy in the full sample estimations in columns (1) to (3). As a robustness check, we exclude loans with subsequent distressed sale and rerun our analysis on this restricted sample in columns (1'), (2'), and (3') of Table 4.[31] Not only do these results confirm those based on the full sample, but they also document a significantly higher appraisal inflation on securitized relative to portfolio loans – 5.3% in column (3') compared to 3.1% in column (3).

Given that the evidence gathered so far indicates that the difference in appraisal inflation between sold and portfolio refinance loans largely concentrates on notch loans, we next focus on those loans and explore whether appraisal overstatement is in any way related to the type of refinancing, which could inform us on the potential source of appraisal inflation. Borrowers' motivations for seeking cash-out and term refinancing may create incentives for borrowers and/or lenders to influence appraisals.[32]

Table 5 presents the outcome of such an analysis focusing on notch loans – the model specifications are otherwise the same as in Table 4. Columns (1) and (2) present the results for the full sample. These results show that the coefficient estimate of $Sec \times Refi$, the appraisal inflation on securitized loans relative to portfolio loans, is statistically significant for cash-out refinancing loans only, although the magnitude of the effect is similar for cash-out and term refinance loans. The finding is similar when we exclude distressed properties in columns (1') and (2'). In fact, the intensity of appraisal inflation on securitized loans is now much stronger (5.7% in column (1') vs. 3.5% in column (1)). The last two columns of Table 4 additionally control for lender heterogeneity by including lender fixed effects.[33] Although the addition of lender fixed effects has no effect on cash-out loans, the coefficient of the interaction term ($Sec \times Refi$) is now stronger and marginally significant for term refinancing loans (6.5% in column (2") vs. 5.8% in column (2')). Overall, the results in Table 5 point to cash-out refinancing as a potential cause of the additional appraisal inflation on securitized refinance loans.

The evidence presented in this section consistently shows that sold notch loans have higher appraisal inflation than portfolio notch loans. Higher appraisal overstatement could negatively affect mortgage investors by causing mortgage under-insurance and possibly higher default risk.[34] Furthermore, the

[31]Excluded loans are backed by properties whose subsequent sales were foreclosure, REO sale, or short sales. Distressed property sales typically have noticeably lower transaction price than normal market sale. Servicers also play an important role in distress sales and may adopt different loss mitigation strategies for portfolio loans and sold loans.

[32]Cash-out refinance mortgages allow homeowners who have paid down their mortgages and/or whose properties appreciated to extract part of the built up equity by getting a new mortgage for a larger amount than the existing loan. The amount of equity that the borrower can extract will depend on the property's appraised value. For a term refinance loan, the borrower is generally wants to take advantage of more favorable mortgage rates to lower financing costs.

[33]Mortgage lenders order property appraisals and could have an impact on appraisal quality – this led to the adoption of the Home Valuation Code of Conduct following the 2007 mortgage market crisis (Agarwal, Ambrose, and Yao, 2014). On the one hand, a lender may put pressure on appraisers to inflate appraisals in order to maximize origination revenues if originated loans are largely destined to securitization. On the one hand, a lender may adopt policies and procedures that ensure accurate property valuations to lower default risk if the lender plan to carry the loans on its balance sheet or is worried about potential liability to secondary-market investors.

[34]A 2% to 5% appraisal overstatement could lower the required coverage for PMI by one or even two categories, and

higher default risk associated with inflated appraisals may not be fully priced in the mortgage rates. The next section investigates these issues.

4.3 Loan Performance and Pricing Differences

Having documented that securitized refinancing loans have higher appraisal inflation, which appears to be a deliberate decision on the part of lenders, we now consider whether these loans are more likely to default because of the additional risk associated with appraisal inflation, and whether this additional risk is properly priced in mortgage rate. Unlike Section 4.2 where we include both purchase and refinance loans to better identify difference in appraisal overstatement, our default and pricing analyses include refinance loans and compare portfolio and securitized notch loans while use non-notch loans as a control group to difference out potential compounding factors in a manner somewhat similar to Equation (2).

We define default as the first occurrence of 90-day default, bankruptcy, or foreclosure within 12 or 24 months after origination – we use these two most commonly used definitions of default in the literature to ensure that the results are robust. The explanatory variable of interest in our model reported in Table 6 is the interaction term Sec x $Notch$. Its coefficient measures the difference in default between securitized and portfolio notch loans. Other control variables include securitization status, notch loan dummy, and other loan characteristics at origination such as borrower credit score (FICO), combined LTV, documentation status, DTI, loan amount, and interest rate type. We also control for lender fixed effects and MSA times origination quarter fixed effects. Again, due to the large number of fixed effects included in our model, we adopt a LPM estimation approach.

Table 6 reports estimation results of default within 12 and 24 months after origination. In line with our previous results showing that properties securing securitized notch loans have higher appraisal inflation, column (1) shows that those loans are also more likely to default. Average 12-month default rate on securitized notch loans are 2.3% higher than on portfolio notch loans, and 3.6% (i.e., 2.3%+1.3%) higher than on portfolio non-notch loans – the magnitudes of these estimates are significant compared to average 12-month default of 2.7% and 4.4% on portfolio and securitized refinance loans, respectively (Table 1). After we divide our sample into cash-out and term refinancing loans in columns (2) and (3), we find that the documented increase in 12-month default on notch loans is restricted to cash-out refinancing. While securitized cash-out notch loans default at a much higher rate than portfolio notch loans (by 2.72%), portfolio and securitized term refinance notch loans have statistically similar average default rates. Twenty-four month default regressions in column (1'), (2,), and (3') confirm these findings – as expected, 24-month default estimates are higher due to the longer observation period. Confirming

will therefore lead to significant under-insurance of the mortgage.

the validity of our results, the effects of most control variables included in our models are relatively intuitive. For example, lower FICOs, higher CLTVs, and higher loan amounts are associated with higher likelihoods of default. Our analysis suggests that higher appraisal inflation on securitized notch loans may have contributed to the higher default rate observed at those notches. Compared to lenders, MBS investors ended up holding under-insured mortgages with higher probability of default.

The previous analyses show that sold notch loans have higher appraisal inflation and that the higher appraisal inflation most likely caused the observed higher default rate. This suggests adverse selection in mortgage securitization as worse quality loans were sold to the MBS investors. However, if the additional credit risk associated with the higher appraisal inflation in sold notch loans is priced in the mortgage rates and MBS prices, then our previous findings is not sufficient to claim adverse selection in private securitization. They could just be due to differences in lenders' and investors' risk preferences. Next, we attempt to investigate whether the additional risk at sold notch loans is priced in mortgage contract rate – we do not have access to MBS pricing data.

To address this question, we regress mortgage rates on the same set of variables as in the previous default regressions. Table 7 reports regression results for the full sample in the first three columns and fixed-rate mortgages (FRMs) in the last three columns.[35] Whether we examine all refinancing loans in column (1) or restrict our analysis to cash-out and term loans in columns (2) and (3), respectively, we find no significant difference in mortgage rates charged on securitized and portfolio notch loans – the same is true when we restrict the analysis to FRMs.[36] This indicates that the additional risk for sold notch loans is not priced in mortgage rates, therefore not passed through MBS investors. Therefore, our findings strongly suggest adverse selection in private securitization based on appraisal inflation.[37] Table 7 also shows that, compared to portfolio loans, securitized non-notch loans pay higher interest rates, which compensates investors for the higher default rate found in Table 6.

4.4 Lenders' Informational Advantage and Adverse Selection

This section further investigates information asymmetry and adverse selection in securitization. The existence of adverse selection in mortgage securitization based on appraisal inflation relies on lenders having some information advantage about property values over MBS investors. Although this may be

[35]We separately examine FRMs because they have more homogeneous loan terms and pricing than adjustable rate mortgages.

