ESSAYS ON
AGENCY PROBLEMS IN SECURITIZATIONS

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INTRODUCTION

1 Relevance and problem

Asset backed securities (*ABS*, or *securitizations*) enable financial institutions to transfer assets to the capital market, which otherwise would not be tradable (for example mortgages or credit card receivables). For the originating financial institutions, ABS are an additional source of refinancing and an instrument of active credit risk management. ABS allow portfolio adjustments in the composition of their exposures. For investors, securitizations enable them to invest in asset classes they would otherwise be unable to access. In this respect, securitizations complement the financial markets and increase the flexibility for investors to diversify their portfolios. For central banks, securitizations are an important feature in the context of quantitative easing, particularly when conventional monetary policy does not have the desired effect. In Q2/2020, the European securitization market had an outstanding amount of € 999 billion (AFME, 2020). The large volume of the market underlines its enormous importance.

As a prerequisite of this dissertation, a brief introduction into the security design of ABS and the agency problems in the securitization market is essential: The *originator* is a financial institution, which *pools* assets and seeks to transfer them to the capital market. The special purpose vehicle (*SPV*) is an entity often owned by the originator, which buys the assets and issues *tranches* to the capital market. The *servicer* (who is usually also the originator) monitors the exposures after the deal origination. The servicer is also responsible for the work out of non-performing or defaulted exposures. (Hartmann-Wendels et al., 2019).

Financial research has revealed several *agency problems* emerging from asymmetric information in the securitization markets: Adverse selection and moral hazard have been problems, especially in the pre-crisis US securitization market (e.g., Keys et al., 2010; Demiroglu/James, 2012; Agarwal, 2012; Jiang et al., 2014). These problems emerged from a poorly conceived security design (incomplete contracts) and false incentives (Hartmann-Wendels et al., 2019). Ultimately, the originators of the securities used the ABS deals to transfer unwanted assets to investors. These had to bear the losses while the originators benefited from the good quality loans remaining on their balance sheets. On top of that, to satisfy the demand for securitizations,

originators engaged in the originate-to-distribute model. In this model, originators lend money to borrowers without an appropriate credit risk assessment (screening) and transfer the loans into an ABS deal immediately. The short time of exposure to the credit risk increased the incentives to lend money to unworthy borrowers (Hartmann-Wendels et al., 2019). The severity of these problems was amplified by the investors' reliance on the good credit ratings of the securitizations. The demand for these ABS deals was high since they offered a higher yield than bonds with the same rating. Instead of attempting to understand why yields were higher at a given rating, investors neglected to analyze the deals and the induced incentive problems. The substantial holdings of securitization positions facilitated the spread of the crisis when the US subprime crisis emerged, which led to the freeze of the securitization markets (ECB, 2011).

Although the incentive problems and the resulting losses in European deals were less severe than in the US, the EU had to intensify the regulation of the securitization market in order to re-establish trust in the market. This was of particular importance since the EU and the ECB see the securitization market as a desirable complement to the capital market. The most important regulatory actions, the introduction of the minimum retention rules and the European securitization regulation (EUSR), are the focus of this dissertation. The minimum retention rules (implicitly) require the originator to retain a material fraction of at least 5% of the deal volume (EU, 2009). Retaining a part of the deal, which is also called "skin in the game", puts the originator in the same position as the investors and therefore harmonizes interests of banks and investors. Since the minimum retention requirements failed to revive the securitization markets (see also Figure III.1), the EU saw an urge to further regulate the securitization market with the EUSR. Enacting the EUSR, the EU aims to reduce asymmetric information in the market, increase the investors' understanding of the underlying risk and remove the investors' negative perception towards securitizations. Therefore, on the one hand, it imposes higher standards for the security design of all European securitizations (design features). On the other hand, it introduces a quality signal for simple, transparent, and standardized securitizations, the STS label, which is assigned to deals fulfilling even higher standards (EU, 2017). While the introduction of a quality label reduces asymmetric information, it carries the risk that investors again rely only on the existence of the label instead of analyzing the deals' riskiness before investing. However, performing a due diligence is crucial since the originators' incentives are determined by the design features (and not by the label). A repetition of the abovementioned investors' incautious reliance on labels would be a hazardous development, which diametrically contradicts the objectives pursued by the EU with the EUSR in general and the STS concept in particular.

2 Aims and research questions

The focus of this dissertation are analyses of the effects of the abovementioned regulations – minimum retention requirements and the EUSR – on the mitigation of agency problems in the securitization market. This dissertation aims to add to the existing literature by answering the question what the effects of regulatory measures imposed within the EU's post-crisis regulatory interventions on the securitization market are. Additionally, the dissertation contributes to the literature by studying the importance of the security design features of and labels of complex financial securities for the market participants, especially originators and investors. The following research questions are investigated in the context of three essays within the cumulative dissertation:

<u>Minimum retention requirements and the originators' behavior (Essay I)</u>

- Why does retention lead to superior loan performance? Do banks treat loans differently depending on the loans' assignment to a retention or no-retention deal?
- Do banks select loans into different types of deals?

<u>Minimum retention requirements and the pricing of tranches (Essay II)</u>

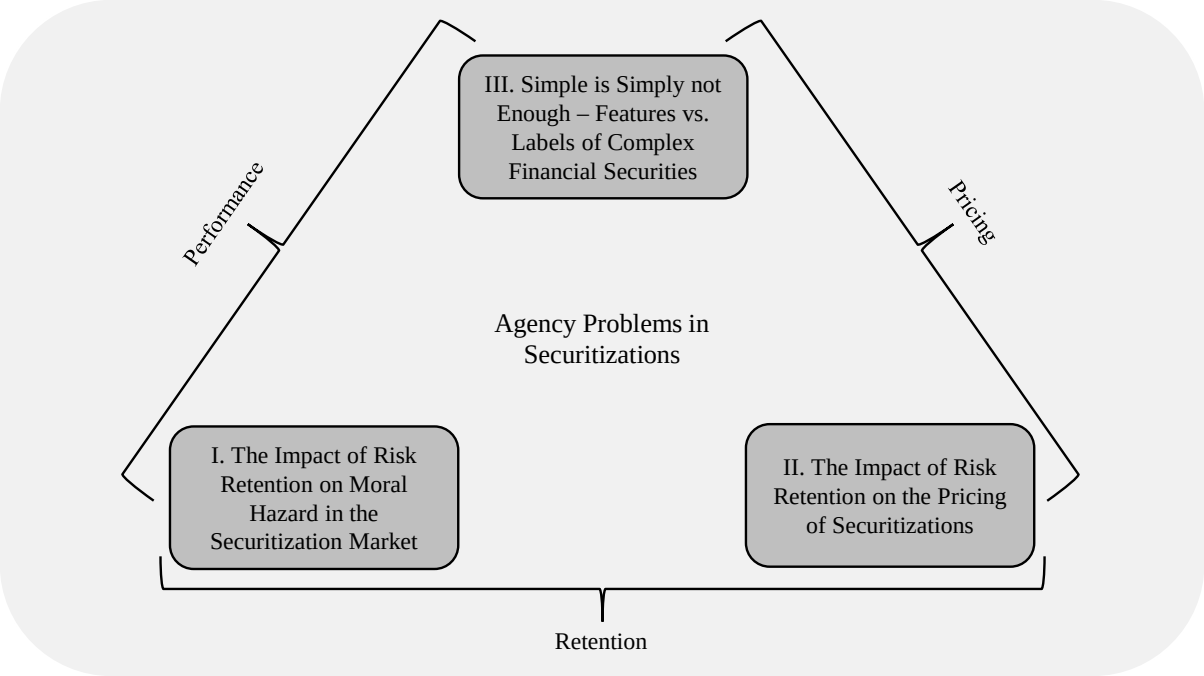
- Do investors anticipate the asymmetric information and incentive problems in the absence of retention; especially, do investors consider retention when they price securitization?
- Do investors of information sensitive ABS tranches have different preferences regarding retention than those of the information insensitive ABS tranches?

