The Impact of Risk Retention Regulation on the Underwriting of Securitized Mortgages

Craig Furfine*
Department of Finance
Kellogg School of Management
2211 Campus Drive
Evanston, IL 60208
Tel: (847) 467-2905
Email: c-furfine@kellogg.northwestern.edu

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Abstract

The Dodd-Frank Act requires securitization sponsors to retain not less than a 5% share of the aggregate credit risk of the assets they securitize. This paper examines how the implementation of risk-retention requirements affected the underwriting of mortgage loans. Using a difference-in-difference empirical framework, I find that risk retention implementation is associated with mortgages being issued with markedly higher interest rates, yet notably lower loan-to-value ratios and higher income to debt-service ratios. These findings suggest that the risk retention rules have made securitized loans safer, yet at a significant cost to borrowers. Further evidence suggests that the risk-retention rules are binding, with the amount of risk being retained following implementation roughly three times that of before, while lenders also seemed to accelerate the securitization of originated loans during the months immediately before the rules took effect. Finally, after controlling for observable loan characteristics, loans subject to risk retention requirements appear to be less likely to become troubled.

Keywords: Dodd-Frank, Securitization, Risk retention, Mortgages, CMBS
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There have been a number of reasons proposed as to why securitization markets fared so poorly during the financial crisis. Among the most common explanations are those related to incentive problems among the parties to the securitization process — the originators, the sponsors, and the investors. According to common perception, firms originating mortgages quickly sold them, relieving them of any downside risk if a mortgage borrower ultimately defaulted. Similarly, sponsors pooling mortgage loans quickly passed along the risk of default to the investors of mortgage-backed securities (MBS). This "originate to distribute" model is believed to have led to originators becoming lax in their screening of risks, thereby reducing the quality of assets being securitized. As expressed by the Financial Crisis Inquiry Commission (2011), "Collapsing mortgage-lending standards and the mortgage securitization pipeline lit and spread the flame of contagion and crisis." Thus, it is no surprise that after the fact, financial regulators and policymakers incorporated risk retention or "skin in the game" requirements as part of the reform of financial markets specified by the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act. This component of the law attempts to align the incentives of the various parties involved in securitizations by requiring securitization sponsors to retain no less than 5% of the underlying credit risk in the pool of risky assets being securitized.[1]

This study examines whether and to what extent the new rules for risk retention affect mortgage underwriting. A major challenge to isolate the impact of risk retention is

[1] By contrast, Willen (2014) argues that the financial crisis was, in part, exacerbated by intermediaries having *too much* exposure to real estate markets on their balance sheet and thus risk retention requirements, to the extent that they would have added more exposure, would be misguided.

that in writing the rules implementing Dodd-Frank, regulators exempted certain loans from risk-retention requirements. Thus, it is necessary to look at a securitized loan market where risk retention rules were binding. This paper examines the market for *commercial* mortgages, which are loans collateralized by property such as industrial warehouses, shopping centers, offices, and apartment buildings. Although regulators also exempted certain commercial mortgages from risk-retention requirements, such exemptions (as described more fully below) were far less encompassing, exempting approximately 60% of the commercial mortgage market. Thus, with a substantial fraction of the market subject to the new regulation, it is empirically possible to examine how the implementation of risk retention regulation differentially impacted commercial mortgage loans subject to the new rules relative to those exempted.

Using a difference-in-difference empirical framework, the paper's key finding is that commercial mortgages securitized in deals subject to the new risk retention requirements typically had (a) interest rates that were approximately 47 basis points higher (b) loan-to-value ratios that are approximately 3.6 percentage points lower, and (c) income to debt-service ratios that are 26% of debt service higher. These findings suggest that risk-retention significantly affected the underwriting of mortgages that were securitized, with borrowers paying significantly higher interest rates to borrow on notably less favorable terms if their loan was to be placed in a deal subject to the new risk retention rules. Thus, the implementation of risk retention rules seems to have achieved a policy goal of making securitized loans safer, yet at a significant cost to borrowers.

The paper also documents that risk-retention rules substantially changed the look of commercial mortgage securitization. In particular, the amount of risk being retained following implementation is roughly three times that of before, while lenders also seemed to accelerate the securitization of originated loans during the months immediately before the rules took effect. Finally, not only is risk-retention associated with loans being safer along observable dimensions, it also appears that loans subject to risk-retention rules have become safer in unobservable ways, too. In particular, after controlling for observable loan characteristics, loans subject to risk retention requirements have become troubled less frequently.

1. Previous literature on risk retention and the impact of Dodd-Frank[2]

If individual loan quality were perfectly observable by the originator of the loan, the sponsor of the deal, and the investors in the securities, all three would agree on the value of each loan, and thus, on the value of the deal's securities. Thus, much research explores how information asymmetries influence security design (i.e., the best way to sell claims on risky assets). In an early theoretical model, Leland and Pyle (1977) demonstrate that an entrepreneur can signal the quality of a project by agreeing to retain some of the underlying risk in that project. Since risk retention is costly, the signaling mechanism is credible. Riddiough (1997) applies this idea in the context of asset-backed security (ABS)

[2] Demiroglu and James (2015) provide a useful overview of the issues associated with regulating risk retention.

design. In his model, the issuer can increase the proceeds from securitization by creating multiple securities, or tranches, with differing levels of exposure to the issuer's private information. The issuer then sells the least informationally-sensitive securities to avoid an adverse selection discount. In a similar context, DeMarzo and Duffie (1999) present a model where an issuer signals his private information by retaining a portion of the security offered to investors. The design of offered securities reflects a tradeoff between the cost of risk retention and cost of illiquidity arising from informational sensitivity. DeMarzo (2005) applies this framework to the ABS market. His model explains the tranching of ABS as the result of the issuer optimally retaining the most informationally-sensitive portion of the security. Pooling arises from the consideration of two opposing forces. On the one hand, pooling risky assets is undesirable to the issuer due to an information effect, since it eliminates the issuer's asset-specific informational advantage. On the other hand, pooling is beneficial due to a diversification effect, since it allows issuance of securities that are less sensitive to an issuer's private information, thereby enhancing liquidity by alleviating the adverse selection problem. Hartman-Glaser et al. (2012) develop a model highlighting a tradeoff between underwriter effort and loan quality. The costly hidden effort leads to a relationship between underwriter action and the performance of securitized loans over time. They show that issuer risk-retention is close to the optimal contract. Pagès (2013) develops a model of securitization that motivates how risk retention can be part of the optimal security design. However, his model emphasizes that a "one-size" five percent requirement is inconsistent with the differing risks inherent in

securitized assets. His model also illustrates how the various forms of risk retention provide different incentives for sponsors. Sponsors retaining risk by holding the riskiest securities benefit relatively more from good pool performance, whereas those retaining risk by holding proportional shares of the entire securitization structure do not suffer from payment suspension found in his model's optimal contract. Guo and Wu (2014) develop a model explicitly designed to evaluate the impact of risk retention regulation. Their model maintains a reliance on information asymmetries to create an equilibrium where investors discount the price they are willing to pay for claims on risky assets due to the lemons effect. They then proceed to analyze how mandatory risk-retention and improved disclosure can be used to improve social welfare. In their framework, regulation that mandates a fixed level of risk retention increases the adverse selection problem because it reduces the information content of the securitization decisions. In their model, optimal risk retention should vary according to the riskiness of the underlying assets and can be complementary to disclosure regulation.

As described, there has been a good deal of theoretical research motivating the importance of risk retention by a deal sponsor as a means to signal information regarding deal (underlying loan) quality. In addition, there have been empirical studies that shed light on the influence that regulating risk retention might have. For example, Keys et al. (2009) examines the more general issue of how regulation can influence the incentives and lending behavior of loan originators. They find that regulated banks originated lower quality loans than unregulated independent mortgage institutions. They interpret their

findings to be supportive of using risk retention regulation to improve lender incentives, although they discuss such regulation as it would apply to all originators rather than to the actual rule, which applies to deal sponsors. Demiroglu and James (2012) provides evidence that sponsor risk retention is empirically significant. Their study shows that when loan originators are affiliated with a deal's sponsor, incentives to underwrite increase, which lead to higher quality loans in both observable and unobservable dimensions. Begley and Purnanandam (2016) proxy for risk retention by the thickness of a residential mortgage-backed security (RMBS) deal's first-loss (equity) tranche at the time a deal's securities are issued. They find that deals with greater risk retention (larger equity tranche) are those that contain loans with better ex post performance. Thus, there is some empirical evidence suggesting that risk retention does influence deal structuring and loan performance. Fabozzi et al. (2015) reviews the risk retention proposals for commercial mortgage-backed securities (CMBS) and highlight the relative restrictive nature of the qualified commercial real estate (QCRE) exemption to the rule. In their analysis, they show how changes to the proposed QCRE definition would allow a greater fraction of the underlying collateral to meet the QCRE definition, although these changes were not ultimately accepted by regulators in deciding upon the final risk retention rules for CMBS. In related work, Floros and White (2016) document that for residential mortgages, there is a similar exclusion to risk retention regulations if the underlying loans are qualifying residential mortgages (QRM). Their analysis questions the omission of

credit scores and loan-to-value ratios from QRM definitions, despite these factors being predictive of future default.

There has been extensive empirical examination of various government policies that were put into place to resolve troubled mortgages originated before the crisis. For example, Agarwal et al. (2017a) and Ganong and Noel (2017) examine the impact of the Home Affordable Modification Program (HAMP) and Agarwal et al. (2017b) examines the impact of the Home Affordable Refinancing Program (HARP). These studies have looked at how policy can improve ex post outcomes. Notably, there has been little examination of the impact of Dodd-Frank on mortgage underwriting on an ex ante basis. The notable exception is DeFusco et al. (2017), who examine the impact of Dodd-Frank's ability-to-repay (ATR) rule on the underwriting of jumbo residential mortgages. They find that the ATR rule led to a 10-15 basis point increase in mortgage rates, yet had a more significant impact on mortgage quantity – eliminating roughly 15 percent of the affected market.

2. The securitization of commercial mortgages and the risk retention guidelines

The securitization process begins with a loan originator. Originating institutions underwrite and issue mortgages secured by commercial property such as office buildings, retail establishments, industrial properties, apartment buildings, and other specialized real estate like hotels, medical facilities, or self-storage facilities. As part of the underwriting process, originators will determine if a borrower qualifies for a loan and if so, what

characteristics it should have. In this study, I will quantify the outcome of the underwriting process with three key loan metrics – its interest rate, its loan-to-value (LTV) ratio, and its income to debt-service ratio, traditionally measured in commercial markets by the debt service coverage ratio (DSCR)[3]. Interest rates represent the direct cost of borrowing. A loan's LTV and DSCR are measures of ex post borrowing capacity. That is, loans with more borrower friendly terms have higher LTVs and lower DSCRs.