[36]Since McDash reports servicing data, it does not contain mortgage origination pricing information, such as annual percentage rates (APRs) or points. Consequently, we cannot affirmatively conclude that the additional appraisal inflation on securitized notch loans is not priced outside of interest rates.

[37]However, this does not mean that borrowers do not face higher financing costs. The insignificant coefficient of *Notch* in Table 7 only indicates that there is no major rate difference between notch securitized and portfolio loans. Lenders may charge more points on average on notch securitized loans, which most likely would not be passed through to investors.

true for local lenders, since property values are largely driven by local factors, outside or big lenders may not have superior knowledge than investors about property values. To test this hypothesis, we explore differences in appraisal inflation between loans originated by small lenders, who tend to be local, and those originated by big (national) lenders.[38]

Table 8 reports our tests of asymmetric information investigating whether the difference in appraisal inflation between securitized and portfolio refinancing loans documented in Table 4 varies with lenders' local market knowledge. For this exercise, we estimate the same model as in Table 4, except for the addition of lender fixed effects in Table 8 to control for lender heterogeneity. Therefore, we are capturing within-lender average differences in appraisal inflation between securitized and portfolio refinance loans. Columns (1) and (2) of Table 8 show no difference in appraisal inflation between securitized and portfolio notch or non-notch loans originated by large lenders. This result aligns with the idea that big lenders lack the local market knowledge to cherry-pick which loans to securitize based on appraisal inflation.[39] In contrast, small lenders appear to take advantage of their local market knowledge when securitizing originated loans. Column (1') finds no significant difference in the level of appraisal inflation on securitized and portfolio non-notch loans, but column (2') shows that securitized notch loans have higher appraisal inflation than non-sold loans. These results suggest that the impact of securitization on appraisal inflation found in our previous analyses largely confines to notch loans originated by small lenders, who appear to take advantage of their familiarity with local housing markets.

Next, we cursorily explore the role of lender-MBS issuer affiliation on lenders' propensity to take advantage of information asymmetry about appraisal quality when selecting which mortgages to sell to MBS issuers. To identify lender-issuer affiliation, we need both lender and issuer identities. However, although the RealtyTrac data contain lender information, neither McDash nor RealtyTrac has issuer information. Following Yavas and Zhu (2021), we identity lender-issuer affiliation using changes in investor status in McDash. We can observe in McDash whether a mortgage enters into the database as a portfolio or a securitized loan and can use that information to infer whether the lender and issuer are likely to be affiliated.[40]

The rationale for checking lender-issuer relationship relies on the assumption that lenders are less

[38]We classified big lenders as those who originated at least thirty mortgages in our sample and small lenders as those with less than thirty loans. The results remain similar if changing the threshold to fifty or one hundred mortgages originated.

[39]It is also possible that large lenders deliberately refrain from using appraisal inflation when deciding which loans to securitize due to reputational concerns.

[40]If a mortgage enters the McDash data as a portfolio loan and its investor status later changes to sold loan, which implies that the same servicer likely handles the loan before and after securitization, then it is safe to assume that the lender is likely to be affiliated with the issuer. If, however, a mortgage enters the data set directly as a sold loan, then it is likely that the servicer took over when the loan was sold and is therefore less likely to be affiliated with the lender, which implies that the lender and the issuer are less likely to be affiliated. This classification method is not perfect. For this reason, we think of lender-issuer affiliation as likely affiliation and unaffiliation as unlikely affiliation.

motivated to sell lower quality loans to related issuers because of aligned economic interests. After identifying affiliation for securitized loans, we divide them into two subgroups: affiliated and unaffiliated loans. We then add the portfolio loans to each subgroup in order to assess differences in appraisal inflation between portfolio and securitized loans within each subgroup. Table 9 reports the regression results for the affiliated and unaffiliated sub-samples. For affiliated notch and non-notch loans, we find no difference in appraisal inflation between portfolio and securitized refinance loans. In contrast, for our unaffiliated issuers subsample, securitized notch loans show significantly higher levels of appraisal inflation than portfolio loans, whereas non-notch loans show no difference in appraisal inflation between portfolio and securitized refinance loans. These results suggest that lenders may have exploited their informational advantage about appraisal quality to benefit themselves and related parties in the secondary market.

4.5 Additional Robustness Tests

This section conducts additional tests on the relationship between securitization and appraisal inflation for the purposes of confirming the robustness of our previous results. We first look at how appraisal inflation correlates with borrowers' mortgage product choices and next consider alternative property valuation measures.

4.5.1 Variations in Appraisal Inflation by Mortgage Types

This section provides additional evidence on intensity of appraisal overstatement and adverse selection. The importance of appraisal inflation certainly varies with borrowers' financial situation because financially-constrained borrowers may gain more from appraisal inflation than borrowers who are in a stronger financial situation. This may lead to heterogeneity in appraisal inflation across mortgage product types. For example, financially constrained borrowers may have more difficulty meeting mortgage down payment requirements or a greater need to extract equity through refinancing, thus creating an added incentive to seek high property valuations, which could also lower mortgage financing costs. Therefore, appraisal inflation is likely to be more severe among riskier loan types and for lenders the marginal benefit of cherry picking better appraisal quality loans is likely to be higher among those loans. We explore these questions from two perspectives: mortgage interest types (FRM vs. ARM) and combined LTV. For this analysis, we use the same model as in column (1) of Table 4 with the addition of lender fixed effects, but we restrict our sample to notch loans given that the effect of securitization on appraisal inflation concentrates on those loans. As in Table 4, we include purchase loans to control for price appreciations.

Table 10 summarizes our findings. When we divide our sample between FRM and ARM loans in columns (1) and (2), the effect of securitization on appraisal overstatement is only significant for the ARM subgroup. Whereas FRM securitized and portfolio notch refinance loans have similar appraisal overstatement, the level of appraisal inflation on ARM securitized notch refinance loans is 4.44% more than on corresponding portfolio notch loans. There are a number of possible explanations for this finding. ARM loans are generally riskier than FRM loans and ARM borrowers during the 2005-06 period may have been more financially constrained, thus providing lenders additional motivation to adversely select against holding loans with high appraisal inflation in their portfolios. It is also possible that ARM loans were predominantly used by borrowers refinancing their mortgages in order to extract equity from their homes. Columns (3) and (4) restrict our previous regression model to loans at 80% LTV and those at above 80% LTV, which would require private mortgage insurance in most cases. For the 80%-LTV loans, we find no difference in appraisal inflation between securitized and portfolio notch refinance loans. In contrast, the average appraisal inflation on loans with LTV greater than 80% is 9.74% higher on securitized than comparable portfolio refinance loans. Although this figure seems large, it is not surprising because this group of loans may be more likely to experience substantial appraisal inflation to bring down LTV, thus increasing the chance of loan approval and reducing financing costs for borrowers. The results again indicate that adverse selection in securitization happens where the intensity of appraisal inflation is more severe.

4.5.2 Using Hedonic Property Values

Our main appraisal inflation measure uses the adjusted subsequent sale price of the same property as anchor value. However, it is possible that the requirement of a repeat sale biases our sample because properties with subsequent sales may be characteristically different from those that did not sell during the same period. To address this potential selection issue and check the robustness of our previous findings, we construct hedonic property prices, which do not require repeat sales. Since hedonic estimates use information available to lenders at loan origination, this avoids look-ahead bias in our appraisal inflation measure. We develop hedonic price estimates for each property in our sample using the RealtyTrac recorder and assessment data and then use those estimates as alternative estimates of fair market value to generate new measures of appraisal inflation. Since we only use these hedonic price estimates to check the accuracy of our results, we limit the analysis to Los Angeles County, California, the most populated county in the U.S. We estimate the hedonic property prices at loan origination using recent nearby property transactions, for only that information is available to the appraisers when they conducted the appraisals. We estimate hedonic prices at loan origination using previous three-month and six-month transactions.[41] We exclude loans with valuation ratio (appraisal/hedonic price) in the top and bottom one percentile of the sample to eliminate data errors and make sure that our results are not driven by outliers. We treat these hedonic price estimates as fair property values and then generate new measures of appraisal inflation as the ratio of appraised value to hedonic price.