<u>Features and labels of complex financial securities (Essay III)</u>

- How does the EUSR affect the pricing of securitizations? Are the features of the security design or the label relevant for the pricing of securitizations?
- Does the regulation affect loan performance? And if so, are the features of the security design or the label relevant for the loan performance?

Figure A shows how the essays are connected. The effect of retention in the context of asymmetric information is in the focus of essays I and II. Essays II and III have the analysis of the pricing of tranches in common. Besides the prices effect, Essay III investigates the effects on loan performance, which in turn corresponds to Essay I. In the next section, I summarize the conducted research and present the results of the essays.

Figure A: Linkage of the essays



3 Summary of essays

Subsequently, I present summaries of each essay of this dissertation:

I. The Impact of Risk Retention on Moral Hazard in the Securitization Market

with Martin Hibbeln

This paper has been presented/accepted for presentation at the Financial Management Association (FMA) Europe Meeting 2021, Cyprus; International Banking, Economics, and Finance Association (IBEFA) Summer Meeting 2020, Denver; Annual Meeting of the Southwestern Finance Association (SWFA) 2020, San Antonio; 7th Bordeaux Workshop in International Economics and Finance "Banking Regulation, Risk and Governance" of the Association Française de Science Economique (AFSE) 2019, Bordeaux; "Financial System of the Future" of the Federal Reserve Bank 2019. Atlanta; Annual Meeting of the German Finance Association (DGF) 2019, Essen; Doctoral Brownbag Seminar in Economics, Mercator School of Management 2019, Duisburg; Research Seminar 2019, University of St. Gallen; Research Seminar 2019, University of Tübingen; Belk-Kingston-Mercator Doctoral Workshop 2018, London. This paper is supported by the German Research Foundation (DFG), Grant no. 434130478.

There are various incentive problems in the securitization market because the originators are not exposed to the underlying risk after securitization. The retention of a part of the deal is expected to mitigate adverse selection and moral hazard due to a harmonization of interests of investors and originators (e.g., Chemla/Hennessy, 2014) and it has been shown that it leads to an increased deal performance (e.g., Begley/Purnanandam, 2017; Ashcraft et al., 2019). However, whether this is due to a mitigation of adverse selection and/or moral hazard, remains unanswered. Therefore, we investigate *why* loan performance is superior for retention loans. We

analyze whether originators treat loans differently if they retain a fraction of the deal, which might impact screening and monitoring effort as well as the workout of non-performing or defaulted loans. We contribute to the existing literature in three ways: First, we decompose the effect of retention on loan-level performance. Second, we provide evidence that the harmonization of interests leads to an improved bank behavior after securitization, which represents a mitigation of moral hazard. Loan characteristics at securitization, however, do not differ systematically. Third, we show that retention mitigates incentive problems which helps to restore trust in the securitization market.

Our analyses are based on a data set consisting of 24 million loan-quarter observations of European residential mortgage backed security (RMBS) deals issued between 2009 and 2017. Using pooled ordinary least squares (OLS) and pooled logit regressions, an instrumental variables (IV) approach and propensity score matching, we find the following results, which are in line with the theoretical arguments of decreased asymmetric information: Retention improves monitoring efforts and enhances the prevention and the handling of non-performing loans. The probability of becoming non-performing is lower in retention deals. Distressed retention loans are non-performing for a shorter period and in arrears with a smaller amount. Retention improves the workout process of non-performing and defaulted loans. Additionally, we show that retention leads to an improvement of all loss components. To sum up, we add to the literature by presenting evidence that retention effectively mitigates moral hazard in the securitization market.

II. The Impact of Risk Retention on the Pricing of Securitizations

with Martin Hibbeln

This paper has been presented/accepted for presentation at the International Banking, Economics, and Finance Association (IBEFA) Summer Meeting 2020, Denver; Annual Meeting of the Southwestern Finance Association (SWFA) 2020, San Antonio; Doctoral Brownbag Seminar in Business Administration, Mercator School of Management, 2018, Duisburg; Belk-Kingston-Mercator Doctoral Workshop 2018, London. Former versions of this paper circulated under the titles “Do Investors Consider Asymmetric Information in Pricing Securitizations?” and “How Smart are Investors after the Subprime Mortgage Crisis? Evidence from the Securitization Market”. The paper was awarded with a best paper award at the Annual Meeting of the SWFA 2020.

In the previous essay, we provide evidence that retention helps to mitigate asymmetric information between the originator and investors. However, we did not investigate the question whether the investors anticipate the desirable effects of retention. The investors might be willing to pay higher prices due to the reduction of asymmetric information. On average, retention would lead to reduced credit spreads of the tranches. This effect might particularly be driven

by high-risk tranches. Nevertheless, for investors of the relatively safe AAA tranches, asymmetric information is not as problematic as for non-AAA investors. Instead, AAA investors might rely on diversification and subordination. Another question is whether different types of investors prefer different types of retention: While investors of non-AAA tranches are expected to prefer equity retention, which means that the originator retains the first loss piece (equity tranche) of a deal, investors of AAA tranches might prefer vertical slice retention, in which the originator retains a fraction of each tranche of the deal. From their perspective, only vertical slice retention can assure proper monitoring incentives because the equity tranche is likely to be defaulted when retention becomes relevant to AAA investors.

We investigate these questions considering credit spreads of more than 3000 tranches which belong to about 1000 European deals. The sample period captures the years 2009 to 2019. Implementing pooled OLS and an IV approach, we find that investors indeed consider asymmetric information in pricing securitizations, which is indicated by lower credit spreads for tranches belonging to retention deals. This is in line with the theoretical arguments of decreased asymmetric information and the findings of the empirical literature (including Essay I of this dissertation). If we take a closer look at the effect, we find that retention is more important to investors of the riskier non-AAA tranches, which is plausible since these investors are more sensitive to information and can rely less on subordination. Regarding different retention types, we find that, as expected, non-AAA investors prefer equity retention instead of vertical slice retention. However, we do not find preferences for AAA investors for which we would have expected a preference for vertical slice retention as only this retention type ensures that the originator has skin in the game in economic downturn scenarios.

III. Simple is Simply not Enough – Features versus Labels of Complex Financial Securities

with Martin Hibbeln and Fabian Rendchen

This paper has been presented/accepted for presentation at the Brownbag Seminar in Economics, University of Duisburg-Essen 2020, Duisburg; International Doctoral Congress (IDOC) 2020, Duisburg; Banking Research Workshop Münster, 2020; Research Seminar 2020, University of Konstanz. This paper is supported by the German Research Foundation (DFG), Grant no. 434130478.

The EU persistently attempts to revive the post-crisis European securitization market. Besides the introduction of the minimum retention requirements and several other market interventions, the EU enacted the EUSR, which entered into force in 2019. This regulation demands stricter minimum requirements regarding the security design features for all European securit-

izations. Another important concept introduced by this regulation is the label for STS securitizations, emphasizing simple, transparent, and standardized deals. These aspects should strengthen the assessment of the risk taken on when investing in complex financial securities. Therefore, deals, which meet a whole range of required features, receive a quality label signaling high-quality securitization standards. As there is no empirical evidence in the literature regarding the importance of labels and features of complex financial securities for the pricing of their tranches and securitized loan performance, we investigate their effect on originators and investors.

Using a data set of RMBS deals issued between 2015 and 2019 containing more than 30 million loan-quarter observations, we apply several pooled OLS and pooled logit regressions, a fixed effects model, and an IV approach. On the one hand, we find that design labels are relevant for the pricing of complex financial securities although it is not decisive for securitized loan performance. On the other hand, we find that loan performance is determined by the features of the security design. These findings are both in line with the theoretical arguments. However, investors seem to neglect the fact that the features are highly relevant for the originators' behavior and therefore the loan performance. Instead, they rather rely on the label. On top of that, investors unexpectedly even demand a risk premium for deals issued under the new requirements of the EUSR (but without the STS label) compared to deals issued before the enactment of the regulation. This finding is a hint to a mispricing of these deals because their security design features, and the loan performance of these deals are superior than in pre-EUSR deals. Regarding the importance of the different features, we find a performance increasing effect for the minimum requirements of the regulation whereas the STS concept does not seem to be important for loan performance which is interesting for evaluating the importance of the different parts of the regulation. This is plausible because the EU, in fact, has made the most important features obligatory for all securitizations.