Having originated a commercial mortgage loan, the originator decides whether to keep the loan or sell it to another party. A commercial mortgage loan that is sold is typically securitized. The decision to keep or sell a loan involves evaluating the interaction of buyers and sellers of a commercial mortgage loan in an environment where the seller has superior information regarding loan quality. The theoretical literature discussed above describes a tradeoff faced by originators in this environment. On the one hand, originators wish to sell loans to free up resource constraints so that they may make additional profitable loans. On the other hand, originators may refrain from selling loans because they face a lemon's discount that arises from their informational advantage.

Commercial loans being prepared for securitization are sold to a deal sponsor. The sponsor purchases commercial mortgages from one or more originators and at the same time, might originate their own loans, too. The deal sponsor determines which loans to

[3] The debt-service coverage ratio measures the ratio of the income generated by the property (through rents collected, etc.) to the debt service required by the loan. Thus, higher values of DSCR imply, all else equal, a safer loan. This can be thought of as the inverse of the debt service-to-income (DTI) commonly used as an underwriting metric in residential mortgages.

pool together and how to structure the securities that are ultimately going to be sold to investors. Unlike residential mortgages, commercial mortgage loans typically never prepay. This is because commercial mortgages typically contain outright contractual bans on prepayment, high prepayment penalties, or yield maintenance or defeasance requirements that make it uneconomical for the borrower to prepay.[4] As a result, the sponsor's structuring of CMBS deal focuses solely on the tranching of default risk, which leads to a traditional senior-subordinate tranche structure of the deal's securities. The sponsor's objective is straightforward – acquire loans and securitize them as long as the securities can be sold for an amount greater than the cost to acquire the loans (net of transactions cost).

CMBS investors purchase the securities sold by the deal sponsor and receive cash flows backed by the payments received on the loans in the deal's underlying pool. These investors in CMBS have heterogeneous preferences and tend to focus on buying securities with a particular risk profile. For instance, many investors of CMBS buy only the most senior, AAA-rated bonds, and thus can be viewed as being simply demanders of safe and liquid securities. At the other end of the credit spectrum would be investors that buy the riskiest, first-loss securities in the offering. These investors, known as B-piece investors, are high-yield investors with the commercial real estate expertise necessary to understand the risks inherent in the pool of underlying loans. Between the institutional investors

[4] Defeasance requires a borrower seeking to prepay a securitized loan to place Treasury securities into the pool in an amount that would generate the originally promised principal, along with interest payments.

looking for fixed income securities and the commercial real estate experts who seek high yields in exchange for careful underwriting and analysis are other investors, who are a cross between the investors at either end of the capital structure. Although the risk-return tradeoff faced by each type of investor is rather different, all investors share the objective to acquire securities at no more than a fair risk-adjusted price. The securitization process for commercial mortgages is outlined in Figure 1.

CMBS investors are at an information disadvantage relative to the deal's sponsor. To avoid an excessive lemons discount, deal sponsors can signal the underlying loan pool is of high quality by retaining some of the risk of the underlying pool. This intuition motivated the part of the Dodd-Frank Act that called for a risk retention requirement on deal sponsors. By imposing a minimum level of retention, it was hoped that loan quality could be enhanced because sponsors would only be willing to retain the risk of pools of high quality mortgage loans. Specifically, the regulatory implementation of the risk retention rules specifies that a securitization sponsor "retain not less than 5 percent of the credit risk of any asset that the (sponsor), though the issuance of an asset-based security (ABS), transfers, sells, or conveys to a third party, and prohibit(s) a securitizer from directly or indirectly hedging or otherwise transferring the credit risk that the securitizer is required to retain."[5]

The risk retention rules allow sponsors to satisfy their commitment in three ways (Figure 2). First, sponsors can hold an eligible vertical interest by retaining a portion (at

[5] See Department of the Treasury (2014).

least 5%) of each class of the securitization or by holding a single vertical security that represents an interest in each class of securities being sold. Second, sponsors can hold an eligible horizontal interest, which would necessitate a sponsor retaining a first loss horizontal interest in the issuing entity in an amount equal to no less than 5% of the fair value of all securities issued in the transaction. This horizontal interest may consist of one or multiple (consecutive) security classes. Third, sponsors can satisfy the risk retention requirement through any combination of horizontal and vertical risk retention so long as the combined retention is not less than 5% of the fair value of the transaction. For instance, a sponsor can hold a 3% vertical interest and a 2% horizontal interest to satisfy the risk retention requirements.

For CMBS, the risk retention rules allow for horizontal risk retention to be delegated to a third-party (B-piece) purchaser satisfying additional requirements,[6] although the sponsor remains responsible for the B-piece buyer's compliance with the risk retention rules. Although a separate entity, the B-piece buyer plays the same signaling role to other investors as the sponsor plays in other securitization markets. Before the financial crisis, a failure of a sponsor to find a willing B-piece investor would essentially doom a securitization. Thus, CMBS pools were assembled and tranched in a way that B-

[6] The third-party purchaser must specifically negotiate for the purchase of such first-loss position, holds adequate financial resources to back losses, provides due diligence on all individual assets in the pool before the issuance of the asset-backed securities, and meets the same standards for risk retention as the Federal banking agencies and the Commission require of the securitizer. The 5% risk retention requirement can be satisfied if up to two (B-piece) investors purchase the riskiest 5% (by market value) of the securities offered on a pari passu basis and hold these securities for at least five years. See Department of the Treasury, Office of the Comptroller of the Currency, 12 CFR Part 43, Docket No. OCC-2013-0010 page 170.

piece investors were willing to invest and that would make the overall deal profitable for the sponsor.[7] In exchange for submitting the winning bid, the successful B-piece investor received the same rights and had the same incentives as the sponsor would have had if the riskiest tranches of the deal been held by the deal sponsor. Not only does the B-piece investor receive the cash flows associated with its security interest, it also controls the workout of loans that become troubled over the life of the pool and bears the risk of the initial losses experienced by the underlying pool.[8] Thus, the B-piece investor, since it is the one subject to the first dollar of losses on the underling pool of commercial mortgages, was historically the investor with skin in the game.

Allowing horizontal risk retention to be satisfied by B-piece buyers was one way that regulators sought to provide some degree of continuity in the way that CMBS were sold. However, current regulations require that the B-piece to be sold for a minimum of 5% of total deal proceeds to satisfy horizontal risk retention, a threshold that is much

[7] As part of the pool formation process, B-piece investors could exert pressure on the sponsor in terms of the specific loans being placed into the pools. For example, during pool formation, prospective B-piece investors would be provided details regarding the loans that the sponsor wishes to securitize. The B-piece investor also reviews more detailed information on the ten largest collateral loans, which typically total 50% of the proposed issuance, by balance. This additional information includes the major tenants of the commercial property and the expiration schedules of the property's significant leases. B-piece investors submit bids to the sponsor, but the bids contain not only a price at which the investor is willing to pay for the riskiest tranches of the deal, but also various stipulations, rights, or flexibility that could affect a sponsor's profitability on a given transaction. Examples of these non-price terms include the offer to buy a transaction if a certain loan is removed from the pool, or the right to remove a certain number of loans deemed to have excessive risk (called "kick-outs"). These kick-out rights are one way that B-piece buyers could ultimately influence the underlying collateral pool, although during the years immediately prior to the financial crisis, such kick-outs were rare.

[8] Technically, the pooling and servicing agreement of the securitization would typically grant the "controlling class," which is the security holder in the first-loss position, the right to appoint the special servicer, the institution that controls the workout process.

higher than had typically been the case. In the years immediately preceding the financial crisis, the typical CMBS B-piece was approximately 3% of the *face* value of the outstanding securities. Given that these securities were typically sold at a significant discount to par, they likely amounted to no more than 2% of total deal proceeds. Thus, satisfying today's 5% minimum threshold via a horizontal structure requires B-piece investors to acquire a substantially larger first-loss positions than they had done historically. In addition, the rules require B-piece buyers to hold their first-loss position for a minimum of five years, whereas prior to the financial crisis, B-piece buyers were permitted to sell their securities immediately.[9] Perhaps due to these higher costs associated with buying B-pieces, some CMBS deals sold since the implementation of the risk retention rules have chosen to use vertical (V-shaped) and the combination of vertical and horizontal (L-shaped) retention to satisfy the rules. Note that in V-shaped (L-shaped) risk retention, the deal sponsor will be holding all (part) of the 5% requirement.

One important component of the new risk retention guidelines is that regulators provided two key exemptions to the risk retention rules. The first key exemption relates to securities issued with a guarantee of timely principal and interest by a Government Sponsored Enterprise (GSE) such as Fannie Mae or Freddie Mac.[10] Because these agencies, through their guarantee, are essentially exposed to the entire credit risk of the transaction,

[9] Regulatory agencies reasoned that, after a five-year period, the quality of the underwriting would be sufficiently evident that the initial third-party purchaser or, if there was no initial third- party purchaser, the sponsor, would suffer the consequences of poor underwriting in the form of a reduced sales price for such interest.

[10] This exemption lasts while they operate under the conservatorship or receivership of the FHFA with capital support from the US Government.

agency sponsors would not additionally have to retain an additional 5% of the deal. Thus, the new risk retention rules essentially imposed no change on deals sponsored by agencies such as Freddie Mac and Fannie Mae. Although the GSEs are more known for their role in residential mortgage securitization, they also sponsor securitizations of commercial mortgages backed by commercially owned housing such as apartment buildings, mobile home parks, and health care facilities such as assisted living communities. The second exemption pertains to securitizations of so-called "qualifying commercial real estate (QCRE) loans." Such loans satisfying minimum underwriting criteria are also exempt from any risk retention requirements. However, the criteria were set at levels where extremely few commercial mortgages would qualify as QCRE loans.[11] Among the loans used in this paper's analysis, approximately 4% of non-agency backed securitized commercial mortgages would seem to satisfy conditions necessary to be classified as QCRE loans.[12] Thus, for commercial mortgage securitization, the GSE exemption appears

[11] The borrower would have been required to have a DSCR of at least 1.25x for qualifying multi-family property loans, 1.5x for qualifying leased QCRE loans, and 1.7x for all other commercial real estate loans. The loan would have been required to have either a fixed interest rate or a floating rate that was effectively fixed under a related swap agreement. The loan documents also would have had to prohibit any deferral of principal or interest payments and any interest reserve fund, resulting in excluding interest-only loans from qualifying as QCRE loans. QCRE loans further have a maximum amortization period of 25 years for most commercial real estate loans, and 30 years for qualifying multi-family loans, with payments made at least monthly for at least 10 years of the loan's term. Furthermore, payments made under the loan agreement would be required to be based on a straight-line amortization of principal and interest over the amortization period (up to the maximum allowed amortization period, noted above). The minimum loan term could be no less than 10 years and no deferral of repayment of principal or interest could be permitted. The combined loan-to-value (CLTV) ratio for first and junior loans for QCRE loans are required to be less than or equal to 70 percent and the LTV ratio for the first-lien loan be less than or equal to 65 percent; or that the CLTV and LTV ratios be less than or equal to 65 and 60 percent, respectively, for loans with valuation using a capitalization rate below a certain threshold.