As before, we restrict this analysis to jumbo refinancing loans. Since hedonic property values are computed at loan origination, there is no need to identify subsequent property sales in order to estimate property values at the time of loan origination, which eliminates the need to control for price appreciations using purchase loans. Consequently, this analysis does not adopt the DID framework laid out in Equation 2. Instead, we contrast portfolio and securitized notch loans while using non-notch loans as a control group to difference out potential difference between the two mortgage investor groups.

Table 11 presents our model specification comparing appraisal inflation on securitized and portfolio notch and non-notch loans based on our 3-month hedonic price estimates. The dependent variable in these regressions is the property's appraisal value at loan origination divided by its hedonic value estimate at that date. As in our appraisal inflation estimations in Table 4, the estimations in Table 11 include an extensive set of loan characteristics at origination and housing characteristics. We also include zip code and loan origination quarter fixed effects. Again, we are interested in the coefficient of the interaction term, Sec x $Notch$. As before, the regressions in columns (1), (2), and (3) document a significant amount of appraisal inflation (2.2%) on securitized notch loans compared to notch portfolio loans that largely stems from cash-out refinancing loans. Among cash-out refinancing loans, securitized notch loans have around 2.5% higher appraisal than the corresponding portfolio loans. The results are unchanged when we add lender fixed effects in the next three columns or when we use 6-month hedonic price estimates in Table A.5. These results are strongly consistent with the findings from previous analysis using our repeat sale appraisal inflation measure.

To sum up, the main finding of this study that sold refinance loans have higher appraisal overstatement than corresponding portfolio loans is robust to various model specifications. This result does not appear to be driven by differences in market valuations between sold and portfolio loans, differences in servicing between the two loan groups, or lender heterogeneity. We find that inflated appraisals on sold notch loans are associated with higher default. However, the additional credit risk is not priced in mortgage rates, which adversely affect MBS investors. These results evidence the presence of adverse selection in securitization based on property appraisal values.

[41] Our hedonic model includes an extensive set of property characteristics, location fixed effects, and time trends – see Table 11 notes.

5 Conclusions

Residential MBS investors suffered heavy losses as a result of the housing market meltdown that led to the Great Recession. Inflated appraisals, which conveys misleading information regarding collateral values to mortgage investors, have often been cited as one main reason of the foreclosure crisis and resulting massive MBS losses. However, due to data constraints, critical questions such as whether lenders sold loans with higher appraisal inflation to MBS investors and the types of loans that were involved have not been fully investigated by academic research. This paper investigates adverse selection as of appraisal inflation in securitization in the years leading to the mortgage crisis. Understanding the exact relation between securitization and appraisal inflation is of importance for the future of private securitization.

Combining nationwide mortgage and real estate transaction data sets, we conduct an ex-ante analysis of whether lenders factor appraisal inflation in their securitization decision and an ex-post examination of differences in appraisal inflation between securitized and similar portfolio loans using refinance jumbo loans in order to accurately estimate the effect of appraisal overstatement on mortgage securitization by lenders. Our our ex-post empirical methodology adopts a difference-in-differences design by using purchase loans as a control group.

Our results show that loans with higher appraisal inflation have a higher probability of sale into MBS pools. Ex post, sold loans carry significantly higher appraisal inflation than similar portfolio loans. The effect centers on loans at critical LTV notches. In addition, we find no difference in pricing between sold and portfolio notch loans, despite the higher default rate on sold notch loan. Lenders likely exploit their informational advantage about appraisal quality to benefit themselves or affiliated entities in the secondary market. The results are robust after controlling the potential impact of servicer and lender effects, and hold when we infer appraisal inflation from repeat sale transactions or hedonic price estimates. These findings indicate the existence of adverse selection in securitization based on appraisal inflation with lenders choosing to keep mortgages with lower appraisal inflation and selling those with higher appraisal inflation, without compensating MBS investors for the additional risk. Appraisal inflation is a crucial concern for the stability of mortgage markets. It may be difficult to combat asymmetric information about appraisal quatlity. However, adequate policies/regulations or innovative security designs are called for to reduce appraisal overstatement, the ability of lenders to capitalize on asymmetric information about appraisal quality, and the perverse incentives created by securitization.

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Table 1: Summary Statistics - Refinance Loans

	Portfolio		Securitized	
Variable	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
$Appraisal_0$ (in \$1000)	784.675	238.644	753.711	228.381
$Price_1$ (in \$1000)	587.030	281.259	536.897	263.909
Valuation Ratio ($Appraisal_0/Adj\_Price_{01}$)	1.173	0.293	1.181	0.296
Notch	0.292	0.455	0.341	0.474
FICO (in 100)	7.039	0.554	6.969	0.595
CLTV (in %)	74.632	10.039	75.889	10.992
LowDoc	0.580	0.494	0.519	0.500
DTI (in %)	35.054	14.615	37.803	11.910
FRM	0.093	0.291	0.223	0.416
Exotic	0.361	0.480	0.403	0.490
OwnerOccupied	0.866	0.341	0.915	0.279
Term (in months)	382.068	49.776	371.347	41.961
Interest (in %)	4.722	2.557	5.806	2.193
LoanAmount (in \$100K)	5.666	1.547	5.463	1.406
Tenure (in months)	50.898	27.134	54.172	26.754
LotSize (in 1000)	17.611	37.839	17.738	38.515
SQFT (in 1000)	2.194	1.450	2.157	6.996
PropertyAge (in years)	28.895	25.845	29.397	25.605
Bedroom	2.971	1.611	3.030	1.522
Bath	2.381	1.225	2.345	1.771
Distress	0.323	0.468	0.400	0.490
Default12	0.027	0.161	0.044	0.206
Default24	0.104	0.306	0.162	0.368
Default	0.326	0.469	0.497	0.500
N of Obs	3,056		10,242	

Notes: Our study sample is made up of refinancing jumbo loans originated in 2005 and 2006. This table reports the summary statistics for portfolio and securitized refinancing loans separately. The property valuation at $Time_0$ is the appraised value at loan origination ($Appraisal_0$). The valuation of the same property at $Time_1$ is the transaction price of the subsequent sale ($Price_1$). Adj_Price_{01} is the HPI-adjusted subsequent transaction price. Valuation ratio (appraisal inflation) is the ratio of $Appraisal_0$ to Adj_Price_{01}. Notch equals one if LTV ratio equals 0.8, 0.85, 0.9, 0.95 or 0.97. Otherwise, notch equals zero. If the subsequent sale is a distressed sale, distress equals 1. Otherwise distress equals zero. If a borrower defaults within 12 months or 24 months or the sample time period, default12m/default24m/default equals 1 correspondingly, otherwise equals zero.

Table 2: Summary Statistics - Notch=0 versus Notch=1

		Portfolio		Securitized	
Variable	*Sample*	*Notch=0*	*Notch=1*	*Notch=0*	*Notch=1*
Valuation Ratio	Full Sample	1.1581	1.2076	1.1512	1.2389
Valuation Ratio	Distress=0	1.0881	1.1085	1.0729	1.1406
Default12m		0.0204	0.0415	0.0272	0.0777
Default24m		0.0718	0.1829	0.1076	0.2670

Notes: This table reports summary statistics for refinance loans. The sample is divided into loans with LTV at notches (Notch=1) versus those not at notches (Notch=0). We report the summary statistics for portfolio loans and securitized loans separately. The valuation ratio, $Appraisal_0/Adj\_Price_{01}$, equals property appraised value at $Time_0$ for a refinance loan divided by the HPI-adjusted subsequent transaction price at $Time_1$ of the same property. Notch equals one if LTV ratio equals 0.8, 0.85, 0.9, 0.95 or 0.97. Otherwise, notch equals zero. We report the valuation ratio for the overall refinance sample and the sample excluding those with subsequent distressed sales.