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I. THE IMPACT OF RISK RETENTION ON MORAL HAZARD IN THE SECURITIZATION MARKET

Martin Hibbeln and Werner Osterkamp

Abstract

Based on European RMBS deals with 24 million quarterly loan observations, we examine the effect of risk retention on bank behavior. We show that retention deals perform better due to improved monitoring effort and workout processes. We find that the probability of rating updates or collateral revaluations is higher for retention loans, and the rating quality is better; retention loans have a lower probability of becoming non-performing, a lower delinquency amount, and a shorter time in arrears. Moreover, non-performing and defaulted retention loans are more likely to recover. Reduced losses for deals with retention are driven by lower default rates, lower exposures at default, and higher recovery rates. Our results suggest that retention reduces moral hazard and incentivizes banks to exert higher effort, which results in superior securitized asset performance.

Keywords: security design; asset-backed securities; retention; moral hazard; monitoring

JEL classification: D82, G01, G18, G21, G28

1 Introduction

The originate-to-distribute (OTD) business model enabled banks to lend money to borrowers almost without being exposed to default risk because they transferred it immediately to investors. Due to the very short risk exposure, banks lowered their screening and monitoring efforts. Even if regulators by now require that the credit risk assessment for securitized loans corresponds to balance sheet loans (Article 408 of the Capital Requirement Regulation (CRR)), this only aims to reduce adverse selection at loan securitization, but the originator's behavior *after* securitization is also decisive for the performance of securitized loans. Retaining a fraction of asset-backed securities (ABS) might be crucial to alleviate persisting incentive problems. We test theoretical predictions regarding increased monitoring incentives by evaluating whether bank behavior is more favorable if they have "skin in the game": Do banks treat securitized loans differently – in terms of monitoring or during the workout process – depending on whether they retained a fraction of the deal?

While recent research shows that deals without retention perform worse than deals with retention do (Begley/Purnanandam, 2017), the question of *why* deals with retention show superiror performance, remains unanswered. We first confirm a superior loan performance in the presence of retention by showing that the loss volume is lower for retention loans. To provide insights on the reasons for such superior loan performance, we decompose the effect of retention by investigating the loss components separately: the default indicator, the exposure at default, and the loss given default. To examine the economic channels of improved loan performance, we investigate the effect of retention on monitoring activities for loans securitized in a deal with retention ("retention loans") versus loans securitized in a deal without retention ("no-retention loans"). Furthermore, we analyze the impact of retention on arrears prevention as well as the recovery of non-performing and defaulted loans and the underlying restructuring arrangements. We evaluate this based on a data set of residential mortgage-backed securities (RMBS) from the European Data Warehouse (EDW), which is part of the loan-level initiative of the ECB and consists of more than 24 million quarterly loan observations.

To answer our research question, we are interested in the *within-originator heterogeneity* regarding retention loans and no-retention loans. Therefore, we compare the behavior of originators towards retention loans versus no-retention loans at a given time. Using originator-time fixed effects and a set of controls, our setting allows us to compare loans securitized by the same originator and with similar loan characteristics at time *t*, but differ only in the affiliation to a deal that is equipped with retention ("retention deal") and without retention ("no-retention

deal"). Additionally, we perform a propensity score matching and an instrumental variable (IV) approach to examine the causal effect of retention on our dependent variables.

Investigating the impact of retention on the originators' behavior is crucial because regulators left discretionary freedom in treating securitized loans differently *after* securitization. We provide strong evidence for a reduction of moral hazard in the presence of risk retention by analyzing the originators behavior. We find that originators increase their effort substantially to avoid losses: First, in deals with retention, originators increase monitoring actions. This is indicated by significantly more frequent rating updates and collateral revaluations (both 3 times more likely for retention loans) as well as a higher rating quality, which increases the AUC value by 9% of the sample average. Second, in retention deals, originators are more effective in preventing loans from becoming non-performing. Our results suggest that retention loans have a 58% lower likelihood of becoming non-performing and the delinquency amount is about € 350 less for retention loans. Third, originators with skin in the game are more successful in the workout process of non-performing and defaulted loans. The time in arrears is 12 months lower and the probabilities of recovery from non-performing or default are both 40% higher for retention loans. Our results for loan performance suggest that retention helps to reduce the losses of RMBS loans by about € 112 per loan and year, which is driven by a 1.5 times lower default rate, a € 16,000 decreased exposure at default, and an 11 percentage points higher recovery rate. This results in a substantial loss reduction of around € 1.75 million per year for the average RMBS deal. Overall, we provide evidence that the security design can mitigate agency problems in the securitization market. Our analyses provide detailed information on the changes in the originators' behavior when the originator has skin in the game, resulting in substantially reduced moral hazard. We offer a comprehensive image of the originators' actions in securitization with and without retention.

A potential endogeneity concern is the selection of bad quality loans into the different types of deals, given ample evidence for adverse selection in the pre-crisis US RMBS market. Although there is no evidence for a similar adverse selection problem in the post-crisis EU RMBS market, we address this concern in several ways. First, comparing retention and no-retention loans, we do not find any evidence that banks systematically select less risky loans into retention deals based on *observable* loan characteristics. Second, our sample only consists of high-documentation loans, for which adverse selection based on *unobservables* is less of a concern (Demiroglu/James, 2012; Jiang et al., 2014; Rajan et al., 2015). Third, the selection of bad quality loans for securitizations is prohibited in the EU. Even if we cannot investigate unobservable loan characteristics with EDW data, originators have to consider that regulators have

a larger information set: In regulatory audits, regulators get access to internal bank data, so that most "unobservable" loan characteristics become observable. Thus, adverse selection would be easily verifiable for regulators since they can test if the securitized pool is a random draw from the balance sheet loans. Testing for moral hazard, however, is much more difficult: Even if the EU requires that screening and monitoring of credit and counterparty risk is ensured through effective systems for all financial institutions (Article 79c Capital Requirements Directive (CRD) IV),[1] the intensity of monitoring effort is hardly verifiable. Thus, despite their legal obligations, it is reasonable that originators vary their monitoring effort mainly based on economic considerations. Fourth, to ensure that the effect of retention is indeed causal, we implement an instrumental variable approach. To sum up, our results support the view that we can attribute the more favorable performance of retention loans mainly to higher bank effort in monitoring and during the workout process.

We contribute to the literature on security design, the financial crisis, and the impact of asymmetric information in banking. The impact of security design is a recent topic in the theoretical literature (Daley/Green, 2016; Sirignano et al., 2016; Williams, 2016; Hartman-Glaser, 2017; Sirignano/Giesecke, 2019; Hébert, 2018; Daley et al., 2020; Adelino et al., 2019), which also establishes that retention improves incentives by assuring that the originator has skin in the game. Combining pooling, tranching, and retention of the equity tranche is a close approximation of the optimal security design (DeMarzo, 2005; Hartman-Glaser et al., 2012; Vanasco, 2017). Well-designed securitization contracts can improve screening incentives and reduce losses, as well as defaults of tranches (Demiroglu/James, 2012; Malamud et al., 2013; Ghent et al., 2019). However, the amount of retention can signal asset quality to uninformed investors, hence, a compulsory retention amount impedes this signaling opportunity. Against this background, a prescribed flat-rate retention can be socially suboptimal due to the information destruction (Leland/Pyle, 1977; Boot/Thakor, 1993; DeMarzo/Duffie, 1999; Hartman-Glaser, 2017; Guo/Wu, 2014; Vanasco, 2017). Moreover, retention seems to be a substitute for reputation and ratings (Hartman-Glaser, 2017; Daley et al., 2020). Chemla/Hennessy (2014) introduce a theoretical model in which the originator's effort depends on the level of equity retention. Since higher retention increases the originators willingness to pay for monitoring activities, it decreases moral hazard. We add to the literature by providing empirical evidence that retention proves to be effective in increasing monitoring effort and decreasing moral hazard in securitizations.

[1] This rule does apply to both, securitized and balance sheet loans.