[12] Fabozzi et al. (2015) estimates that 3.58% of all non-agency securitized commercial mortgages between 1997 and 2015 would satisfy the QCRE standards according to regulators' re-proposal for risk retention guidelines, which were little changed before the final rules.

quantitatively significant, whereas the qualifying commercial real estate loan exemption does not.

Final rules implementing risk retention requirements for commercial mortgages were agreed to in October 2014, but had a delayed implementation. Securitizations of commercial mortgages that were subject to the new rules became effective for all deals securitized after December 24, 2016.

3. Risk retention and loan underwriting

This section formally documents the correlation between the implementation of risk retention rules and loan underwriting. The data come from Prospectus Supplements from a complete set of multi-borrower Commercial Mortgage Backed Securities (CMBS) that settled between January 1, 2014 and March 31, 2018. These CMBS Deals are split into two groups. First, deals designated as "Agency" are those whose securities were backed by guarantees issued by government sponsored enterprises such as Freddie Mac and Fannie Mae. All other CMBS deals I will refer to as "Non-Agency." During the sample period, there were 844 Agency and 301 Non-Agency deals. For each deal where data from its Prospectus Supplement were available on Bloomberg, information on both the underlying loans and the underlying collateral properties were collected.[13] The loan data provide details of each individual loan being securitized including its originator,

[13] For the Non-Agency deals, the Supplements also contain information on the major leases within each property.

origination date, size, interest rate, loan-to-value (LTV), and debt service coverage ratio (DSCR). I merge the loan data with information from the property data, which provides the location and type of the property serving as collateral for each loan. The sample of loans was trimmed by dropping loans secured by multiple properties, loans secured by properties outside of the United States, or securitized more than 18 months after origination. Observations were also dropped if there was no data reported for the interest rate on the loan. The final sample contains 62,155 loans, of which 49,319 were securitized in Agency deals and 12,836 were securitized in Non-Agency deals.

Summary statistics on the underlying sample of loans are reported in Table 1. Note that for Agency loans, the data on LTV and DSCR are significantly less complete than data on interest rates. The data for Non-Agency loans is more complete. Panel A of Table 1 reports that Agency loans had lower mean interest rates, higher mean LTVs, and lower mean DSCRs than Non-Agency loans. Overall, the Agency part of the commercial mortgage market is roughly 60% of the overall dollar value of lending, which indicates that a substantial fraction of the market remains subject to risk retention requirements. Panels B and C of Table 1 calculate summary statistics on subsamples divided by whether or not the given loan was securitized prior to the implementation of the risk retention rule. As indicated in these panels, following the implementation of risk retention rules, average interest rates rose for Non-Agency loans but fell for Agency loans. LTV ratios fell for Non-Agency loans but rose for Agency loans. DSCRs rose for Non-Agency loans but fell for Agency loans. Thus, Non-Agency loans appear to have been underwritten more

conservatively (lower LTV and higher DSCR) yet became more expensive following implementation of the new risk retention rules. By contrast, Agency loans were underwritten more loosely, yet became less expensive. These summary statistics preview the main finding of the paper that will be analyzed more carefully below.

One potential critique of these summary statistics is that the loans that are securitized in an Agency deal are fundamentally different than those loans securitized in Non-Agency deals. In particular, Fannie Mae and Freddie Mac do not provide guarantees on securities backed by loans secured by all types of commercial property. Table 2 tabulates the property types securitized in Agency deals and compares that to the property that serves as collateral in Non-Agency deals. As illustrated in Table 2, Agency loans are nearly entirely backed by apartment buildings, which the industry refers to as Multifamily Housing. Non-Agency loans have a more diverse set of collateral property, although Multifamily Housing is the single largest category of collateral within Non-Agency loans. Table 3 reports the summary statistics analogous to Table 3 for the subsample of loans that are collateralized by Multifamily Housing. Even within this restricted subsample of loans, Non-Agency loans had lower mean LTVs and higher mean DSCRs following the implementation of risk retention rules, whereas Agency loans did not.

To test the impact of risk retention, I employ a difference-in-difference methodology. The sample contains loans securitized both before and after the implementation date of December 24, 2016 as well as loans that were subject to the new

rule (Non-Agency) and those that were not (Agency). After defining the variable $NonA_{id}$ to equal 1 if loan i was securitized in a deal d that was a Non-Agency deal and 0 otherwise and the variable $Post_d$ to equal 1 if Deal d was settled after December 24, 2016 and 0 otherwise, the benchmark model can be expressed as

$$y_{idt} = \alpha + X'_{idt} \cdot \gamma + \beta_1 \cdot NonA_{id} + \beta_2 \cdot Post_d + \beta_3 \cdot NonA_{id} \times Post_d + \varepsilon_{idt}, \quad (1)$$

where y_{idt} represents either the interest rate, the LTV, or DSCR on loan i that was originated on date t and securitized in deal d. The matrix X_{idt} captures additional control variables of the particular loan, deal, and date of origination. The coefficient of interest is β_3, which measures the change in the dependent variable around the implementation of risk retention rules for loans subject to the rule (Non-Agency) *relative* to the change in the dependent variable around the implementation date for loans *not* subject to the rules (Agency), holding constant loan-specific and time-specific factors.

Column 1 of Table 4 reports the coefficients on β_1, β_2, and β_3 when neither loan-specific nor time-specific variables are included as controls and where the dependent variable is the interest rate on the loan. The point estimate of β_3 is 0.149, which means that the interest rate on loans subject to risk retention rules are 14.9 basis points higher on average following the implementation of the rule relative to the change in interest rates on loans not subject to risk retention. The point estimate is highly significant.[14] Column 2 of the table adds X_{idt} variables measuring the rate on a 10-year Treasury bond and the BAA-Treasury spread on the date of loan origination as well as allowing these interest

[14] Standard errors are clustered by both origination month and originator.

rate variables to interact with the indicator for whether or not the loan was securitized in a Non-Agency deal. These interest rates were added to the specification to control for the level of risk-free interest rates and a market measure of credit conditions that were present at the time the underlying loan was originated.[15] After adding these additional controls, the estimate of β_3 increases to 0.267. The third column of Table 4 adds to X_{idt} control variables for loan size, an indicator for whether the loan is fully amortizing, and fixed effects for each loan's originator, property type, and location (State) of the collateral.[16] The fourth column adds fixed effects for the month of origination. According to the specification in the fourth column, the estimate of β_3 is 0.373. That is, after controlling for origination month, originator, property type and location, as well as the level and credit spread of interest rates, Non-Agency loans that were securitized after risk retention rules were implemented carried interest rates 37.3 basis points higher. Columns 5 and 6 in Table 4 repeat the estimation of the specification from column 4 only replacing the dependent variable with each loan's LTV and DSCR, respectively. Note, as mentioned earlier, the number of observations drops noticeably as these variables were not reported for a large fraction of Agency loans. The point estimate of β_3 is -0.0307 for LTV and 0.232 for DSCR. This indicates that loans securitized in deals subject to risk retention carried lower LTVs and higher DSCRs after controlling for the same set of fixed effects and credit

[15] In specifications not shown, lagging the interest rate variables to reflect the potential for advanced interest rate "locks" had little effect on the coefficients estimated.
[16] There are 98 unique originators, 13 property types, and collateral located in all 50 states and the District of Columbia.

market controls. The final three columns of Table 4 repeat the analysis shown in Columns (4)-(6) on the subsample of loans that were collateralized by Multifamily Housing. Within this reduced subsample of loans, the findings are unchanged, with the implementation of risk retention being associated with higher interest rates, lower LTVs, and lower DSCRs.

The results presented in Table 4 have suggested that risk retention is associated with higher interest rates and more conservative underwriting. However, the estimates reported in Table 4 assumed that originators knew at the time of origination whether or not the loan would be securitized in a deal that would be subject to risk retention. This assumes knowledge about (a) whether the loan being made would be securitized in an Agency or Non-Agency deal and (b) whether the loan would be securitized before December 24, 2016. With respect to (a), commercial property other than Multifamily, Mobile Home Parks, and some Health Care facilities cannot acquire financing that will be securitized in a deal carrying a guarantee from Fannie Mae or Freddie Mac. Thus, lenders originating loans secured by these other property types know that if securitized, those deals will be subject to risk retention if the deal settles after December 24, 2016. Also, lenders themselves tend to specialize in either Agency or Non-Agency lending. Within the sample period, only 16 of the 98 lenders originated loans that were securitized in both Agency and Non-Agency deals. Among these 16, only 5 do appreciable business in both segments. Thus, lenders typically understand if a loan they originate would be securitized in an Agency or Non-Agency deal. However, lenders would still face uncertainty regarding the timing between loan origination and securitization. Clearly, loans originated after

December 24, 2016 would be securitized after risk retention rules were implemented. However, loans originated before that date may not be. The earlier specification assumed perfect foresight regarding future securitization timing, which adds noise to the independent variable $Post_d$. This measurement error can be expected to bias downward the previously reported coefficients.

To address this potential bias, I estimate equation (2),

$$y_{idt} = \alpha + X'_{idt} \cdot \gamma + \beta_1 \cdot NonA_{id} + \beta_2 \cdot \Pr(Post_d) + \beta_3 \cdot NonA_{id} \times \Pr(Post_d) + \varepsilon_{idt}, \quad (2)$$

where instead of the indicator variable $Post_d$, I use an estimated probability of each loan being securitized after December 24, 2016 based on the day that the loan was originated and the observed empirical distribution of the time between loan origination and securitization. This probability estimate is calculated as follows. First, I define a variable *TimeToSale* as the number of days between each loan's origination date and the date that the securitization deal containing that loan settles. I then calculate the empirical probability distribution for *TimeToSale* separately for Agency and Non-Agency loans for all loans that were originated in 2015.[17] These empirical distributions are shown in Figure 4. Note that it takes noticeably longer to securitize a loan for an Agency deal than for a Non-Agency deal. The median time to securitization for a loan originated in 2015 is 153 days for an Agency loan, but only 62 days for a Non-Agency loan. Then, I assume that every loan in the sample will have a *TimeToSale* drawn from these distributions. It is

[17] By focusing on loans originated in 2015, I avoid the potential for anticipation of risk retention regulation to influence *TimeToSale*.

therefore straightforward to calculate the ex-ante probability of an Agency or Non-Agency loan being securitized prior to December 24, 2016 based on the loans' origination date. For example, suppose an Agency and a Non-Agency loan have both been originated on September 15, 2016. This is 100 days before December 24, 2016. Using the probability distributions shown in Figure 4, we can estimate that 78.48% of Non-Agency loans and 22.79% of Agency loans in 2015 were securitized within 100 days. Therefore, I can estimate the probability that the Non-Agency loan originated on September 15, 2016 will be securitized after December 24, 2016 as 1-78.48% = 21.52%. Similarly, the probability of the Agency loan originated on September 15, 2016 being securitized after December 24, 2016 is estimated as 1-22.8% = 77.2%. Thus, the probability of settlement after the risk retention rules have been implemented can be estimated for every loan in the sample based on its origination date and whether it was an Agency or Non-Agency loan.