Table 3: Securitization Decision and Appraisal Inflation

	Model (A)			**Model (B)**		
	(1)	*(2)*	*(3)*	*(1')*	*(2')*	*(3')*
Dep. Var: Securitization Dummy	*All Loans*	*Notch=0*	*Notch=1*	*All Loans*	*Notch=0*	*Notch=1*
Appraisal Inflation	0.0060	-0.0125	0.0627^{***}	-0.0274	-0.0089	0.1516^{**}
	(0.0132)	(0.0167)	(0.0230)	(0.0449)	(0.0523)	(0.0695)
Control Variables	Y	Y	Y	Y	Y	Y
MSA*YYQQ Orig. FE	Y	Y	Y	Y	Y	Y
Lender FE	Y	Y	Y	Y	Y	Y
R-Square	0.1871	0.1904	0.2566	0.2049	0.2142	0.3133
N. Obs.	13,298	8,912	4,386	5,308	3,551	1,757
Appraisal Inflation	$\mathbf{ValuationRatio - \widehat{Appreciation}}$			$\mathbf{\widehat{ValuationRatio} - \widehat{Appreciation}}$		

Notes: This table investigates whether appraisal inflation has any impact on a lender's securitization decision. It reports the coefficient estimates and standard errors of the OLS regressions. Dependent variable is securitization status. Refinance loans are included in the analysis. Appraisal inflation in Model A is measured as the difference of the valuation ratio ($Appraisal_0/Adj\_Price_{01}$) and the estimated property appreciation rate ($\widehat{Appreciation}$). Valuation ratio is the ratio between property appraised value at origination and the subsequent sale price (HPI-adjusted) of the same property. Property appreciation rate of refinance loans is estimated in two steps: (1)estimate the new purchase loan appreciation equation (appreciation = $Price_0/Adj\_Price_{01}$) , and (2)apply the coefficient estimates from (1) to the refinance loans to have the $\widehat{Appreciation}$. Since the valuation ratio for refinance loans contains property-specific appreciation information that may not be captured by local HPI, Model A intends to extract the property-specific appreciation from the valuation ratio to have a cleaner measure of appraisal inflation. Appraisal inflation in Model B is measured by taking the difference of the estimated valuation ratio ($\widehat{ValuationRatio}$) and the estimated property appreciation rate ($\widehat{Appreciation}$). $\widehat{ValuationRatio}$ is estimated in three steps: (1)divide the refinance loans into a random 60% estimation sample and a 40% holdout sample; (2) use the estimation sample to run regression of valuation ratio regardless of the securitization status; and (3)apply the coefficient estimates from (2) to the holdout sample to have $\widehat{ValuationRatio}$. Property appreciation rate is estimated with securitization status in Model A and regardless of the securitization status in Model B. The purpose of model B is to not only extract property appreciation from the valuation ratio to infer appraisal inflation but also eliminate potential reverse causality between securitization and appraisal inflation. Other control variables include loan characteristics at origination, MSA*origination quarter fixed effects and lender fixed effects. Standard errors are clustered by MSA. *** p<0.01,** p<0.05, * p<0.10.

Table 4: Securitization and Appraisal Inflation – DID Regression Overall Sample Results

	Full Sample			Excluding Distress Sales		
	(1)	*(2)*	*(3)*	*(1')*	*(2')*	*(3')*
Variable	*All loans*	*Notch=0*	*Notch=1*	*All Loans*	*Notch=0*	*Notch=1*
Sec x Refi	0.0018	-0.0076	0.0312**	-0.0047	-0.0140	0.0529**
	(0.0088)	(0.0113)	(0.0158)	(0.0108)	(0.0133)	(0.0224)
Sec	-0.0064	0.0003	-0.0248**	0.0009	0.0082	-0.0308*
	(0.0070)	(0.0094)	(0.0119)	(0.0087)	(0.0112)	(0.0164)
Refi	0.0609***	0.0853***	0.0179	0.0596***	0.0763***	0.0130
	(0.0079)	(0.0100)	(0.0145)	(0.0095)	(0.0117)	(0.0201)
Control Variables	Y	Y	Y	Y	Y	Y
MSA*YYQQ Orig FE	Y	Y	Y	Y	Y	Y
MSA*YYQQ LaterSale FE	Y	Y	Y	Y	Y	Y
R-Square	0.4036	0.4182	0.4896	0.3173	0.3444	0.5069
N. Obs.	21,072	13,182	7,890	12,978	9,000	3,978

Notes: This table reports the coefficient estimates and standard errors of the DID regressions of appraisal inflation. The focus is the interaction term that indicates the difference in valuation bias between portfolio and securitized refinance loans. New purchased loans are included as a control group to account for the unobservable differences leading to different property appreciations between the two groups. The table reports the results of the overall samples and the sub samples excluding loans where the subsequent transaction is a distressed sale such as short sale or foreclosure sale. The dependent variable, valuation ratio, represents the ratio of property valuation (that is used to calculate LTV ratio) at origination to the HPI-adjusted subsequent sale price of the same property. The property valuation at orignation is the appraised value for a refinance loan and the sale price for a new purchase loan. Notch equals one if the LTV ratio equals 0.8, 0.85, 0.9, 0.95 or 0.97. Otherwise, notch equals zero. Standard errors are clustered by MSA. *** $p<0.01$,** $p<0.05$, * $p<0.10$.

Table 5: Securitization and Appraisal Inflation on Notch Loans – Cash-Out and Term Refinance

	Full Sample		Excluding Distress Sales			
	(1)	*(2)*	*(1')*	*(2')*	*(1")*	*(2")*
Variable	*Cash-Out*	*Term*	*Cash-Out*	*Term*	*Cash-Out*	*Term*
Sec*Refi	0.0346**	0.0366	0.0572**	0.0572	0.0580**	0.0652*
	(0.0166)	(0.0237)	(0.0231)	(0.0359)	(0.0234)	(0.0365)
Sec	-0.0256**	-0.0205	-0.0259	-0.0184	-0.0347**	-0.0255
	(0.0120)	(0.0129)	(0.0165)	(0.0183)	(0.0167)	(0.0186)
Refi	0.0154	0.0142	0.0072	0.0187	0.0078	0.0147
	(0.0151)	(0.0213)	(0.0206)	(0.0309)	(0.0208)	(0.0312)
Controls	Y	Y	Y	Y	Y	Y
MSA*YYQQ Orig FE	Y	Y	Y	Y	Y	Y
MSA*YYQQ LaterSale FE	Y	Y	Y	Y	Y	Y
Lender FE	N	N	N	N	Y	Y
R-Square	0.5026	0.5490	0.5214	0.5865	0.5396	0.6116
N. Obs.	7,233	4,716	3,721	2,446	3,721	2,446

Notes: Notes: This table divides notch loans into cash out refinance and term refinance sub samples. We report the results of the full samples and the sub samples excluding loans where the subsequent transaction is a distressed sale such as a short sale or a foreclosure sale. Loans included are those at LTV ratio notches. It reports the coefficient estimates and standard errors of the DID regressions of valuation ratio. The main interest is the difference in the valuation ratio between portfolio refinance and securitized refinance loans. New purchased loans are included as a control group to account for the unobservable difference in property appreciation between sold and portfolio loans. The dependent variable, valuation ratio, represents the ratio of property valuation (that is used to calculate LTV ratio) at origination to the HPI-adjusted subsequent sale price of the same property. The property valuation at orignation is the appraised value for a refinance loan and the sale price for a new purchase loan. Notch equals one if LTV ratio equals 0.8, 0.85, 0.9, 0.95 or 0.97. Other model specifications and control variables are the same in Table 3. Otherwise, notch equals zero. Standard errors are clustered by MSA. *** $p<0.01$,** $p<0.05$, * $p<0.10$.