In contrast to the rich theoretical literature, there are few empirical findings on the effect of retention. For the US pre-crisis RMBS market, voluntary retention of a thicker equity tranche reduces the loan delinquency rate; investors seem to benefit from the decline in credit risk and lower the tranches' risk premiums; hereby, an above-median retention amount is associated with a 25 bp decrease in yield spreads and a reduction of abnormal defaults (Begley/Purnanandam, 2017). In line with this finding, mandatory equity retention according to the Dodd-Frank-Act leads to a lower default probability of more senior tranches and lower spreads of tranches (Ashcraft et al., 2019; Flynn et al, 2020; Ciochetti/Larsson, 2017). However, it remains unclear how retention affects the performance of individual loans depending on the banks' behavior. We contribute to this strand of the literature by disentangling the effect of retention on loan-level performance. We provide a comprehensive analysis of delinquencies, decompose the losses due to defaults, and analyze the effort to recover non-performing and defaulted loans using loan-level data.

A second related strand of the literature deals with the contribution of ABS to the financial crisis. In the pre-crisis period, many originators securitized loans *without* retaining a material fraction of the deal. This practice is an integral part of the OTD model as a main driver of the financial crisis. Because of the major lack of incentives, the OTD model leads to decreasing quality of securitized loans, especially if a bank is capital-constrained or performed poorly in terms of negative stock returns. The increased securitization activity with the OTD model deteriorated the lenders' information gathering before loan origination on the one hand, and led to the systematic securitization of worse loans on the other hand (Berndt/Gupta, 2009; Keys et al., 2010; Titman/Tsyplakov, 2010; Purnanandam, 2011; Nadauld/Sherlund, 2013; Jiang et al., 2014). Moreover, loans securitized after some time on a bank's balance sheet are less risky than are loans securitized within the OTD model. In line with this reasoning, recent research investigates the relationship between time to securitize and loan performance, pointing out that lemons seem to be sold first (An et al., 2011; Adelino et al., 2019). We contribute to this literature by showing that skin in the game harmonizes the interests of originators and investors, which leads to superior loan and deal performance. We provide evidence that skin in the game mitigates moral hazard problems, and therefore supports the restoration of trust in the securitization market, thus helping to resolve the ongoing adverse effects of the financial crisis.

A third stream of literature more broadly deals with asymmetric information in securitizations. These information asymmetries can be problematic, first, before loan origination between lender and borrowers, especially regarding the originators' screening incentives (theoretically:

Pennacchi, 1988; Gorton/Pennacchi, 1995; Holmstrom/Tirole, 1997; Petersen/Rajan 1994; empirically: Keys et al., 2010; Purnanandam, 2011; Griffin/Maturana, 2016). While Bubb/Kaufman (2014) provide evidence that discontinuities in the credit scores of securitized loans do not serve as good measures to prove moral hazard in securitizations, moral hazard cannot be rejected for the Italian securitization market (Albertazzi et al., 2017). We, therefore, focus on bank behavior after securitization to analyze moral hazard and provide evidence that retention incentivizes banks to exert higher effort after securitization, resulting in mitigated moral hazard. Second, information asymmetries can be problematic after loan origination and before the securitization decision, indicating that the securitized pool is not a random sample of the originators' balance sheet loans but that the originators use this method to remove undesired exposures from their balance sheets (Downing et al., 2009; An et al., 2011; Keys et al., 2010; Titman/Tsyplakov, 2010; Purnanadam, 2011; Agarwal et al., 2012; Ghent/Valkanov, 2016; Adelino et al., 2017; Kara et al., 2019). Nevertheless, some studies find no difference between securitized and balance sheet loans, or that securitized loans even have better quality (Benmelech et al., 2012; Albertazzi et al., 2015). We contribute to this literature by demonstrating that retention does not significantly affect loan quality at securitization in the post-crisis European RMBS market. However, we note that this could be a consequence of the regulatory requirement in the EU that the credit risk assessment of securitized loans has to correspond to balance sheet loans. Third, information asymmetries can be problematic after loan securitization between originator and investor, if originators treat securitized loans differently in terms of monitoring effort, modifications, renegotiations, and the probability of redefaults (Wang/Xia, 2014; Kara et al., 2019; Maturana, 2017; Piskorski et al., 2010; Agarwal et al., 2011; Zhang, 2013; Ghent/Valkanov, 2016; Kruger, 2018; Adelino et al., 2013; Adelino et al., 2014). We contribute to this literature by showing that the originators' monitoring activities improve not only for balance sheet loans, but also for securitized *retention* loans: Banks exert higher effort in terms of rating updates, collateral revaluations, and rating quality. Furthermore, we provide evidence that retention mitigates delinquencies in terms of the probability of becoming non-performing, delinquency amount and time in arrears, as well as the probability of resolving non-performing loans (NPLs) and defaults.

2 Data

2.1 Institutional setting and sample selection

In the wake of the financial crisis, the European ABS market froze almost completely due to a lack of trust. To provide access to information about the quality of the underlying assets of eligible ABS and thereby regain trust in the ABS market, the ECB established the loan-level initiative. Market participants should be able to verify and analyze the composition of a deal's loan pool before investing. In this respect, the EDW database was created with the aim of increasing transparency and restoring confidence in the European ABS market (Trichet, 2011).

In addition, the CRD introduced the minimum retention rules in Article 122a on January 1, 2011. Article 405 of the Capital Requirement Regulation (CRR) slightly re-defines minor aspects, and the current version of the retention rules are set in the European framework for securitizations. Since the introduction of the retention rules, the retention requirement is fulfilled if the originator retains "a material net economic interest in the securitization of not less than 5%" of the deal volume (see Article 122a CRD IV). When considering an investment into securitizations, investors located in the EU have to make sure that the respective transaction fulfills the retention requirements; otherwise, EU investors are not allowed to hold the securitization position. However, it is generally possible for European originators to issue securitizations without retention after 2010 that only non-EU investors can purchase. We provide further information and an overview of the different types of retention in the EU and the US in Appendix I.A.

In Q2/2019, the outstanding European ABS deals amounted to € 1.25 trillion, of which € 684 billion was on RMBS (SIFMA, 2019). The residential RMBS market consists mainly of private-label securitizations since commercial banks are the primary users of the market to transfer their exposures to investors. In European deals, originators of both, retention and no-retention deals usually act as the servicer of a deal, which is true for all deals in our sample. Hence, the originators remain responsible for monitoring activities, renegotiation and restructuring arrangements after securitization. In contrast to the US, restructuring loans after securitization is permitted in the EU and we have information available if a borrower and originator agreed to restructure the loan.

Our data set consists of loan-level data from the EDW database. We collect all quarterly European RMBS deal submissions issued between 2009 and 2017 and track the submissions until the end of 2017. We exclude all loans that have no unique identifier within a deal, a negative time to maturity, or have missing values for at least one of our control variables. Moreover,

we only consider deals of originators that issued retention *and* no-retention deals. As we can track loans over time, our final sample consists of 24.9 million loan-quarter-observations of 2.4 million loans in 156 deals.

2.2 Variable measurement

We manually extract all retention information directly from the investor prospectuses. To generate our binary key variable *Retention*, we search the prospectuses for retention information using the key words retain, retention, subordinated loan, 122a CRD, and 405 CRR. After the introduction of the minimum retention rules, most originators reveal only that the deal fulfills the regulatory requirements; thus, we assume that they choose the legal minimum of 5% (as Flynn et al., 2020 show for the US). For deals issued before 2011, we consider retention as fulfilled only if the retention amount is at least 5% of the deals' nominal value for consistency. If this threshold is not exceeded or there is no retention information available in the prospectuses, then we assign no (qualified) retention. While in 2009 and 2010, only a few deals have retention, the number of deals without retention dropped throughout the introduction of the minimum retention rules in 2011.

Table I.1: Distribution of retention observations over time

This table displays the number of deal-level observations per year (Panel A), and the number of observations of no-retention loans and retention loans in the data set (Panel B). Since the EDW database was introduced in 2012, regular submissions begin in 2012 and are tracked until 2017. No-retention deals and no-retention loans are assigned for deals without reported retention in the investor prospectus or with retention of less than 5%.