Table 5 reports the estimates from the estimation of Equation 2, with the probabilities first estimated by the process exemplified by Equation 3. The coefficients on β_3 continue to be highly significant, and are generally larger in economic magnitude than those reported in Table 4. Risk retention is associated with interest rates 47.0 basis points higher, LTVs 3.63 percentage points lower, and DSCRs 0.259 higher.

4. Variation across loans and deals

The previous section documented that loans securitized in deals subject to risk retention were originated with higher interest rates, lower LTVs, and higher DSCRs.

Overall, that suggests that loans securitized in deals subject to risk retention had more lender-friendly terms. That is, the loan promised higher interest rates yet had characteristics associated with being lower risk. In this section, additional empirical tests are run to explore whether changes to underwriting variables is robust across all deals and loans.

The first additional test explores whether deal sponsors who also originate loans underwrite loans different from other originators who are simply selling their loans to the sponsor before securitization. The intuition is that risk retention rules are applied at the level of the sponsor. Originators of loans are not subject to the rules, but sponsors of the deals are. That suggests a possibility that loans originated by sponsors may potentially differ from those originated by others. In Table 6, I report the coefficient estimates from a triple difference specification where I additionally allow underwriting criteria to vary according to whether or not the originator is also a sponsor of the deal in which the loan is placed. As shown in the table, the coefficient on Non-Agency loans interacted with the probability of being sold after risk retention rules are in place continues to be highly significant with approximately the same magnitudes as reported in Table 5. However, the triple difference coefficient indicating that the loan was originated by a deal sponsor suggests that the reduction in LTV within the Multifamily Housing sample appears only in the sample of loans originated by a deal's sponsor.

The second additional empirical test explores whether the type of originator may influence the impact of risk retention rules on commercial mortgage underwriting. For

this empirical exercise, each of the 98 originators in the sample were categorized into three groups: *banks*, *real estate investment trusts* (REITs), or *other*. The originators in the *other* group were mostly mortgage banks or private debt funds. Triple difference equations were estimated, again allowing the impact of risk retention to vary across the type of lender. Within the Multifamily Housing subsample, the coefficient estimates reported in Table 7 suggest that higher interest rates following risk-retention implementation were only found among bank and REIT lenders. Banks and REITs reduced LTVs by more than other lenders, although these differences are not statistically significant. Finally, banks increased the DSCRs on Multifamily loans more than other lenders. Thus, the evidence suggests that the change to underwriting standards following the implementation of risk-retention regulation was larger for bank lenders as opposed to non-bank lenders.

The final additional empirical test regarding underwriting changes explores the different forms of risk retention. As explained earlier, risk retention can be satisfied in one of three ways: horizontal (H), vertical (V), or L-shaped (L). Clearly, pursuing V-shaped risk retention requires the holding of the safest security portfolio, whereas pursuing H-shaped risk retention – because it is entirely composed of first-loss tranches – would be the riskiest holding. On the other hand, V-shaped risk retention is generally held by the sponsor, whereas H-shaped risk retention is typically sold to third party B-piece buyers. Thus, it is not obvious which shape of risk retention a sponsor should prefer. In the sample considered in this paper, there are 23 deals using V-shaped retention, 24 deals using H-shape retention, and 16 deals using L-shaped retention. This balanced use of risk retention

methods suggests, too, that sponsors have not been convinced of the superiority of one method over another. The final empirical test adds a triple difference specification, allowing the shape of risk retention to influence the degree to which originators alter their standards in response to the new rules. Note that this specification makes an additional strong assumption on originators, which is not only are they estimating whether a loan will be securitized after the risk retention rules have been implemented, but they also know with certainty the form of risk retention that the sponsor will select. Table 8 reports the coefficients estimated from this final specification. For the full sample of loans, the coefficient estimates suggest that risk retention shape did not correlate with underwriting metrics. The benchmark in these specifications were L-shaped deals, where the coefficients are little changed from those reported in Table 5. Within the Multifamily Housing subsample, the evidence indicates a correlation between horizontal retention and lower interest rates as well as higher DSCRs for loans in vertical deals.

5. Is risk-retention regulation a binding constraint?

The previous two sections documented an economically significant relationship between the implementation of risk retention regulation and the underwriting of commercial mortgages. In this section, I document other facts suggesting that risk-retention had a significant impact on the securitized mortgage market.

As mentioned, risk-retention regulation mandated that securitizers retain risk equal to a minimum of 5% of deal value. For this regulation to be binding, it must be the case

that this 5% threshold be larger than what a securitizer would have optimally wanted to hold absent the regulation. As a benchmark, I examine the size of the B-piece of Non-Agency securitizations in the pre-crisis (2004-2007) period. As described, the B-piece investor traditionally has performed the risk-retention function for Non-Agency securitizations. Across the 234 Non-Agency deals securitized between 2004 and 2007, the average retention by the B-piece buyer was equal to 3.4% of total deal *face value*. Note that I measure retention by face rather than market value because before risk-retention implementation, market prices for B-pieces were not disclosed. We can compare this pre-crisis experience with retention levels observed in recent deals that have used the horizontal retention method. As shown in Figure 4, the average size of a recent B-piece is 10.3% of deal face value.[18] Thus, satisfying risk retention regulation requires nearly three times the retention that was observed before the crisis.

Not only has risk retention regulation significantly increased the size of a deal's B-piece, but it has also significantly lowered the variability of B-piece size. As depicted in Figure 4, most pre-crisis deals had retention levels between 1.5% and 5% of deal face value. This variability of risk retention was meaningful because it represented securitizers' signaling the quality of the underlying pool to their potential bond investors. Consistent with the theory of risk retention, securitizers would have larger B-pieces (retain more risk) as compensation for riskiness in the underlying loan pool. The first column in Table 9

[18] This suggests that B-pieces sell for a price approximately equal to 50% of face value in order to achieve 5% of deal proceeds, since most other securities sell near par.

shows the output of a regression of B-piece size (as a fraction of deal face value) on pool-level underwriting characteristics. In the sample of 234 Non-Agency deals issued between 2004 and 2007, one sees a positive relationship between pool LTVs and pool interest rates and B-piece size. That is, riskier pools led securitizers to retain more risk pre-crisis.

By contrast, since risk retention regulation has been implemented, there is virtually no variability in the size of the B-piece. Nearly all of the 24 deals using horizontal retention have a retention level between 10.0% and 10.6%, presumably because the regulatory minimum retention levels are binding and that no extra retention is wanted beyond what is necessary to reach 5% of deal proceeds. The second column of Table 9 repeats the previous regression on the sample of the 24 post-regulation horizontal retention deals. In this small sample, there does not appear to be a positive correlation between observable risk characteristics and the size of the retained B-piece. Taken together, the findings in Figure 4 and Table 9 suggest that risk-retention has been a binding constraint, significantly increasing the size of the retained risk, thus limiting the ability of securitizers to use retention size as a signaling tool.

Another indication that risk retention regulation was a binding constraint upon securitizers can be seen in their efforts to securitize loans quickly prior to the implementation of the rule. In Figure 5, I plot the cumulative distribution function for the time between origination and securitization. On the left side, the data represents Non-Agency lending calculated over three distinct time periods. The grey line represents loans originated in the six months immediately preceding the implementation of risk-retention

regulation. The gray line lies to the left of the lines drawn for loans originated either earlier in 2016 or following implementation in early 2017. The median time to securitize a Non-Agency loan was 3.5 months during the first half of 2016, but this median time was reduced to just over 2 months in the months immediately before risk retention went into effect. The right panel of Figure 5 repeats the same calculations for Agency lending. Among these loans that were not subject to the implementation of risk-retention regulation, there is no obvious reduction in the time to securitize in the months immediately before the regulation took effect.

6. Risk retention and default

This paper has documented that risk-retention regulation is associated with higher interest rates and less borrower-friendly terms. In addition, the evidence on the size of risk retention and the apparent rush to securitize before the regulation took effect suggest that overall, the implementation of risk-retention regulation has reduced the supply of securitized commercial mortgage credit in observable ways. However, if all relevant information regarding the riskiness of a mortgage loan could be summarized in the observables such as interest rates and LTVs, then there would be no need for risk-retention regulation. Thus, the motivation for regulation stems from the information asymmetries between originators, securitizers, and investors. Having shown that loans subject to risk-retention regulation were safer in observable dimensions, in this section, I

present preliminary evidence that loans subject to risk-retention requirements were also safer in not-readily-observable ways, too.

In practice, the riskiness of a loan is generally measured by the probability that the loan will default. There are many loan features easily observable to market participants that are likely informative regarding a loan's default likelihood. For instance, loans with higher LTVs and higher interest rates might be expected to be more likely default. In this section, I explore whether loans subject to risk-retention are more or less likely to default *after* controlling for the readily available characteristics of the loan.

The most apparent challenge to this analysis is the fact the risk-retention regulation for commercial mortgage lending was only implemented in late 2016. Thus, many loans have only been outstanding for a short time, and thus observable default rates are likely rather low. For each loan in the sample, I checked its performance history as of payments due in June 2018. In my sample of 62,155 loans, only 2,871 (4.62%) had a status other than "Performing." Of these, approximately 80% were still current, but had been placed on a servicer "watchlist", which indicates potential problems with either the borrower or property.