Table 6: Appraisal Inflation and Mortgage Performance – Are Sold Notch Loans More Likely to Default than Portfolio Notch Loans?

	12-Month Default			24-Month Default		
	(1)	*(2)*	*(3)*	*(1')*	*(2')*	*(3')*
Variable	*All Loans*	*Cash-Out Refi*	*Term Refi*	*All Loans*	*Cash-Out Refi*	*Term Refi*
Sec * Notch	0.0230**	0.0272***	-0.0028	0.0413***	0.0505***	-0.0227
	(0.0101)	(0.0095)	(0.0164)	(0.0148)	(0.0146)	(0.0299)
Sec	0.0130***	0.0128***	0.0052	0.0450***	0.0453***	0.0302**
	(0.0042)	(0.0042)	(0.0077)	(0.0048)	(0.0051)	(0.0115)
Notch	-0.0066	-0.0108	0.0129	0.0049	-0.0082	0.0762**
	(0.0082)	(0.0087)	(0.0179)	(0.0132)	(0.0131)	(0.0311)
FICO	-0.0596***	-0.0542***	-0.0677***	-0.1197***	-0.1124***	-0.1359***
	(0.0045)	(0.0044)	(0.0076)	(0.0059)	(0.0062)	(0.0115)
CLTV	0.0008***	0.0007**	0.0004	0.0044***	0.0041***	0.0029***
	(0.0002)	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0006)
LowDoc	-0.0035	-0.0072*	0.0012	0.0203***	0.0079	0.0198**
	(0.0038)	(0.0040)	(0.0062)	(0.0062)	(0.0056)	(0.0098)
DTI	0.0003**	0.0003***	-0.0001	0.0004*	0.0004*	0.0001
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0005)
FRM	-0.0193***	-0.0211***	-0.0120	-0.0492***	-0.0486***	-0.0618***
	(0.0047)	(0.0045)	(0.0122)	(0.0084)	(0.0089)	(0.0185)
Exotic	-0.0065	-0.0063	-0.0032	-0.0237***	-0.0204***	-0.0314**
	(0.0046)	(0.0053)	(0.0089)	(0.0059)	(0.0066)	(0.0128)
OwnerOccupied	-0.0024	-0.0087	0.0116	-0.0528***	-0.0601***	-0.0122
	(0.0067)	(0.0080)	(0.0122)	(0.0131)	(0.0140)	(0.0295)
Term	0.0002***	0.0002***	0.0002**	0.0004***	0.0003***	0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
LoanAmount	0.0025**	0.0022**	0.0003	0.0056**	0.0041	0.0086**
	(0.0011)	(0.0010)	(0.0020)	(0.0026)	(0.0025)	(0.0040)
MSA*YYQQ Orig FE	Y	Y	Y	Y	Y	Y
Lender FE	Y	Y	Y	Y	Y	Y
R-Square	0.1270	0.1341	0.1759	0.2375	0.2349	0.2951
N Obs	13,275	11,361	3,987	13,275	11,361	3,987

Notes: This table investigates whether sold notch loans have different default probability than portfolio notch loans. Refinance loans are included in the analysis. It reports the coefficient estimates and standard errors of the OLS regressions of default. The dependent variable, default, equals one if a borrower missed at least three mortgage payments or was in foreclosure or bankruptcy status within twelve or twenty-four months after origination (Default12m and Default24m), and equals zero otherwise. Independent variables include loan characteristics at origination, MSA*origination quarter fixed effects, and lender fixed effects. Standard errors are clustered by MSA. *** $p<0.01$,** $p<0.05$, * $p<0.10$.

Table 7: Appraisal Inflation and Mortgage Pricing – Are Sold Notch Loans Priced Higher than Portfolio Notch Loans?

	Full Sample			FRM		
	(1)	*(2)*	*(3)*	*(1')*	*(2')*	*(3')*
Variable	*All Loans*	*Cash-Out Refi*	*Term Refi*	*All Loans*	*Cash-Out Refi*	*Term Refi*
Sec x Notch	0.0505	0.0427	0.0108	-0.1235	-0.1724	-0.1634
	(0.1356)	(0.1442)	(0.1613)	(0.1316)	(0.1621)	(0.1231)
Sec	0.5616***	0.4767***	0.4477***	0.0045	0.0381	0.0260
	(0.0465)	(0.0463)	(0.0671)	(0.0669)	(0.0782)	(0.0956)
Notch	-0.0485	0.0078	-0.1006	0.1512	0.1902	0.1816
	(0.1332)	(0.1410)	(0.1347)	(0.1434)	(0.1681)	(0.1422)
FICO	-0.5492***	-0.5839***	-0.1000*	-0.2673***	-0.2756***	-0.1457***
	(0.0441)	(0.0471)	(0.0534)	(0.0238)	(0.0240)	(0.0434)
CLTV	0.0083***	0.0106***	0.0040	0.0067***	0.0068***	0.0048
	(0.0023)	(0.0020)	(0.0039)	(0.0013)	(0.0011)	(0.0031)
LowDoc	-0.4029***	-0.3508***	-0.3933***	0.0788**	0.0637*	0.0785
	(0.0560)	(0.0596)	(0.0716)	(0.0334)	(0.0338)	(0.0606)
DTI	0.0034	0.0039	0.0056**	-0.0005	0.0000	-0.0014
	(0.0024)	(0.0027)	(0.0027)	(0.0015)	(0.0018)	(0.0016)
FRM	0.7490***	0.6351***	0.9956***	0.0000***	0.0000***	0.0000***
	(0.0666)	(0.0658)	(0.0700)	(0.0000)	(0.0000)	(0.0000)
Exotic	0.8480***	0.7537***	0.9724***	-0.0035	-0.0029	0.0447
	(0.0620)	(0.0723)	(0.0468)	(0.0314)	(0.0329)	(0.0524)
OwnerOccupied	-0.0096	-0.0923	0.2219	-0.2272**	-0.2937**	-0.3504***
	(0.0609)	(0.0599)	(0.1442)	(0.1001)	(0.1162)	(0.1301)
Term	-0.0033***	-0.0021***	-0.0059***	0.0011***	0.0010***	0.0009*
	(0.0007)	(0.0007)	(0.0013)	(0.0003)	(0.0003)	(0.0005)
LoanAmount	-0.0324**	-0.0237	-0.0491**	0.0013	0.0004	0.0155
	(0.0143)	(0.0178)	(0.0220)	(0.0073)	(0.0080)	(0.0139)
MSA*YYQQ Orig FE	Y	Y	Y	Y	Y	Y
Lender FE	Y	Y	Y	Y	Y	Y
R-Square	0.4440	0.4624	0.4433	0.5736	0.5859	0.6472
N. Obs.	13,275	11,361	3,987	2,565	2,311	847

Note: This table investigates whether the additional default risk associated with inflated valuation for sold notch loans is priced in the mortgage rates. Refinance loans are included in the analysis. It reports the coefficient estimates and standard errors of the OLS regressions of mortgage rate. Independent variables include loan characteristics at origination, MSA*origination quarter fixed effects and lender fixed effects. Standard errors are clustered by MSA. *** p<0.01,** p<0.05, * p<0.10.