Panel A: Observations of deals outstanding							
	2012	2013	2014	2015	2016	2017	Total
No-Retention Deals	15	43	43	39	28	24	192
Retention Deals	22	68	83	90	100	90	453
Total	37	111	126	129	128	114	645

Panel B: Observations of loans outstanding							
	2012	2013	2014	2015	2016	2017	Total
No-Retention Loans	161,924	1,823,559	1,870,406	1,576,689	1,199,716	491,459	7,123,753
Retention Loans	222,727	3,108,006	3,629,352	4,358,137	4,347,760	2,146,168	17,812,150
Total	384,651	4,931,565	5,499,758	5,934,826	5,547,476	2,637,627	24,935,903

Nevertheless, some deals were issued without retention even after 2010. Originators must consider that retention deals are costly because of the potential losses. If an originator wants to avoid these losses, then, on the one hand, the originator can carry out cost-intensive screening

and monitoring tasks, such as collecting information from credit bureaus or verifying documents or collateral values. On the other hand, originators can avoid these losses by foregoing EU investors as potential investors, which makes the issuance of new no-retention deals possible after 2010. Table I.1 presents the distribution of retention across the sample period.

As dependent variables, we use indicator variables for *Rating Updates* and *Collateral Revaluations* of the collateral, *Rating Quality*, Δ*Rating Quality*, an indicator variable for non-performing loans (*NPL*), *Time In Arrears*, *Delinquency Amount*, and indicator variables for delinquency recovery (*NPL Recovery*) and *Default Recovery*. In addition, we use *Loss*, an indicator variable for *Defaults*, *Exposure At Default* and *Recovery Rate* as dependent variables. Appendix I.B provides an overview of the variable definitions. Table I.2 presents descriptive statistics of the dependent variables. Some values are missing due to data quality, but most occur because some variables are only available in special cases, such as the exposure at default and the recovery rate in case of default. Except for the internal credit rating, all required variables are mandatory for submissions to the EDW database.

For the internal credit rating as one of our dependent variables, we cannot provide descriptive statistics. The rating is considered optional in the loan-level initiative and is unfortunately not standardized; consequently, each originator submits different rating classes. This makes it hard to compare ratings between deals and very often difficult to interpret the rating scale within a deal. The most accurate variable to measure the rating systems' evaluation of credit risk would be the probability of default (PD), which is, however, not provided. Nevertheless, for our analyses, we do not need a continuous or ordinally scaled variable. Instead, when analyzing incentives, we use the frequency of rating updates as a proxy for monitoring effort on the one hand, and use separate rating fixed effects for each deal when measuring the ability of each deal's rating system to predict future defaults as a proxy for the effort to reduce asymmetric information on the other hand.

As control variables, we use a loan's *Interest Rate* and *Time To Maturity* as measures of credit risk. Additionally, in line with the finalization of the Basel III reforms, we use *Loan To Value* (LTV) as a key figure for real estate-related exposures (BIS, 2017). *Loan Balance* (and the *Original Loan Balance*) is an essential variable for the securitization decision and a proxy for risk concentration (Ghent/Valkanov, 2016). Table I.2 provides the summary statistics of the control variables. Loan balances with values of 0 occur for the loans' last observations (redeemed loans), some first observations (e.g., if a loan is granted but not yet disbursed) or for defaulted loans (when the outstanding balance is flagged as defaulted).

Summing up the average deal characteristics, its size is € 1.55 billion and consists of around 15,700 loans. The average sample loan has an original volume of about € 102,000, an interest rate of roughly 3.3%, and a remaining maturity of 21 years. The loan amount corresponds to about 73% of the collateral value.

Table I.2: Descriptive statistics of the dependent and control variables

This table presents the summary statistics of our dependent and control variables. N refers to the number of quarterly loan observations; for rating quality (and Δrating quality), N represents deal-level observations. Delinquency amount, loss and exposure at default are measured in Euro, time in arrears is measured in months. Rating update, collateral revaluation, non-performing loan (NPL), default, NPL recovery and default recovery are binary indicator variables. The recovery rate and rating quality are measured in percent, Δrating quality is measured in percentage points. Regarding selection into securitization, we analyze differences with respect to several loan variables, which we use as controls in the other sections; the corresponding descriptive statistics can be found below. We provide all variable definitions in Appendix I.B. To account for outliers, we winsorize the variables at the 99.5% level.

	N	Mean	SD	Min	q50	Max
Section I.4.1 Monitoring after Securitization						
Rating Update (0/1)	6,532,858	0.1	0.3	0	0	1
Collateral Revaluation (0/1)	22,652,021	0.4	0.5	0	0	1
Rating Quality (%)	407	80.93	8.09	60.32	81.35	98.21
ΔRating Quality (%-p)	407	4.57	7.45	-8.75	2.08	29.18
Section I.4.2 Restructuring and Workout Process of NPLs						
NPL (0/1)	24,935,903	0.000	0.2	0	0	1
Time in Arrears (months)	201,479	31.96	22.78	1	27.37	104.77
Delinquency Amount (€)	201,347	1482	13,230	0	509.28	2,945,756
NPL Recovery (0/1)	492,679	0.3	0.5	0	0	1
Default Recovery (0/1)	119,223	0.0	0.2	0	0	1
Section I.5 Loan Characteristics at Securitization						
Interest Rate, Loan Balance, Loan to Value, Time to Maturity; see *Control Variables* below						
Section I.6 Losses and Decomposition of Losses						
Loss (€)	24,826,395	49.2	3,128.7	0	0	616,470
Default (0/1)	24,908,897	0.001	0.1	0	0	1
Exposure at Default (€)	33,061	150,055	557,303	0	102,000	11,666,525
Recovery Rate (%)	10,054	88.5	31.2	0.0	100	100
Control Variables						
Interest Rate (%)	24,935,903	3.3	1.7	0	3.7	7
Loan Balance (€)	24,935,903	102,023	74,505.6	0	89,500	479,006
Orig. Loan Vol. (€)	24,935,903	120,449	81,622.7	3500	104,000	535,000
Loan to Value (%)	24,935,903	72.8	33.0	1.7	73.6	143
Time to Maturity (month)	24,935,903	253.0	112.0	9.0	258.0	990

3 Empirical strategy

Theory suggests that requiring deals to include retention should harmonize the interests of originators and investors. In particular, the theoretical model of Chemla/Hennessy (2014) predicts that retention reduces moral hazard by incentivizing banks to exert higher monitoring effort. If retention has this desired effect, we should find an improvement in the originators' behavior. We test this prediction and expect retention to increase monitoring effort, decrease delinquencies and defaults, and improve the workout process for a given originator, compared to the originator's actions in a deal without retention. We conduct a *within-originator* analysis to indicate how a given originator treats two loans that differ only in whether the loans are assigned to a retention or a no-retention deal.