With these limitations in mind, Table 10 presents the marginal effects estimated from a probit model, where the dependent variable is equal to 1 if the loan was anything but performing as of June 30, 2018 and equal to 0, otherwise. The independent variables are the three observable characteristics of the loans that might be thought to predict default – the loan interest rate, the loan's LTV, and the loan's DSCR – as well as the

same control variables used in the regressions reported in Table 4. That is, the dependent variables in the earlier specifications are added to this specification as controls. Note, in particular, that these specifications include month-of-origination fixed effects to control for the obvious connection between time since origination and default likelihood. As shown in Table 10, the marginal impacts of the three loan underwriting metrics are of the predicted sign. Loan interest rates and LTVs are positively correlated with future non-performance, while loan DSCRs are negatively correlated with loan performance. However, these estimates are generally not statistically significant at traditional levels. Note, though that the difference-in-difference coefficient is negative, strongly significant, and economically large. The point estimate of -0.0482 indicates that holding observable characteristics of a loan constant, a loan subject to risk-retention is nearly 5% less likely to have a status other than performing, relative to both similar loans securitized before the regulation's implementation and to loans securitized after the regulation and not subject to the regulation. The second column of Table 10 repeats this empirical estimation for the multifamily loan subsample. Among multifamily loans, the results are rather similar, both qualitatively and quantitatively. These findings provide preliminary evidence that loans subject to risk-retention regulation were safer in unobservable dimensions.

7. Interpretation and conclusion

The evidence in this paper is consistent with originators using tighter underwriting criteria for loans that would be sold in deals subject to new regulations on risk retention.

This is consistent with the intent of policymakers, who implemented the rules precisely to improve the quality of loan underwriting. The estimates suggest that the impact of the new regulation was economically significant, with meaningful reductions in LTVs and increases to DSCRs. At the same time, the additional requirement of risk retention poses an additional cost to sponsors, which at least in part, seems to have been passed through to borrowers, who face noticeably higher interest rates for securitized borrowing following the implementation of the new rules.

The evidence is somewhat consistent with bank lenders reacting more strongly to the new rules than other lenders. It could be that bank lenders, because they face more direct regulatory oversight, may be more sensitive to the new rules and respond more strongly to their implementation, although the empirical evidence on this point is mixed.

The evidence also indicates that risk-retention requirements were binding in the sense that the magnitude of risk retained is substantially higher than during the years preceding the financing crisis. Because the constraint is binding, there is also far less variability in the amount of retention being done across deals, which may limit the informativeness of the securitizer's retention decision. Further evidence on the binding nature of the requirement is the reduction in time between origination and securitization in the months immediately preceding the implementation of risk retention.

Preliminary evidence also exists that loans subject to risk-retention regulation were safer in observable ways. Controlling for readily observable measures of ex ante risk, loans

subject to risk-retention regulation were nearly 5% less likely to have a loan status in June 2018 other than performing.

Overall, the results in this paper indicate that risk retention rules significantly impact the underwriting of mortgages. Aside from the impact on commercial mortgage markets documented here, the results suggest that risk retention rules will become an increasingly important factor for the underwriting of residential mortgages, too. Non-prime residential lending has continued to rapidly increase and if exemptions given to the GSEs expire in 2021 as currently scheduled, then a much greater fraction of residential lending will also be subject to these same rules.

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FIGURE 1: THE SECURITIZATION OF COMMERCIAL MORTGAGES

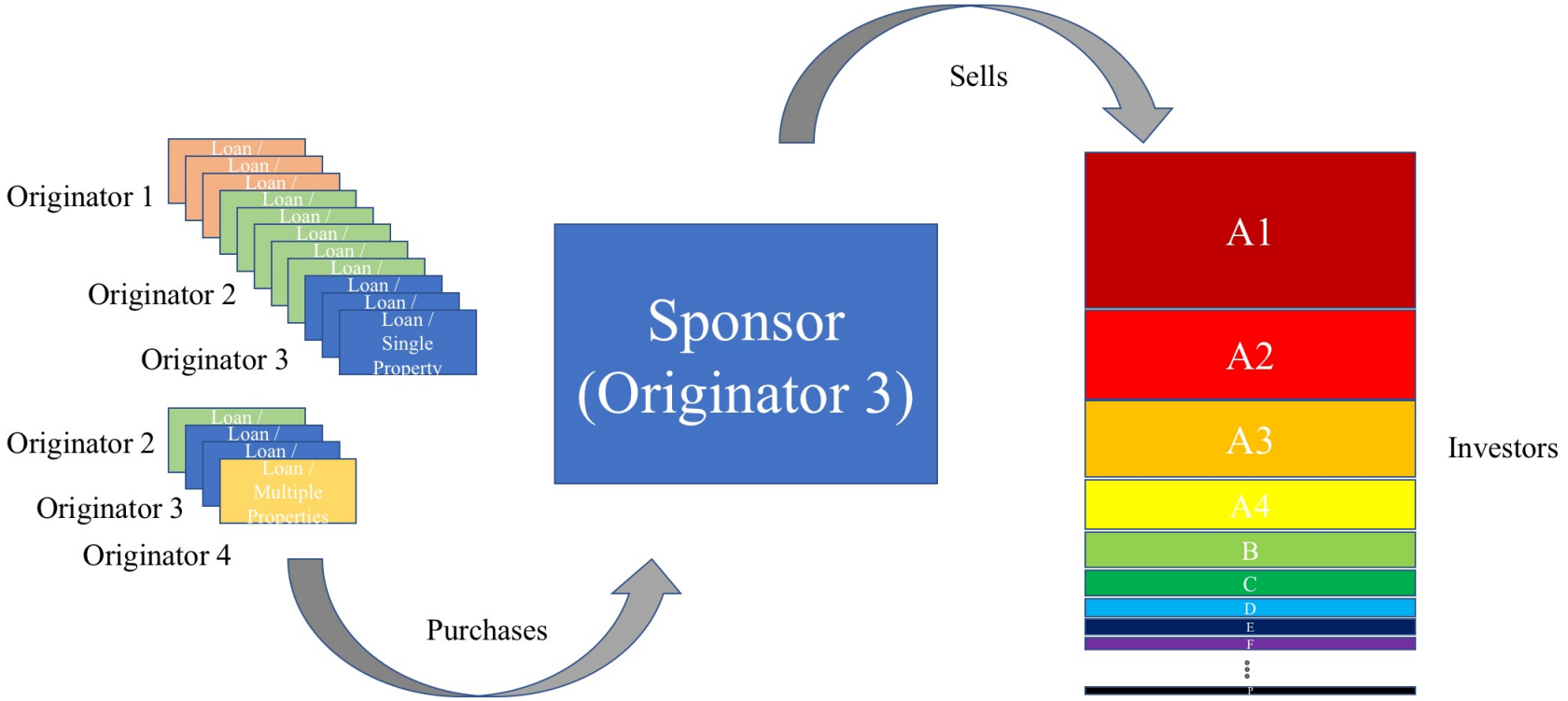
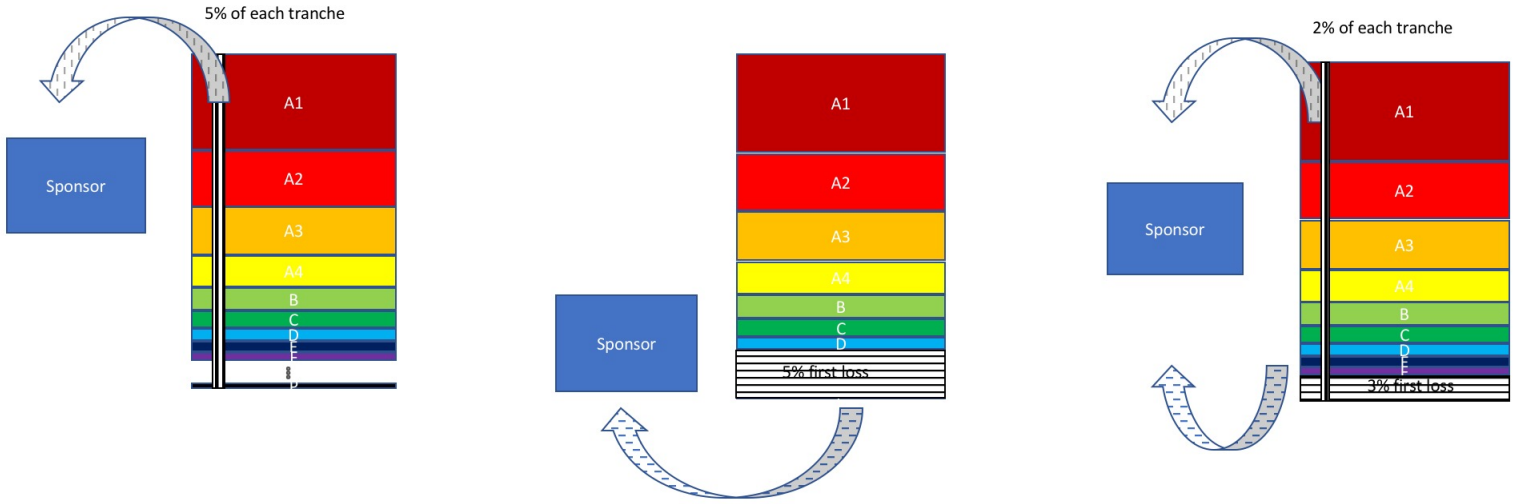


FIGURE 2: THREE METHODS OF RISK RETENTION



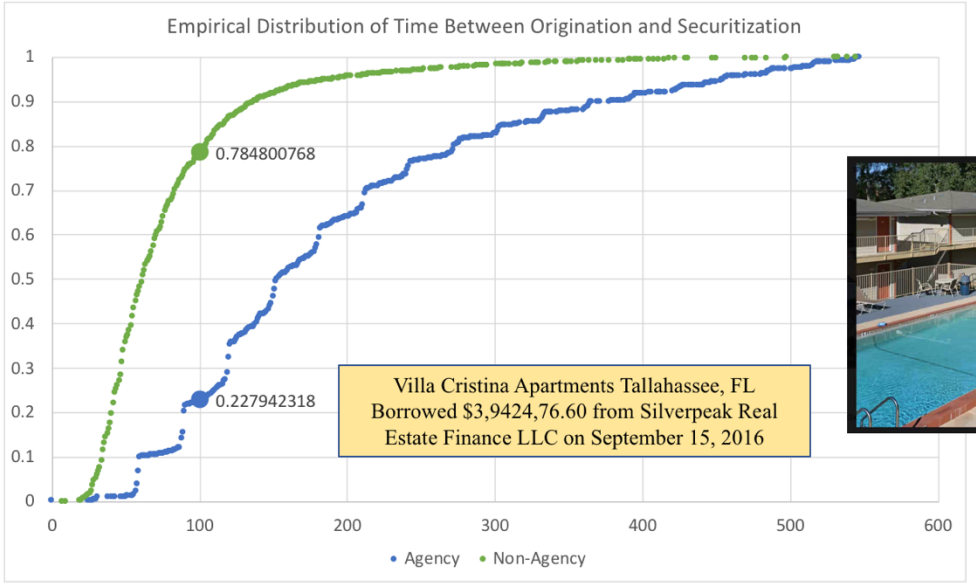
V-shaped H-shaped L-shaped

FIGURE 3: ESTIMATING THE TIMING OF SECURITIZATION

$Pr(ParkWest\ is\ Sold\ After\ December\ 24, 2016\ ) = 1 - \Pr(PW\ Sold\ Within\ 100\ days) = 1 - 0.7848 \approx .2152$