Table 8: Asymmetric Information and Adverse Selection Based on Appraisal Inflation – Small versus Big Lenders

	Big Lenders		Small Lenders	
	(1)	*(2)*	*(1')*	*(2')*
Variable	*Notch=0*	*Notch=1*	*Notch=0*	*Notch=1*
Sec * Refi	0.0015	0.0266	-0.0308	0.1101**
	(0.0126)	(0.0180)	(0.0349)	(0.0505)
Sec	-0.0154	-0.0361***	0.0290	-0.0133
	(0.0107)	(0.0135)	(0.0286)	(0.0389)
Refi	0.0802***	0.0294*	0.0855***	-0.0223
	(0.0109)	(0.0164)	(0.0317)	(0.0465)
Controls	Y	Y	Y	Y
MSA*YYQQ Orig FE	Y	Y	Y	Y
MSA*YYQQ LaterSale FE	Y	Y	Y	Y
Lender FE	Y	Y	Y	Y
R-Square	0.4493	0.5284	0.6207	0.6812
N. Obs.	10,682	6,327	2,520	1,577

Notes: This table investigates the role of asymmetric information and the adverse selection in property valuation. We divide the sample by the size of lender. Big lender sample includes loans by lenders who originated more than thirty mortgages in the sample. Small lender sample includes loans by lenders with less than thirty loans originated in the sample. Small lenders are likely to be local lenders who possess more private information on property valuation. Large lenders are likely to be national lenders who have less amount of private information in property valuation. Notch equals one where the LTV ratio equals 0.8, 0.85, 0.9, 0.95 or 0.97. The dependent variable, valuation ratio, represents the ratio of property valuation (that is used to calculate LTV ratio) at origination to the HPI-adjusted subsequent sale price of the same property. The property valuation at orignation is the appraised value for a refinance loan and the sale price for a new purchase loan. Other model specifications and control variables are the same as in Table 4. Standard errors are clustered by MSA. *** p<0.01,** p<0.05, * p<0.10.

Table 9: Lender-MBS Issuer Affiliation and Adverse Selection Based on Appraisal Inflation

	Unaffiliated		Affiliated	
	(1)	*(2)*	*(1')*	*(2')*
Variable	*Notch=0*	*Notch=1*	*Notch=0*	*Notch=1*
Sec * Refi	0.0040	0.0469**	-0.0125	0.0288
	(0.0147)	(0.0199)	(0.0129)	(0.0189)
Sec	-0.0134	-0.0419**	0.0050	-0.0257*
	(0.0140)	(0.0184)	(0.0108)	(0.0139)
Refi	0.0703***	0.0179	0.0850***	0.0257
	(0.0108)	(0.0166)	(0.0106)	(0.0162)
Controls	Y	Y	Y	Y
MSA*YYQQ Orig FE	Y	Y	Y	Y
MSA*YYQQ LaterSale FE	Y	Y	Y	Y
Lender FE	Y	Y	Y	Y
R-Square	0.5158	0.5524	0.4594	0.5586
N. Obs.	6,918	4,346	9,229	4,976

Note: This table investigates one potential channel of adverse selection in property valuation, lender-MBS Issuer affiliation. Affiliated sample includes sold loans that lender and MBS issuer are likely to be affiliated. Unaffiliated sample includes sold loans that lender and MBS underwriter are unlikely to be affiliated. Portfolio loans are included in both samples. Notch equals one where the LTV ratio equals 0.8, 0.85, 0.9, 0.95 or 0.97. The dependent variable, valuation ratio, represents the ratio of property valuation (that is used to calculate LTV ratio) at origination to the HPI-adjusted subsequent sale price of the same property. The property valuation at orignation is the appraised value for a refinance loan and the sale price for a new purchase loan. Other model specifications and control variables are the same as in Table 4. Standard errors are clustered by MSA. *** p<0.01,** p<0.05, * p<0.10.

Table 10: Additional Tests – Variations Across Mortgage Types

	(1)	*(2)*	*(3)*	*(4)*
	FRM	ARM	CLTV=80%	CLTV>80%
Sec x Refi	-0.0513	0.0444***	0.0279	0.0974***
	(0.0856)	(0.0170)	(0.0198)	(0.0351)
Sec	-0.0154	-0.0388***	-0.0262*	-0.0586**
	(0.0615)	(0.0129)	(0.0147)	(0.0269)
Refi	0.0869	0.0097	0.0369**	-0.0430
	(0.0833)	(0.0155)	(0.0177)	(0.0337)
Controls	Y	Y	Y	Y
MSA*YYQQ Orig FE	Y	Y	Y	Y
MSA*YYQQ LaterSale FE	Y	Y	Y	Y
Lender FE	Y	Y	Y	Y
R-Square	0.8097	0.5081	0.5449	0.6195
N. Obs.	1,029	6,875	5,120	2,784

Note: This table conducts sub sample analysis to investigate where the adverse selection in appraisal inflation is more likely to occur. Notch loans are included in the analysis where the LTV ratio equals 0.8, 0.85, 0.9, 0.95 or 0.97. The dependent variable, valuation ratio, represents the ratio of property valuation (that is used to calculate LTV ratio) at origination to the HPI-adjusted subsequent sale price of the same property. The property valuation at orignation is the appraised value for a refinance loan and the sale price for a new purchase loan. Other model specifications and control variables are the same as in Table 4. Standard errors are clustered by MSA. *** p<0.01,** p<0.05, * p<0.10.

Table 11: Robustness Checks – Using Hedonic Property Values (3-Month Prediction Window)

Variable	*(1)* *All Loans*	*(2)* *Cash-Out Refi*	*(3)* *Term Refi*	*(1')* *All Loans*	*(2')* *Cash-Out Refi*	*(3')* *Term Refi*
Sec x Notch	0.0206***	0.0247***	0.0026	0.0200**	0.0259***	0.0058
	(0.0076)	(0.0083)	(0.0163)	(0.0083)	(0.0093)	(0.0200)
Sec	0.0008	0.0006	0.0104	-0.0011	-0.0024	0.0118
	(0.0050)	(0.0053)	(0.0098)	(0.0054)	(0.0059)	(0.0131)
Notch	-0.0107	-0.0129	-0.0023	-0.0082	-0.0116	-0.0003
	(0.0076)	(0.0082)	(0.0147)	(0.0081)	(0.0090)	(0.0178)
Controls	Y	Y	Y	Y	Y	Y
Zip FE	Y	Y	Y	Y	Y	Y
Closing Quarter FE	Y	Y	Y	Y	Y	Y
Lender FE	N	N	N	Y	Y	Y
R-Square	0.5102	0.5128	0.5964	0.5644	0.5682	0.6953
N. Obs.	4,748	4,227	1,111	4,748	4,227	1,111

Note: This table uses the hedonic estimate of property value at loan origination as an alternative market valuation of the property. The dependent variable measures valuation bias as the ratio between appraised value and the hedonic valuation of the same property. We estimate the hedonic property prices at loan origination using previous three-month nearby property transactions, for only that information is available to the appraisers when they conducted the appraisals. Loans included are refinance mortgages. Independent variables include loan characteristics at origination, Zip code and closing quarter fixed effects, and lender fixed effects. Standard errors are clustered by zip. *** p<0.01,** p<0.05, * p<0.10.