A major challenge is that the originators' actual actions and efforts regarding these lender-borrower-relationships, and therefore the actual monitoring quality, are not observable. Hence, we must use proxy variables for the originators' behavior. First, we investigate moral hazard in the presence of retention, controlling for loan characteristics. As proxy variables for monitoring effort, we analyze the likelihood of rating updates, the likelihood of collateral revaluations, and the rating systems' ability to predict future defaults ("rating quality"). As proxy variables for the effort to prevent losses, we investigate the probability of becoming non-performing. Regarding modifications, renegotiations and the workout process, we examine the time in arrears, the delinquency amount, the likelihood of recovering non-performing and defaulted loans, as well as the frequency and effectiveness of restructuring arrangements. Second, we analyze whether loan characteristics differ at loan securitization depending on retention, which would indicate a selection problem based on observable characteristics. In addition, we address the potential selection problem based on *unobserved* characteristics in several ways: I) We only consider high-documentation loans in our sample, for which adverse selection based on unobservables is less of a concern (Demiroglu/James, 2012; Jiang et al., 2014; Rajan et al., 2015). II) The EU regulation requires that the risk assessment of securitized loans has to correspond to balance sheet loans, which also applies to retention deals and no-retention deals. While we cannot examine possible differences in unobservable characteristics, originators must be aware that regulatory audits, in which the regulator has access to the bank internal data, would reveal such an adverse selection and is therefore unlikely. III) We implement an IV approach to rule out remaining concerns regarding the selection problem. Third, in addition to analyzing the impact of retention on moral hazard and adverse selection, we provide a comprehensive analysis of losses, in which we disentangle the loss amount into default rate, exposure at default, and

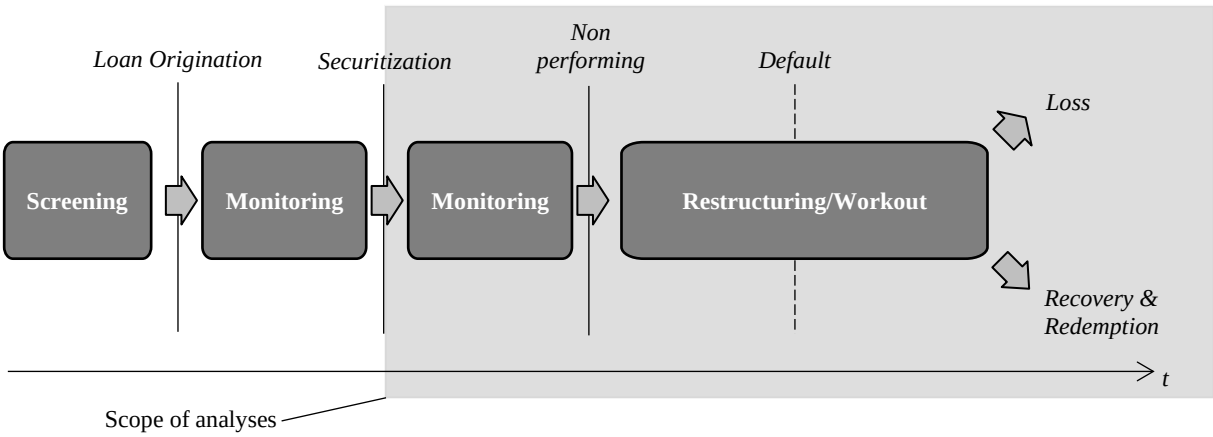
recovery rate. Taken together, the different proxies of moral hazard provide a comprehensive image of the effect of retention on bank behavior, resulting in a substantial mitigation of moral hazard. Table I.3 and Figure I.1 provide an overview of the subsequent analyses.

Table I.3: Overview of dependent and key variables and their purpose

Section	Purpose / Proxy for	Variable
I.4.1	Monitoring after Securitization	Rating Update Collateral Revaluation Rating Quality Δ Rating Quality
I.4.2	Restructuring and Workout Process of Non-Performing Loans	NPL Time in Arrears Delinquency Amount NPL Recovery Default Recovery
I.5	Loan Characteristics at Securitization	Interest Rate Time to Maturity Loan to Value Loan Balance
I.6	Losses and Decomposition of Losses	Loss Default Exposure at Default Recovery Rate

Figure I.1: Scope of analyses

This figure presents the credit process over time. Since we observe loans after securitization, the grey area indicates the scope of the analyses. We begin the analyses with the monitoring effort (Section I.4.1). Afterwards we analyze the restructuring and workout process of non-performing loans (I.4.2). Then we rule out that retention loans are already different from no-retention loans at securitization (I.5). Finally, we analyze and decompose the losses in the presence of retention (I.6).



We next describe our empirical strategy to investigate the effect of retention on the originators' behavior and support our findings with the established theoretical argumentation. We consider only deals of originators that issued at least one retention deal and one no-retention deal. We restrict this sample to create a comparison of each originator's loans, which are similar in as many characteristics as possible and only differ in whether it is a retention or no-retention deal, at a given point in time. To control for the unobservable heterogeneity of originators, we include originator-time fixed effects.[2] With this strategy, our analyses reveal the *within*-originator heterogeneity regarding retention loans and no-retention loans, indicating that the behavior differs only depending on whether a loan is assigned to a deal with or without retention. In addition, we use several loan characteristics as control variables.

We establish a base model (Equation I.1), to which many of our analyses refer. Hence, for each relevant analysis, we introduce a dependent variable $Y_{i,t}$ below.

$$Y_{i,t} = \beta_0 + \beta_1 \cdot Retention_d + \delta \cdot Controls_{i,t} + \psi_{t\times o} + \psi_{i,year}. \tag{I.1}$$

The indicator variable $Retention_d$ is our variable of interest and takes the value of 1 if a deal d is a retention deal, and 0 otherwise. Because loans with some characteristics might be treated differently than are others, we add the vector $Controls_{i,t}$, which is a set of loan-level control variables of loan i at time t, consisting of *Time To Maturity*, *Interest Rate*, *Loan To Value*, and *Loan Balance*. For all analyses with dependent variables that are euro amounts, we include the nominal amount of *Loan Balance*,[3] otherwise we include the log transformed variable. We provide all variable definitions in Appendix I.B. Due to the time constant variable of interest – the indicator variable retention – we cannot employ deal fixed effects. Hence, we estimate all regression models using ordinary least squares (OLS) or logit regressions. Originator-time fixed effects, as indicated by $\psi_{t\times o}$, control for the unobserved heterogeneity of originators, which can change over time. We include year-of-loan-origination fixed effects, indicated by $\psi_{i,year}$, since the time of loan origination correlates with a loan beeing a retention loan and we cannot rule out the possibility that it also correlates with dependent variables like loan performance measures. The standard errors are heteroskedasticity robust and clustered at deal level for all regressions.

[2] Since originators issue deals with assets from only one country in our sample, originator-time fixed effects also control for country- and country-time-specific effects. In addition, we do not need to account for different default regulations since the EU established the Basel III default definitions.

[3] Thus, we regress euro amounts on euro amounts.

Even if accounting for originator-time fixed effects should eliminate many potential sources of endogeneity, a possible concern is that the assignment of a loan to a retention or a no-retention deal by a given bank is not exogenous, which could lead to systematical differences between retention and no-retention loans. We therefore deal with possible sources of endogeneity in several ways. First, we analyze differences between retention and no-retention loans at the time of securitization, and we find no evidence of systematic selection of riskier loans for no-retention deals, which is plausible because in the EU, the screening of securitized loans has to correspond to balance sheet loans. While investors cannot investigate the unobservable characteristics with EDW data, originators have to take into account that regulators can reveal potential selection based on unobservables in audits since they have access to internal bank data. Second, we perform a propensity score matching for all loan-level analyses, which can reduce the bias due to confounding variables; the corresponding findings are consistent with the results from our main specifications (see Appendix I.C). Third, we implement an IV approach to infer the causal effect of retention. We describe the construction of the instrument and the corresponding results in Section I.7. We construct the instrument following Ashcraft et al. (2019), which indicates the originator's opportunity to securitize loans into no-retention deals instead of retention deals to avoid losses from these loans. The originators could use this opportunity to assign loans with expected poor performance to a no-retention deal and therefore avoid losses from having skin in the game. The greater the percentage of no-retention deals is, the better the originator's expected monitoring is for loans assigned to a retention deal instead, and the better their performance. Ashcraft et al. (2019) show that the tranche performance is improved if the originator has other deals available without having skin in the game. However, they do not show *why* tranche performance improves. On the contrary, we provide evidence that the loan-level performance improves because the originator behaves differently if the originator has skin in the game, leading to a reduction of moral hazard. The results of the propensity score matching and the IV approach both confirm our subsequent findings.

4 Skin in the game and moral hazard

Once the originator securitizes a loan into a no-retention deal (and therefore has no skin in the game), the originator has no exposure to the loan's credit risk and therefore no incentive to avoid possible losses (if reputational concerns are ignored). Thus, the originator could refrain from costly checks of creditworthiness, renegotiations, and modifications, as well as recovery and workout attempts. Subsequently, we investigate the originators' behavior in these aspects

after a loan is securitized depending on the presence of retention. Since the recognition of undesirable developments (e.g., arrears and defaults) is the necessary condition for the prevention of arrears, we begin our analyses with the banks' monitoring effort.