Park West Office Virginia Beach, VA
Borrowed $10,097,000 from NorthMarq Capital on September 15, 2016

September 15, 2016 is 100 days before December 24, 2016



Villa Cristina Apartments Tallahassee, FL
Borrowed $3,9424,76.60 from Silverpeak Real Estate Finance LLC on September 15, 2016

$Pr(Villa\ Cristina\ is\ Sold\ After\ December\ 24, 2016\ ) = 1 - 0.2279 \approx 0.7721$

FIGURE 4: B-PIECE SIZE BEFORE CRISIS AND AFTER RISK RETENTION IMPLEMENTATION

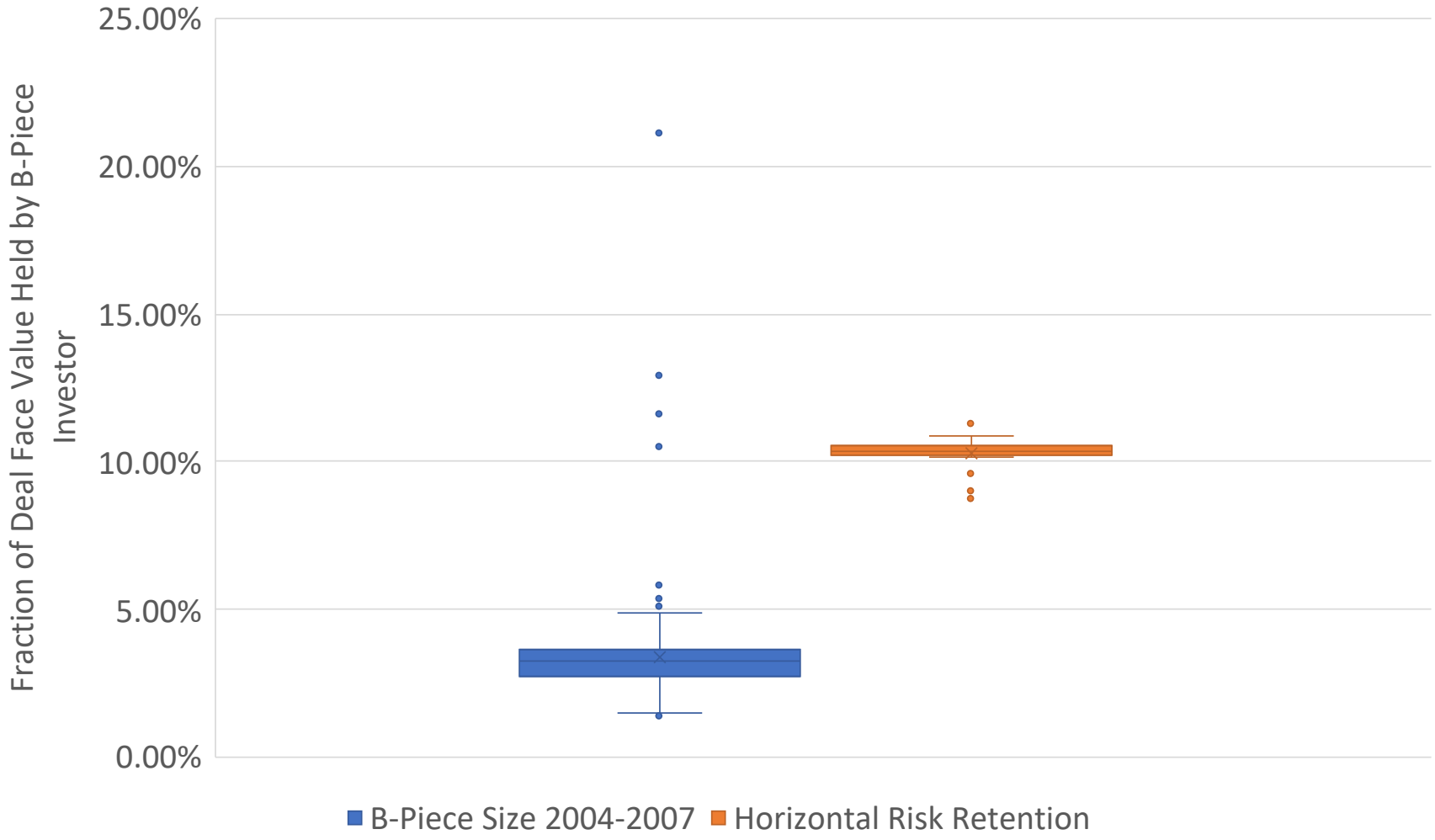
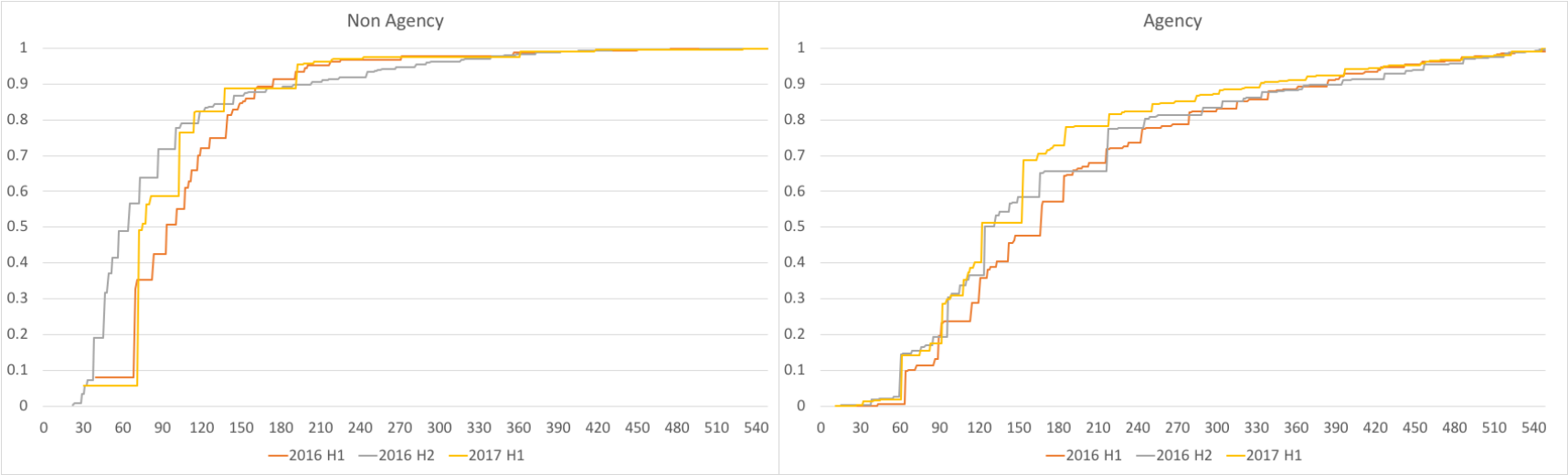


FIGURE 5: TIME BETWEEN ORIGINATION AND SECURITIZATION



These figures plot the cumulative distribution functions of the time between loan origination and securitization. The left panel reports the distribution for Non-Agency loans, which are subject to risk retention regulation. The right panel reports the distribution for Agency loans, which are not subject to risk retention regulation. The gray lines in the panel represent the six months immediately preceding the implementation of the regulation.

TABLE 1: SUMMARY STATISTICS ON THE COMPLETE LOAN SAMPLE

	10th percentile	Median	90th percentile	Mean	SD	Count
Panel A: Full Sample						
Agency Loans						
Loan Size (in millions)	1.192	6.59	27.942	11.714	15.384	49319
Interest rate	3.18	3.91	4.73	3.936	0.631	49319
LTV	0.554	0.706	0.793	0.686	0.102	24857
DSCR	1.275	1.46	2.145	1.614	0.472	24457
Non-Agency Loans						
Loan Size (in millions)	2.513	8.35	50	30.296	107.637	12836
Interest rate	4.077	4.655	5.32	4.681	0.538	12836
LTV	0.513	0.668	0.746	0.643	0.103	12314
DSCR	1.37	1.68	2.48	1.855	0.611	12206
All Loans						
Loan Size (in millions)	1.351	7	30.253	15.552	51.35	62155
Interest rate	3.25	4.074	4.94	4.09	0.683	62155
LTV	0.542	0.695	0.783	0.672	0.104	37171
DSCR	1.29	1.53	2.274	1.694	0.535	36663
Panel B: Securitized Before Dec 24, 2016						
Agency Loans						
Loan Size (in millions)	1.05	6.15	24.475	10.465	13.247	32268
Interest rate	3.08	3.96	4.78	3.956	0.674	32268
LTV	0.55	0.706	0.793	0.685	0.104	15069
DSCR	1.291	1.51	2.189	1.653	0.486	14668
Non-Agency Loans						
Loan Size (in millions)	2.511	7.892	42	25.017	74.45	9800
Interest rate	4.106	4.645	5.25	4.659	0.502	9800
LTV	0.526	0.679	0.748	0.652	0.1	9583
DSCR	1.361	1.66	2.37	1.813	0.574	9535
All Loans						
Loan Size (in millions)	1.255	6.6	26.72	13.855	38.257	42068
Interest rate	3.187	4.15	4.95	4.12	0.704	42068
LTV	0.544	0.696	0.78	0.672	0.104	24652
DSCR	1.308	1.565	2.26	1.716	0.528	24203
Panel C: Securitized After Dec 24, 2016						
Agency Loans						
Loan Size (in millions)	1.474	7.575	34.625	14.078	18.546	17051
Interest rate	3.28	3.83	4.62	3.898	0.539	17051
LTV	0.56	0.707	0.791	0.687	0.099	9788
DSCR	1.254	1.394	2.09	1.554	0.444	9789
Non-Agency Loans						
Loan Size (in millions)	2.517	10.943	78	47.333	175.269	3036
Interest rate	3.945	4.73	5.56	4.75	0.636	3036
LTV	0.484	0.634	0.724	0.612	0.107	2731
DSCR	1.4	1.82	2.84	2.005	0.708	2671
All Loans						
Loan Size (in millions)	1.549	8.039	37.4	19.104	71.243	20087
Interest rate	3.312	3.93	4.89	4.027	0.633	20087
LTV	0.54	0.693	0.786	0.671	0.106	12519
DSCR	1.264	1.445	2.29	1.651	0.545	12460

TABLE 2: PROPERTY TYPE DISTRIBUTION

Agency Loans

	Number	Percent of Total
Health Care	5,521	11
Mixed Use	15	0
Mobile Home Parks	699	1
Multifamily Housing	43,084	87
Total	49,324	100