A Appendix

Table A.1: Summary Statistics of Purchase Loans

	Portfolio		Securitized	
Variable	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
$Price_0$ (in \$1000)	743.050	243.769	692.302	201.172
$Price_1$ (in \$1000)	609.479	301.753	531.865	258.391
Valuation Ratio ($Price_0/Adj\_Price_{01}$)	1.124	0.307	1.164	0.308
Notch	0.373	0.484	0.476	0.499
FICO (in 100)	7.215	0.538	7.076	0.569
CLTV (in %)	80.537	9.965	82.443	9.850
LowDoc	0.462	0.499	0.536	0.499
DTI (in %)	33.777	15.304	37.447	12.287
FRM	0.126	0.332	0.173	0.378
Exotic	0.365	0.482	0.439	0.496
OwnerOccupied	0.813	0.390	0.859	0.348
Term (in months)	382.811	50.670	381.316	48.749
Interest (in %)	5.224	2.180	6.025	1.958
LoanAmount (in \$100K)	5.786	1.713	5.409	1.409
Tenure (in months)	52.229	26.979	51.356	27.010
LotSize (in 1000)	15.703	33.850	14.996	33.004
SQFT (in 1000)	2.264	5.056	1.960	1.065
PropertyAge (in years)	32.677	28.221	33.867	27.706
Bedroom	2.864	1.647	2.820	1.599
Bath	2.348	1.303	2.194	1.727
Distress	0.307	0.461	0.414	0.493
Default12	0.030	0.171	0.076	0.265
Default24	0.099	0.298	0.203	0.402
Default	0.291	0.454	0.494	0.500
N of Obs	1,928		5,880	

Notes: This table reports the summary statistics for portfolio and securitized purchase jumbo loans originated in 2005 and 2006, which are used to control for property appreciation on our corresponding sample of refinance loans. The property valuation at $Time_0$ is the sale price for a new purchase loan ($Price_0$). The valuation of the same property at $Time_1$ is the transaction price of the subsequent sale ($Price_1$). Adj_Price_{01} is the HPI-adjusted subsequent transaction price. Valuation ratio (appreciation) is the ratio of $Price_0$ to Adj_Price_{01}. Notch equals one if LTV ratio equals 0.8, 0.85, 0.9, 0.95 or 0.97. Otherwise, notch equals zero. If the subsequent sale is a distressed sale, distress equals 1. Otherwise distress equals zero. If a borrower defaults within 12 months or 24 months or the sample time period, default12m/default24m/default equals 1 correspondingly, otherwise equals zero.

Table A.2: First-Stage Regression - House Price Appreciation

	Full Sample		Notch=0		Notch=1	
Variable	*Estim.*	*Std. Err.*	*Estim.*	*Std. Err.*	*Estim.*	*Std. Err.*
Intercept	0.9791***	(0.3099)	1.1807***	(0.3687)	0.9107**	(0.4254)
Securitization	-0.0147**	(0.0067)	-0.0047	(0.0082)	-0.0299***	(0.0112)
FICO	-0.0344***	(0.0056)	-0.0292***	(0.0071)	-0.0456***	(0.0089)
CLTV	0.0014***	(0.0003)	0.0021***	(0.0004)	0.0008	(0.0007)
LowDoc	0.0160***	(0.0059)	0.0131*	(0.0076)	0.0107	(0.0093)
DTI	0.0005**	(0.0002)	0.0003	(0.0003)	0.0004	(0.0004)
FRM	-0.0342***	(0.0093)	-0.0160	(0.0108)	-0.0670***	(0.0174)
Exotic	-0.0191***	(0.0066)	-0.0107	(0.0083)	-0.0207*	(0.0108)
Notch	0.0363***	(0.0059)				
OwnerOccupied	-0.0104	(0.0080)	-0.0161	(0.0105)	-0.0092	(0.0123)
Term	0.0004***	(0.0001)	0.0004***	(0.0001)	0.0003***	(0.0001)
Interest	0.0098***	(0.0016)	0.0058***	(0.0020)	0.0130***	(0.0025)
LoanAmount	-0.0294***	(0.0021)	-0.0224***	(0.0026)	-0.0487***	(0.0040)
Tenure	0.0006	(0.0025)	-0.0035	(0.0032)	0.0043	(0.0039)
Default	0.0756***	(0.0074)	0.0846***	(0.0100)	0.0496***	(0.0111)
Distress	0.1573***	(0.0075)	0.1600***	(0.0103)	0.1565***	(0.0110)
LotSize	0.0009***	(0.0001)	0.0009***	(0.0001)	0.0009***	(0.0002)
SQFT	0.0002	(0.0011)	-0.0014	(0.0036)	-0.0007	(0.0014)
PropertyAge	-0.0006***	(0.0001)	-0.0010***	(0.0001)	-0.0003*	(0.0002)
Bedroom	-0.0041	(0.0025)	-0.0022	(0.0031)	-0.0060	(0.0045)
Bath	-0.0011	(0.0020)	-0.0006	(0.0019)	0.0004	(0.0062)
MSA*YYQQ Orig FE	Y		Y		Y	
MSA*YYQQ LaterSale FE	Y		Y		Y	
R-Square	0.5289		0.5869		0.5907	
N Obs	7,808		4,290		3,518	

Notes: This table reports the first-stage regressions of housing appreciation. New purchase loans are included in the analyses. Dependent variable is HPI-adjusted house appreciation from $Time_1$ to $Time_0$ ($Price_0/Adj\_Price_{01}$). Standard errors are clustered by MSA. *** p<0.01,** p<0.05, * p<0.10.

Table A.3: First-Stage Regression - Valuation Ratio

	Full Sample		Notch=0		Notch=1	
Variable	*Estim.*	*Std. Err.*	*Estim.*	*Std. Err.*	*Estim.*	*Std. Err.*
Intercept	1.7397***	(0.4210)	2.0454***	(0.4689)	1.0607***	(0.3432)
FICO	-0.0367***	(0.0053)	-0.0410***	(0.0065)	-0.0263***	(0.0092)
CLTV	0.0010***	(0.0003)	0.0006*	(0.0004)	0.0017*	(0.0009)
LowDoc	0.0286***	(0.0061)	0.0311***	(0.0077)	0.0108	(0.0100)
DTI	0.0007***	(0.0002)	0.0006**	(0.0003)	0.0008**	(0.0004)
FRM	-0.0500***	(0.0081)	-0.0509***	(0.0098)	-0.0365**	(0.0147)
Exotic	-0.0050	(0.0064)	-0.0039	(0.0081)	-0.0101	(0.0102)
Notch	0.0121*	(0.0070)				
OwnerOccupied	-0.0291***	(0.0094)	-0.0307**	(0.0120)	-0.0248*	(0.0150)
Term	0.0002***	(0.0001)	0.0002***	(0.0001)	0.0001	(0.0001)
Interest	0.0018	(0.0013)	0.0032*	(0.0017)	-0.0021	(0.0021)
LoanAmount	-0.0321***	(0.0022)	-0.0315***	(0.0026)	-0.0466***	(0.0045)
Tenure	-0.0020	(0.0025)	-0.0059*	(0.0031)	0.0049	(0.0040)
Default	0.0492***	(0.0074)	0.0372***	(0.0096)	0.0356***	(0.0115)
Distress	0.1641***	(0.0074)	0.1969***	(0.0098)	0.1122***	(0.0112)
LotSize	0.0008***	(0.0001)	0.0007***	(0.0001)	0.0013***	(0.0002)
SQFT	-0.0031	(0.0040)	-0.0044	(0.0049)	0.0143*	(0.0084)
PropertyAge	-0.0002*	(0.0001)	-0.0007***	(0.0002)	0.0001	(0.0002)
Bedroom	-0.0105***	(0.0028)	-0.0142***	(0.0034)	0.0085	(0.0055)
Bath	0.0065***	(0.0018)	0.0067***	(0.0019)	-0.0210**	(0.0083)
MSA*YYQQ Orig FE	Y		Y		Y	
MSA*YYQQ LaterSale FE	Y		Y		Y	
R-Square	0.4481		0.4883		0.5937	
N Obs	7,992		5,303		2,689	

Notes: This table reports the first-stage regressions of valuation ratio for refinance loans. Refinance estimation sample is included in the analyses. The dependent variable, valuation ratio, represents the ratio of property appraised value at origination to the HPI-adjusted subsequent sale price of the same property. Standard errors are clustered by MSA. *** p<0.01,** p<0.05, * p<0.10.