4.1 Monitoring activities with skin in the game

Having skin in the game, originators have to expect losses due to the ongoing exposure to credit risk and loan defaults. As long as monitoring activities are less costly than the expected losses due to retention are, it is rational for the originator to maintain monitoring activities after securitization to avoid losses. Therefore, we expect originators of retention deals to put more effort into costly monitoring activities. This argument is in line with the model of Chemla/Hennessy (2014), which states that the originators maximum willingness to pay for monitoring effort depends on retention. Since we cannot observe the actual monitoring activities or costs, we use the likelihood of rating updates, likelihood of collateral revaluations, and rating quality as proxy variables for monitoring activities. First, we investigate the likelihood of rating updates. If a loan's rating changes over time, then it could be due to a new assessment of credit risk within the monitoring process. However, we cannot rule out the possibility that the rating changed due to a data failure or a redefinition of the rating scale. While the latter reasons should not improve default prediction systematically, rating quality should improve if the rating update is the result of monitoring actions. Against this background, we test whether updated ratings improve default prediction. Indeed, in 95% [89%] of cases, rating updates improve default prediction significantly (at the 10% [1%] level). Another aspect of monitoring borrowers is the revaluation of the collateral, which will often result in a new collateral value. Thus, we investigate the probability of the collateral revaluation. We perform a logit regression of the indicator variables *Rating Updates* and *Collateral Revaluation* on *Retention* as in Equation I.1, with $Y_{i,t} = P(RatingUpdate_{i,t}=1|X_{i,t})$ and $Y_{i,t} = P(CollateralRevaluation_{i,t}=1|X_{i,t})$ as dependent variables.

To conduct the first analysis, we generate an indicator variable *Rating Update*, which takes the value of 1 if the rating of loan i at time t is different from the rating at time $t-1$, representing a rating update. Analogous to rating updates, we generate an indicator variable *Collateral Revaluation*, which equals 1 if the collateral value changed in the last period. We regress these indicator variables on *Retention* and the set of control variables. We report the results of the effect of retention on the likelihood of rating updates (columns 1 and 2) and collateral revaluation (columns 3 and 4) in Table I.4.

Table I.4: Monitoring effort: Rating update and collateral revaluation

This table contains the estimates of logit regressions. Columns (1) and (2) refer to the analysis of the probability of rating updates and (3) and (4) refer to the probability of collateral revaluations (Equation I.1). We provide all variable definitions in Appendix I.B. Odd numbers refer to the regressions with separate originator and time fixed effects, even numbers to regressions with originator-time fixed effects. We include fixed effects for the year of loan origination in all regressions. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	(1) Rating Update	(2) Rating Update	(3) Collateral Revaluation	(4) Collateral Revaluation
Retention	1.302***	1.330***	1.031*	1.165*
	(3.484)	(3.653)	(2.418)	(2.387)
Interest Rate	-0.001	-0.091**	0.095*	0.124**
	(-0.031)	(-2.654)	(2.335)	(3.185)
Log Loan Balance	0.470	-0.053	-0.209**	-0.311***
	(1.624)	(-1.569)	(-2.815)	(-5.134)
Loan to Value	-0.005	0.004***	0.014***	0.014***
	(-1.011)	(3.973)	(3.928)	(4.087)
Time to Maturity	-0.002*	-0.000	0.001**	0.002***
	(-2.032)	(-0.869)	(2.638)	(3.533)
Constant	-9.560***	7.956***	4.210***	1.275
	(-5.439)	(9.783)	(5.489)	(1.113)
Observations	6,321,830	5,736,502	22,629,943	21,192,607
Adj. Pseudo R^2	0.391	0.451	0.622	0.650
Fixed Effects				
Loan Origination Year	Yes	Yes	Yes	Yes
Originator	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Originator x Year	No	Yes	No	Yes
Clustered SE	Deal	Deal	Deal	Deal

The coefficients of the variable *Retention* indicate that the likelihood of rating updates and collateral revaluation increase significantly if a deal has retention. This effect is economically very meaningful. The probability of both rating updates and collateral revaluations, is around three times higher for retention loans than for no-retention loans.[4] This finding suggests that the originators' incentives to avoid losses substantially increase in the presence of retention, which is in line with the theoretical arguments.

[4] As a robustness check, we use the number of rating changes per loan and year as a variation of this analysis. Retention increases the number of rating changes by more than 0.6 changes per year. This result is statistically significant at the 0.1% level. The sample average number of rating changes per year is about 0.25. Evaluating the economic effect of retention, we find that the number of rating updates per year is 2.4 times higher for retention loans.

In a second analysis of monitoring incentives, we investigate the rating quality. If the originator monitors borrowers, then the result is a confirmation or revision of the existing credit rating. A good credit rating predicts future defaults accurately. Therefore, we conclude from a good credit rating system that monitoring effort is high. For this investigation, we perform a two-level procedure. On the first level, we evaluate each deal's rating system using loan-level data. For this purpose, we calculate the explanatory power of each rating system to predict future defaults. This first-level regression is a logit default prediction, where we estimate the probability of a loan defaulting within the next 12 months using the model in Equation I.2.

$$P(Default_{i,t+12} = 1 \mid X_{i,t}) = \beta_0 + \beta' \cdot CreditRating_{i,t} + \gamma' \cdot Controls_{i,t} + \psi_t. \qquad \text{(I.2)}$$

$Default_{i,t+12}$ is an indicator variable equal to 1 if loan *i* defaults within the next four quarters, and 0 otherwise. The vector *CreditRating* considers rating fixed effects based on each deal's rating system. Since loans with some characteristics might be monitored more intensively, we add the vector *Controls* at the first level, which consists of *LoanBalance*, *LoanToValue*, *TimeToMaturity* and *InterestRate.* As we run this regression for each deal separately, it is not possible to include originator-time fixed effects; instead, we add time fixed effects ψ_t to control for the development of rating systems over time due to regulatory influence or macroeconomic effects. We use the area under the receiver operating characteristics (ROC) curve (AUC) for each deal *d* and time *t* as the measure of $RatingQuality_{d,t}$.[5]

As a variation of this analysis, we study the improvement of a bank's rating system compared to a very simple rating system to create another measure of monitoring effort. We create the naïve rating system, which predicts future defaults based on a set of loan-level characteristics from Equation I.1 but omits the interest rate as it is the result of the rating system. We compute the AUC of the naïve rating system, and the variable $RatingQuality_{d,t,naïve}$, analogously. Afterwards, we generate the surplus of the originators' rating systems' ability to predict future defaults $\Delta RatingQuality_{d,t}$ by subtracting the measures of rating quality (i.e., the AUC values), as in Equation I.3.

$$\Delta RatingQuality_{d,t} = RatingQuality_{d,t} - RatingQuality_{d,t,naïve}. \qquad \text{(I.3)}$$

In the first level, we use loan-level data. Because the credit rating is an optional variable in the ECB's data requirements, we restrict our sample for this analysis to deals in which ratings

[5] As a robustness check, we implement the pseudo-R^2 instead of the AUC as a measure of rating. Overall, these results are economically meaningful and in line with the findings for the AUC. The average rating system explains 15% of the defaults in terms of pseudo-R^2. The estimated increase for retention deals is about 5 percentage points, which means that the rating quality is improved by about 33%.

are submitted in general; this reduces the sample to 7.3 million observations. We cannot provide first-level regression results because there is a regression table for each deal, though we do provide data on the explanatory power of the average deal. The average rating system has an area under the curve of 80.9%, which is, on average, 4.6 percentage points better than the naïve rating system.