Non-Agency Loans

	Number	Percent of Total
Full Service Hotels	616	4.76
Limited Service Hotels	1115	8.62
Industrial	580	4.49
Mixed Use	672	5.2
Mobile Home Parks	446	3.45
Multifamily Housing	2662	20.59
Office	2084	16.12
Other	116	0.9
Anchored Retail	2312	17.88
Unanchored Retail	1453	11.24
Self-Storage	858	6.64
Warehouse	14	0.11
Total	12,928	100

TABLE 3: SUMMARY STATISTICS ON THE MULTIFAMILY LOAN SAMPLE

	10th percentile	Median	90th percentile	Mean	SD	Count
			Panel A: Full Sample			
			Agency Loans			
Loan Size (in millions)	1.2	6.625	29.35	12.129	15.997	43079
Interest rate	3.15	3.93	4.75	3.944	0.646	43079
LTV	0.556	0.708	0.793	0.687	0.102	23880
DSCR	1.273	1.457	2.144	1.611	0.472	23485
			Non-Agency Loans			
Loan Size (in millions)	1.5	6.225	24.25	11.203	17.702	2661
Interest rate	3.949	4.64	5.5	4.681	0.616	2661
LTV	0.482	0.696	0.75	0.648	0.139	2199
DSCR	1.31	1.55	2.32	1.779	0.77	2185
			All Loans			
Loan Size (in millions)	1.225	6.599	28.978	12.076	16.102	45740
Interest rate	3.18	3.96	4.81	3.987	0.667	45740
LTV	0.55	0.706	0.792	0.684	0.106	26079
DSCR	1.276	1.463	2.165	1.625	0.507	25670
			Panel B: Securitized Before Dec 24, 2016			
			Agency Loans			
Loan Size (in millions)	1.1	6.232	25.5	10.875	13.804	27782
Interest rate	3.026	3.98	4.8	3.958	0.696	27782
LTV	0.55	0.706	0.794	0.686	0.104	14501
DSCR	1.29	1.509	2.184	1.65	0.484	14105
			Non-Agency Loans			
Loan Size (in millions)	1.7	6.4	22.6	10.868	16.413	2032
Interest rate	4	4.641	5.39	4.681	0.576	2032
LTV	0.518	0.704	0.75	0.658	0.13	1840
DSCR	1.32	1.54	2.205	1.739	0.699	1852
			All Loans			
Loan Size (in millions)	1.138	6.24	25.323	10.874	13.997	29814
Interest rate	3.06	4.01	4.85	4.007	0.712	29814
LTV	0.55	0.706	0.792	0.683	0.108	16341
DSCR	1.293	1.511	2.19	1.66	0.514	15957
	0.426	3.91	22.896	8.798	13.362	29814
			Panel C: Securitized After Dec 24, 2016			
			Agency Loans			
Loan Size (in millions)	1.41	7.484	36.031	14.409	19.145	15297
Interest rate	3.28	3.85	4.64	3.919	0.544	15297
LTV	0.565	0.71	0.793	0.689	0.099	9379
DSCR	1.252	1.39	2.093	1.552	0.448	9380
			Non-Agency Loans			
Loan Size (in millions)	1.077	5.5	29.5	12.287	21.319	629
Interest rate	3.781	4.63	5.7	4.682	0.731	629
LTV	0.28	0.65	0.747	0.596	0.168	359
DSCR	1.26	1.6	3.95	2.001	1.059	333
			All Loans			
Loan Size (in millions)	1.4	7.387	35.839	14.325	19.239	15926
Interest rate	3.29	3.88	4.7	3.949	0.572	15926
LTV	0.554	0.707	0.791	0.685	0.104	9738
DSCR	1.252	1.393	2.116	1.568	0.488	9713

TABLE 4: RISK RETENTION DIFFERENCE IN DIFFERENCE SPECIFICATIONS

	All loans						Multifamily loans		
VARIABLES	Interest rate	Interest rate	Interest rate	Interest rate	LTV	DSCR	Interest rate	LTV	DSCR
Non-Agency Loan	0.703***	0.676***	0.131	0.383*	0.207***	-1.428***	-0.774*	-0.0996*	0.957***
	(0.0303)	(0.0219)	(0.208)	(0.200)	(0.0272)	(0.182)	(0.404)	(0.0561)	(0.363)
Deal Settled After 24Dec2016	-0.0581	-0.0324	-0.00944	0.231***	-0.00766	-0.0865***	0.320***	-0.0159***	-0.0649*
	(0.0376)	(0.0384)	(0.0353)	(0.0317)	(0.00499)	(0.0288)	(0.0409)	(0.00597)	(0.0342)
Non-Agency x Deal Settled After 24Dec2016	0.149***	0.267***	0.294***	0.373***	-0.0307***	0.232***	0.221***	-0.0398***	0.309***
	(0.0465)	(0.0480)	(0.0397)	(0.0351)	(0.00442)	(0.0287)	(0.0721)	(0.00824)	(0.0643)
10 Year Treasury Yield at Origination		0.475***	0.430***	0.117	-2.16e-06	-0.0753	0.0656	0.00451	-0.0914
		(0.0641)	(0.0545)	(0.0857)	(0.0103)	(0.0683)	(0.102)	(0.0123)	(0.0835)
Non-Agency x (Treasury - Average Treasury)		0.155**	0.165***	0.127***	0.0235***	-0.118***	0.212***	0.00263	0.0112
		(0.0642)	(0.0532)	(0.0363)	(0.00505)	(0.0332)	(0.0679)	(0.00818)	(0.0570)
BAA - 10 Year Treasury Spread at Origination		0.0637	0.0559	-0.329**	0.0235	0.0830	-0.253	0.0159	0.169
		(0.0495)	(0.0432)	(0.133)	(0.0155)	(0.0905)	(0.160)	(0.0189)	(0.109)
Non-Agency x (Spread - Average Spread)		0.330***	0.345***	0.426***	-0.0150***	0.0153	0.280***	-0.0219***	0.116**
		(0.0560)	(0.0474)	(0.0422)	(0.00505)	(0.0309)	(0.0754)	(0.00794)	(0.0587)
Log Loan Size			-0.149***	-0.136***	0.0107***	-0.00241	-0.148***	0.0106***	-0.00429
			(0.00820)	(0.00734)	(0.00118)	(0.00563)	(0.00738)	(0.00118)	(0.00567)
Non-Agency x Log Loan Size			-0.131***	-0.134***	-0.00372***	0.0946***	-0.0804***	0.0160***	-0.0513**
			(0.00805)	(0.00812)	(0.00133)	(0.00978)	(0.0225)	(0.00353)	(0.0222)
Loan is fully amortizing			-0.558***	-0.555***	-0.0819***	0.0349	-0.560***	-0.0734***	0.0673*
			(0.0379)	(0.0361)	(0.0163)	(0.0395)	(0.0385)	(0.0163)	(0.0371)
Non-Agency x Loan is fully amortizing			0.763***	0.844***	0.0486**	-0.105*	1.024***	0.0183	-0.186**
			(0.0573)	(0.0597)	(0.0196)	(0.0569)	(0.111)	(0.0433)	(0.0891)
Observations	62,155	62,155	62,155	62,155	37,922	37,424	45,740	26,772	26,396
R-squared	0.197	0.250	0.393	0.435	0.275	0.193	0.335	0.295	0.182
Fixed effects for:									
Origination month				x	x	x	x	x	x
Originator			x	x	x	x	x	x	x
Property type			x	x	x	x			
Location (State) of Collateral Property			x	x	x	x	x	x	x

Robust standard errors (clustered by both origination month and originator) in parentheses

*** p<0.01, ** p<0.05, * p<0.1

TABLE 5: RISK RETENTION DIFFERENCE IN DIFFERENCE SPECIFICATIONS WITH FORECASTED PROBABILTIES OF SETTLEMENT TIMING

	All loans			Multifamily loans		
VARIABLES	Interest rate	LTV	DSCR	Interest rate	LTV	DSCR
Non-Agency Loan	0.381*	0.211***	-1.413***	-0.802**	-0.0933*	0.968***
	(0.201)	(0.0272)	(0.181)	(0.400)	(0.0560)	(0.362)
Probability Deal Settles After 24Dec2016	-0.472***	0.0215	-0.121*	-0.401**	-0.0340	-0.0170
	(0.106)	(0.0132)	(0.0733)	(0.198)	(0.0254)	(0.141)
Non-Agency x Probability Deal Settles After 24Dec2016	0.470***	-0.0363***	0.259***	0.279***	-0.0415***	0.354***
	(0.0368)	(0.00464)	(0.0302)	(0.0775)	(0.00896)	(0.0685)
10 Year Treasury Yield at Origination	0.0696	0.00340	-0.0887	0.0844	0.00369	-0.0947
	(0.0842)	(0.0104)	(0.0690)	(0.104)	(0.0124)	(0.0839)
Non-Agency x (Treasury - Average Treasury)	0.371***	0.0111*	-0.0756*	0.386***	0.00662	0.0276
	(0.0516)	(0.00653)	(0.0429)	(0.0862)	(0.00958)	(0.0681)
BAA - 10 Year Treasury Spread at Origination	-0.319**	0.0262*	0.0755	-0.234	0.0151	0.169
	(0.134)	(0.0155)	(0.0898)	(0.165)	(0.0190)	(0.109)
Non-Agency x (Spread - Average Spread)	0.497***	-0.0194***	0.0337	0.315***	-0.0235***	0.140**
	(0.0434)	(0.00517)	(0.0319)	(0.0778)	(0.00798)	(0.0594)
Log Loan Size	-0.137***	0.0109***	-0.00126	-0.150***	0.0108***	-0.00335
	(0.00741)	(0.00117)	(0.00557)	(0.00757)	(0.00117)	(0.00562)
Non-Agency x Log Loan Size	-0.139***	-0.00359***	0.0941***	-0.0829***	0.0158***	-0.0514**
	(0.00807)	(0.00132)	(0.00975)	(0.0221)	(0.00351)	(0.0221)
Loan is fully amortizing	-0.550***	-0.0809***	0.0344	-0.549***	-0.0730***	0.0692*
	(0.0362)	(0.0162)	(0.0396)	(0.0385)	(0.0163)	(0.0371)
Non-Agency x Loan is fully amortizing	0.683***	0.0563***	-0.133**	0.842***	0.0268	-0.224***
	(0.0598)	(0.0199)	(0.0574)	(0.151)	(0.0467)	(0.0847)
Observations	62,155	37,922	37,424	45,740	26,772	26,396
R-squared	0.433	0.275	0.194	0.327	0.294	0.182
Robust standard errors (clustered by both origination month and originator) in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						
Fixed effects for:						
Origination month	x	x	x	x	x	x
Originator	x	x	x	x	x	x
Property type	x	x	x			
Location (State) of Collateral Property	x	x	x	x	x	x

TABLE 6: RISK RETENTION – IS THE ORIGINATOR THE DEAL SPONSOR?