Table A.4: Securitization Decision and Appraisal Inflation

	Model (A)			Model (B)		
	(1)	*(2)*	*(3)*	*(1')*	*(2')*	*(3')*
Dep. Var: Securitization Dummy	*All Loans*	*Notch=0*	*Notch=1*	*All Loans*	*Notch=0*	*Notch=1*
Appraisal Inflation	0.0060	-0.0125	0.0627^{***}	-0.0274	-0.0089	0.1516^{**}
	(0.0132)	(0.0167)	(0.0230)	(0.0449)	(0.0523)	(0.0695)
FICO	0.0076	0.0153^{*}	-0.0213^{*}	0.0161	0.0217	-0.0068
	(0.0070)	(0.0090)	(0.0129)	(0.0115)	(0.0150)	(0.0228)
CLTV	-0.0007^{*}	-0.0016^{***}	0.0009	-0.0011^{*}	-0.0017^{**}	0.0005
	(0.0004)	(0.0005)	(0.0013)	(0.0006)	(0.0008)	(0.0023)
LowDoc	0.0186^{**}	0.0214^{**}	0.0067	0.0206	0.0270	0.0196
	(0.0082)	(0.0108)	(0.0144)	(0.0137)	(0.0183)	(0.0255)
DTI	0.0010^{***}	0.0015^{***}	0.0006	0.0014^{***}	0.0014^{**}	0.0037^{***}
	(0.0003)	(0.0004)	(0.0006)	(0.0005)	(0.0006)	(0.0010)
FRM	0.1133^{***}	0.1230^{***}	0.0910^{***}	0.1065^{***}	0.1127^{***}	0.1059^{***}
	(0.0110)	(0.0141)	(0.0218)	(0.0185)	(0.0240)	(0.0392)
Exotic	0.0298^{***}	0.0320^{***}	0.0377^{***}	0.0369^{***}	0.0298	0.0379
	(0.0086)	(0.0114)	(0.0146)	(0.0142)	(0.0194)	(0.0253)
OwnerOccupied	0.0528^{***}	0.0913^{***}	-0.0338	0.0528^{**}	0.0839^{***}	-0.0012
	(0.0123)	(0.0164)	(0.0212)	(0.0209)	(0.0288)	(0.0363)
Term	-0.0007^{***}	-0.0007^{***}	-0.0008^{***}	-0.0007^{***}	-0.0006^{***}	-0.0012^{***}
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0003)
Interest	0.0274^{***}	0.0281^{***}	0.0223^{***}	0.0264^{***}	0.0284^{***}	0.0241^{***}
	(0.0020)	(0.0026)	(0.0034)	(0.0033)	(0.0045)	(0.0061)
LoanAmount	-0.0059^{**}	-0.0020	-0.0101^{*}	0.0017	0.0058	-0.0091
	(0.0027)	(0.0035)	(0.0057)	(0.0047)	(0.0060)	(0.0100)
LotSize	-0.0000	-0.0000	0.0003	0.0002	0.0001	0.0005
	(0.0001)	(0.0001)	(0.0003)	(0.0002)	(0.0002)	(0.0007)
SQFT	0.0001	-0.0064	0.0001	0.0001	-0.0085	-0.0066^{**}
	(0.0006)	(0.0051)	(0.0005)	(0.0006)	(0.0097)	(0.0032)
PropertyAge	0.0002	0.0002	-0.0001	0.0004	0.0005	-0.0003
	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0004)	(0.0006)
Bedroom	-0.0036	-0.0024	-0.0009	0.0025	0.0012	0.0030
	(0.0034)	(0.0044)	(0.0073)	(0.0065)	(0.0084)	(0.0132)
Bath	-0.0005	0.0015	-0.0043	0.0011	0.0107	0.0070
	(0.0025)	(0.0028)	(0.0104)	(0.0088)	(0.0115)	(0.0195)
MSA*YYQQ Orig. FE	Y	Y	Y	Y	Y	Y
Lender FE	Y	Y	Y	Y	Y	Y
R-Square	0.1871	0.1904	0.2566	0.2049	0.2142	0.3133
N. Obs.	13,298	8,912	4,386	5,308	3,551	1,757
Appraisal Inflation	$\textbf{ValuationRatio} - \widehat{\textbf{Appreciation}}$			$\widehat{\textbf{ValuationRatio}} - \widehat{\textbf{Appreciation}}$		

Notes: This table investigates whether appraisal inflation has any impact on lender's securitization decision. It reports the coefficient estimates and standard errors of the OLS regressions of securitization decision. Refinance loans are included in the analysis. Appraisal inflation in Model A is measured as the difference of the valuation ratio and the estimated property appreciation rate ($\widehat{Appreciation}$). Valuation ratio is the ratio between appraisal at origination and the subsequent sale price (HPI-adjusted) of the same property. Property appreciation rate of refinance loans is estimated in two steps: (1)estimate the new purchase loan appreciation equation, and (2)apply the coefficient estimates from (1) to the refinance loans to have the $\widehat{Appreciation}$. Since the valuation ratio for refinance loans contains property-specific appreciation information that may not be captured by local HPI, Model A intends to extract the property-specific appreciation from the valuation ratio to have a cleaner measure of appraisal inflation. Appraisal inflation in Model B is measured by taking the difference of the estimated valuation ratio ($\widehat{ValuationRatio}$) and the estimated property appreciation rate ($\widehat{Appreciation}$). $\widehat{ValuationRatio}$ is estimated in three steps: (1)divide the refinance loans into a random 60% estimation sample and a 40% holdout sample; (2) use the estimation sample to run regression of valuation ratio regardless of the securitization status; and (3)apply the coefficient estimates from (2) to the holdout sample to have $\widehat{Ratio}$. Property appreciation rate is estimated with securitization status in Model A and regardless of the securitization status in Model B. The purpose of model B is to not only extract property appreciation from the valuation ratio to infer appraisal inflation but also eliminate potential reverse causality between securitization and appraisal inflation. Other control variables include loan characteristics at origination, MSA*origination quarter fixed effects and lender fixed effects. Standard errors are clustered by MSA. *** p<0.01,** p<0.05, * p<0.10.

Table A.5: Robustness Checks – Using Hedonic Property Values (6-Month Prediction Window)

Variable	*(1)* *All Loans*	*(2)* *Cash-Out Refi*	*(3)* *Term Refi*	*(1')* *All Loans*	*(2')* *Cash-Out Refi*	*(3')* *Term Refi*
Sec x Notch	0.0216***	0.0254***	0.0063	0.0216***	0.0274***	0.0092
	(0.0074)	(0.0082)	(0.0160)	(0.0081)	(0.0091)	(0.0195)
Sec	0.0023	0.0019	0.0127	-0.0003	-0.0015	0.0120
	(0.0049)	(0.0051)	(0.0098)	(0.0053)	(0.0057)	(0.0129)
Notch	-0.0133*	-0.0155*	-0.0064	-0.0119	-0.0148*	-0.0064
	(0.0073)	(0.0080)	(0.0147)	(0.0079)	(0.0088)	(0.0178)
Controls	Y	Y	Y	Y	Y	Y
Zip FE	Y	Y	Y	Y	Y	Y
Closing Quarter FE	Y	Y	Y	Y	Y	Y
Lender FE	N	N	N	Y	Y	Y
R-Square	0.5192	0.5239	0.5984	0.5732	0.5791	0.6989
N. Obs.	4,748	4,227	1,111	4,748	4,227	1,111

Note: This table uses the hedonic estimate of property value at loan origination as the fair valuation of the property. The dependent variable measures valuation ratio (appraisal inflation) as the ratio between appraised value and the hedonic estimate. We estimate the hedonic property prices at loan origination using recent nearby property transactions, for only that information is available to the appraisers when they conducted the appraisals. We estimate hedonic prices using previous six-month transactions. Loans included are refinance mortgages. Independent variables include loan characteristics at origination, Zip code and closing quarter fixed effects, and lender fixed effects. Standard errors are clustered by zip. *** $p<0.01$, ** $p<0.05$, * $p<0.10$.