	All loans			Multifamily loans		
VARIABLES	Interest rate	LTV	DSCR	Interest rate	LTV	DSCR
Non-Agency Loan	0.357***	-0.0283***	0.0133	0.594***	-0.0566***	-0.0279
	(0.0664)	(0.00874)	(0.0568)	(0.0946)	(0.0175)	(0.110)
Probability Deal Settles After 24Dec2016	-0.437***	0.0235	-0.229***	-0.426*	-0.0340	-0.0766
	(0.139)	(0.0159)	(0.0863)	(0.226)	(0.0269)	(0.147)
Originated by Deal Sponsor	-0.158**	-0.00607	-0.0643	-0.183*	0.00372	-0.189***
	(0.0722)	(0.00681)	(0.0489)	(0.102)	(0.00874)	(0.0605)
Non-Agency x Originated by Deal Sponsor	0.0537	0.0168*	0.0722	-0.337**	0.0404**	0.316***
	(0.0811)	(0.00935)	(0.0665)	(0.132)	(0.0183)	(0.120)
Probability Deal Settles After 24Dec2016 x Originated by Deal Sponsor	-0.0965	0.00431	0.0865*	-0.114	0.00245	0.108**
	(0.101)	(0.00911)	(0.0486)	(0.112)	(0.00966)	(0.0504)
Non-Agency x Probability Deal Settles After 24Dec2016	0.424***	-0.0217*	0.410***	0.278	-0.000298	0.412***
	(0.114)	(0.0130)	(0.0724)	(0.180)	(0.0184)	(0.0951)
Non-Agency x Probability Deal Settles After 24Dec2016 x Originated by Deal Sponsor	0.0657	-0.0174	-0.152**	0.0198	-0.0456**	-0.0948
	(0.117)	(0.0132)	(0.0729)	(0.192)	(0.0194)	(0.107)
Observations	62,155	37,922	37,424	45,740	26,772	26,396
R-squared	0.432	0.270	0.188	0.327	0.295	0.183
Std errors (clustered by both origination month and originator) in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						
All regressions include controls for interest rates and spreads, loan size, and amortization type						
Fixed effects for:						
Origination month	x	x	x	x	x	x
Originator	x	x	x	x	x	x
Property type	x	x	x			
Location (State) of Collateral Property	x	x	x	x	x	x

TABLE 7: RISK RETENTION – VARIATION ACROSS LENDER TYPE

	All loans			Multifamily loans		
VARIABLES	Interest rate	LTV	DSCR	Interest rate	LTV	DSCR
Originated by Bank	0.0758	-0.00798	-0.0979**	0.0397	-0.00506	-0.102**
	(0.104)	(0.00630)	(0.0438)	(0.120)	(0.00695)	(0.0448)
Originated by REIT	-0.418**	0.0106	-0.140***	-0.417**	0.0163	-0.137***
	(0.190)	(0.0202)	(0.0513)	(0.187)	(0.0208)	(0.0525)
Non-Agency Loan	0.556***	0.202***	-1.405***	-0.601*	-0.0989*	0.984***
	(0.188)	(0.0271)	(0.178)	(0.354)	(0.0559)	(0.354)
Non-Agency x Originated by Bank	-0.599***	0.0233***	0.0289	-1.206***	0.0149	0.432***
	(0.0891)	(0.00798)	(0.0630)	(0.144)	(0.0111)	(0.104)
Non-Agency x Originated by REIT	0.0502	0.0357***	-0.379***	-0.153	0.00970	-0.200***
	(0.102)	(0.0121)	(0.0600)	(0.138)	(0.0153)	(0.0703)
Probability Deal Settles After 24Dec2016	-0.445***	0.0184	-0.135*	-0.247	-0.0376	-0.0557
	(0.106)	(0.0134)	(0.0745)	(0.188)	(0.0257)	(0.148)
Probability Deal Settles After 24Dec2016 x Originated by Bank	-0.00415	0.00424	0.00455	0.00517	0.00524	-0.0118
	(0.0600)	(0.00688)	(0.0342)	(0.0636)	(0.00690)	(0.0351)
Probability Deal Settles After 24Dec2016 x Originated by REIT	0.00801	0.00781	0.0469	-0.00256	0.00823	0.0389
	(0.0727)	(0.00878)	(0.0396)	(0.0721)	(0.00835)	(0.0388)
Non-Agency x Probability Deal Settles After 24Dec2016	0.340***	-0.0296***	0.150***	-0.235**	-0.0302***	0.163**
	(0.0490)	(0.00729)	(0.0408)	(0.0956)	(0.0114)	(0.0783)
Non-Agency x Probability Deal Settles After 24Dec2016 x Originated by Bank	0.109	-0.0126	0.159***	0.439***	-0.0225	0.384***
	(0.0745)	(0.00973)	(0.0532)	(0.133)	(0.0179)	(0.127)
Non-Agency x Probability Deal Settles After 24Dec2016 x Originated by REIT	0.304***	-0.00867	-0.0176	0.901***	-0.00634	0.0151
	(0.0912)	(0.0128)	(0.0577)	(0.139)	(0.0181)	(0.101)
Observations	62,155	37,922	37,424	45,740	26,772	26,396
R-Squared	0.438	0.275	0.195	0.337	0.295	0.187
Robust standard errors (clustered by both origination month and originator) in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						
All regressions include controls for interest rates and spreads, loan size, and amortization type						
Fixed effects for:						
Origination month	x	x	x	x	x	x
Originator	x	x	x	x	x	x
Property type	x	x	x			
Location (State) of Collateral Property	x	x	x	x	x	x

TABLE 8: RISK RETENTION – VARIATION ACROSS FORMS OF RETENTION

	All loans			Multifamily loans		
VARIABLES	Interest rate	LTV	DSCR	Interest rate	LTV	DSCR
Non-Agency Loan	0.367*	0.211***	-1.410***	-0.782*	-0.0862	0.941***
	(0.202)	(0.0271)	(0.181)	(0.402)	(0.0568)	(0.362)
Non-Agency Loan x Horizontal Risk Retention	0.0194	-0.00965	0.0255	0.611***	-0.0277	-0.350**
	(0.148)	(0.0142)	(0.0995)	(0.222)	(0.0280)	(0.146)
Non-Agency Loan x Vertical Risk Retention	-0.140	0.0209	-0.154	0.111	0.0106	-0.390**
	(0.111)	(0.0220)	(0.156)	(0.203)	(0.0608)	(0.198)
Probability Deal Settles After 24Dec2016	-0.449***	0.0271**	-0.137*	-0.326	-0.0304	-0.0753
	(0.108)	(0.0134)	(0.0744)	(0.203)	(0.0256)	(0.149)
Non-Agency x Probability Deal Settles After 24Dec2016	0.520***	-0.0258***	0.237***	0.322***	-0.0279**	0.285***
	(0.0451)	(0.00570)	(0.0381)	(0.0903)	(0.0123)	(0.108)
Non-Agency x Probability Deal Settles After 24Dec2016 x Horizontal Risk Retention	-0.0434	-0.00438	-0.0260	-0.454*	0.00120	0.315
	(0.153)	(0.0152)	(0.106)	(0.259)	(0.0358)	(0.217)
Non-Agency x Probability Deal Settles After 24Dec2016 x Vertical Risk Retention	0.0106	-0.0384	0.217	-0.431	-0.0262	0.663**
	(0.125)	(0.0235)	(0.163)	(0.280)	(0.0667)	(0.292)
Observations	62,155	37,922	37,424	45,740	26,772	26,396
R-Squared	0.434	0.275	0.194	0.328	0.294	0.183

Robust standard errors (clustered by both origination month and originator) in parentheses
*** p<0.01, ** p<0.05, * p<0.1
All regressions include controls for interest rates and spreads, loan size, and amortization type

Fixed effects for:						
Origination month	x	x	x	x	x	x
Originator	x	x	x	x	x	x
Property type	x	x	x			
Location (State) of Collateral Property	x	x	x	x	x	x

TABLE 9: THE INFORMATIVENESS OF RISK RETENTION

VARIABLES	B-Piece Size 2004-2007	Horizontal Risk Retention Since December 2016
Pool LTV	0.000995***	-0.000969
	(0.000337)	(0.000737)
Pool Interest Rate Spread over Treasuries	0.0143***	-0.00593
	(0.00301)	(0.00556)
Pool Debt Service Coverage Ratio	0.00566	-0.00168
	(0.00477)	(0.00706)
Constant	-0.0602*	0.177***
	(0.0306)	(0.0586)
Observations	234	24
R-squared	0.418	0.393

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 10: RISK RETENTION AND LOAN PERFORMANCE

VARIABLES	All Loans	Multifamily Loans
	Loan is non-performing or on watchlist	
Loan interest rate	0.00481	0.00261
	(0.00355)	(0.00315)
Loan LTV	0.0295	0.0271
	(0.0202)	(0.0202)
Loan DSCR	-0.00512	-0.00730*
	(0.00402)	(0.00436)
Non-Agency Loan	0.0717	0.0857
	(0.0490)	(0.0638)
Deal Settled After 24Dec2016	-0.00494	-0.0188
	(0.0273)	(0.0489)
Non-Agency x Deal Settled After 24Dec2016	-0.0482***	-0.0415***
	(0.0107)	(0.0158)
10 Year Treasury Yield at Origination	-0.00985	0.000605
	(0.0242)	(0.0245)
Non-Agency x (10 Year Treasury Yield - Average 10 Year Yield)	0.0421***	0.0315*
	(0.0135)	(0.0183)
BAA - 10 Year Treasury Spread at Origination	0.0615*	0.0625*
	(0.0344)	(0.0362)
Non-Agency x (Spread - Average Spread)	-0.0123	-0.00601
	(0.0113)	(0.0141)
Log Loan Size	-0.00637***	-0.00540***
	(0.00245)	(0.00207)
Non-Agency x Log Loan Size	-0.00189	-0.00201
	(0.00312)	(0.00417)
Loan is fully amortizing	-0.00109	0.00364
	(0.0277)	(0.0222)
Non-Agency x Loan is fully amortizing	-0.0170	-0.00774
	(0.0325)	(0.0414)
Observations	34,964	24,079
Pseudo R-squared	0.0986	0.1097

Analysis also includes fixed effects for origination month, originator, property type (first column), and the location (State) of the collateral property.
Robust standard errors (clustered by both origination month and originator) in parentheses.
*** p<0.01, ** p<0.05, * p<0.1