In the second level (Equation I.4), we relate the *RatingQuality* (or $\Delta RatingQuality_{d,t}$) to the existence of $Retention_d$.

$$\begin{aligned} Y_{d,t} &= \gamma_0 + \gamma_1 \cdot Retention_d + \psi_{t \times o} + \varepsilon_{d,t} \\ with\ Y_{d,t} &= RatingQuality_{d,t}\ or\ Y_{d,t} = \Delta RatingQuality_{d,t}. \end{aligned} \tag{I.4}$$

In this OLS regression, originator-time fixed effects $\psi_{t \times o}$ control for unobserved originator specific characteristics, and standard errors are clustered at the deal level. The analysis of this second level is based on deal-quarter observations. We provide the results in Table I.5. The highly significant coefficients of retention indicate that the deals' rating quality, as well as the rating systems' surplus over our naïve rating system are significantly higher for retention deals. This effect is economically meaningful since the rating quality improves by about 6 percentage points, which is equivalent to 8% of the average deals' capability of default prediction.

Regarding this analysis, one could argue that the sample consists mainly of deals eligible for the ECB to provide favorable refinancing for the originators. Relevant for the refinancing costs is the riskiness of the deal's tranches. To reduce the reported riskiness, the originator can either improve the average loan quality in the pool or submit upward biased internal ratings to the ECB and rating agencies, holding the average loan quality constant. If this was the case, however, the default prediction of the ratings should deteriorate. Because we are not interested in the actual ratings, but rather in the ability to predict future defaults, this concern about the sample selection does not apply.

Summing up, we find that retention is associated with an increase in the likelihood of rating updates, collateral revaluations, and an improved rating quality, all of which are proxies for monitoring effort. These findings imply that originators treat securitized loans differently if they have skin in the game.

Table I.5: Rating quality

The table contains the estimates of OLS regressions, in which the dependent variable represents the rating quality (Equation I.2). Columns (1) and (2) refer to the quality of the actual rating system. Columns (3) and (4) refer to the surplus of the rating system over a naïve rating system. Control variables are included at the loan-level in the first-level regressions. We provide all variable definitions in Appendix I.B. The sample is restricted to a subset of deals, which generally submit data on the variable internal credit rating and are issued between 2010-2016 to provide at least one full year of default predictions. Odd numbers refer to the regressions with originator and time fixed effects, even numbers to regressions with originator-time fixed effects. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

	(1) Rating Quality	(2) Rating Quality	(3) ΔRating Quality	(4) ΔRating Quality
Retention	0.061***	0.053***	0.084***	0.086***
	(10.332)	(13.435)	(12.130)	(22.066)
Constant	0.753***	0.667***	0.045***	-0.092***
	(128.374)	(22.943)	(6.467)	(-4.737)
Observations	407	407	407	407
Adj. R^2	0.622	0.606	0.661	0.552
1st Level Controls	Yes	Yes	Yes	Yes
Fixed Effects				
Loan Origination Year	No	No	No	No
Originator FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Originator x Time FE	No	Yes	No	Yes
Clustered SE	Deal	Deal	Deal	Deal

4.2 Restructuring and the workout process of non-performing loans

The next set of analyses refers to the originator's behavior regarding NPLs. First, we look at the effort undertaken to prevent loans from becoming non-performing. Second, once a borrower is non-performing, we analyze the delinquency amount and the time in arrears. Third, we investigate the originators' efforts in recovering non-performing and defaulted loans with restructuring arrangements.

Facing financially distressed borrowers, the originator can try to avoid letting the loan become non-performing. For example, the originator can renegotiate the loan terms or agree to restructuring arrangements, such as by reducing the redemption rate. This could put the borrower in the position to pay off the outstanding loan in good order. The necessary conditions to prevent arrears are the identification of impending financial distress and the willingness to prevent a loan from becoming non-performing. Analogous to the considerations in the previous sections, the originator has incentives to prevent losses and delinquency of borrowers only if

the originator has skin in the game. We expect retention to decrease the probability of becoming non-performing *P(NPL=1)*.

To test this expectation, we run OLS and logit regressions according to Equation I.1 with the dependent variable $Y_{i,t} = P(NPL=1)$. We infer the indicator variable *NPL* from the account status. It takes the value of 1 if a loan is in arrears and the time in arrears is greater than 30 days. We present the results in Table I.6. The coefficient of retention implies that the probability of becoming non-performing is 57% lower for retention loans. The following analyses further investigate the originators' actions once a loan becomes non-performing. Taken as a basis for the following analyses, the sample average of time in arrears, given a loan is non-performing, is 32 months, and the median is 27 months. The more effort the originator puts into identifying financially distressed and delinquent borrowers, and the more willing the originator is to adjust loan terms, the faster the originator can resolve the delinquency on average. As skin in the game should incentivize these actions, we expect retention to decrease the time in arrears. In addition, given that a loan is already non-performing, it is in the interest of an originator with skin in the game to avoid a further increase in the delinquency amount, which could potentially lead to higher losses. The originator can do so by renegotiating and modifying the loan terms or restructuring the loan. Thus, we expect retention to decrease the average delinquency amount of NPLs. The model is related to Equation I.1, with $Y_{i,t} = TimeInArrears_{i,t}$ or $Y_{i,t} = DelinquencyAmount_{i,t}$.

The time in arrears and the delinquency amount are both original variables of the EDW data set. We present the results in Table I.6. Retention effectively reduces the time in arrears by more than 12 months. This effect is highly statistically significant and economically meaningful. Retention also decreases the delinquency amount by about € 350. This effect is not due to the different loan size as, first, retention loans are on average larger, and second, we include loan size as a control variable. Regarding the control variables, we observe the plausible effect of riskier loans in terms of LTV, as these tend to be in arrears for a longer period and have a higher delinquency amount.

Table I.6: Preventing and treating non-performing loans

This table contains the estimates of OLS regressions. Columns (1) and (2) refer to the analysis of the probability of becoming non-performing, (3) and (4) refer to the time in arrears given a loan is non-performing and (5) and (6) refer to the delinquency amount given a loan is non-performing (Equation I.1). We provide all variable definitions in Appendix I.B. Odd numbers refer to the regressions with originator and time fixed effects, even numbers to regressions with originator-time fixed effects. We include fixed effects for the year of loan origination in all regressions. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	(1) NPL	(2) NPL	(3) Time in Arrears	(4) Time in Arrears	(5) Delinquency Amount	(6) Delinquency Amount
Retention	-0.540*	-0.537*	-12.816***	-12.209***	-284.862	-351.280*
	(-2.307)	(-2.234)	(-3.523)	(-3.358)	(-1.549)	(-2.112)
Interest Rate	0.147***	0.145***	0.805**	0.745*	33.962	42.376
	(5.024)	(5.035)	(2.629)	(2.599)	(1.117)	(1.409)
Log Loan Balance	0.134***	0.131**	-1.644***	-1.655***		
	(3.397)	(3.167)	(-4.282)	(-4.564)		
Loan Balance					0.015***	0.015***
					(5.264)	(5.453)
Loan to Value	0.016***	0.017***	0.122**	0.124**	1.200	3.922*
	(4.674)	(4.500)	(2.609)	(2.768)	(0.532)	(1.978)
Time to Maturity	-0.001*	-0.001*	-0.001	-0.001	-5.627***	-5.827***
	(-2.134)	(-2.475)	(-0.082)	(-0.178)	(-4.167)	(-4.153)
Constant	-8.341***	-8.957***	21.492***	27.898***	2949.55**	4243.14***
	(-10.211)	(-11.965)	(3.543)	(3.851)	(3.307)	(5.359)
Observations	24,903,628	24,903,628	201,443	201,443	201,347	201,347
Adj. R^2	0.076	0.080	0.486	0.556	0.091	0.144
Fixed Effects						
Loan Origination Year	Yes	Yes	Yes	Yes	Yes	Yes
Originator	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Originator x Year	No	Yes	No	Yes	No	Yes
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal

Another measurement of successful actions to avoid losses is the recovery of NPLs. Following loan account statuses over time, we can track if an NPL becomes performing again. For this case, we generate an indicator variable *NPL Recovery*, which takes the value of 1 if an NPL's account status changes from non-performing in time *t* to performing or redeemed in *t*+1. In case of no or unsuccessful actions, the indicator variable takes the value of 0. Similarly, during the workout process a defaulted loan can become performing again, and afterwards, credit terms are fulfilled, and the loan is repaid. Analogous to the recovery of NPLs, we introduce an indicator variable *Default Recovery*, which takes the value of 1 if a defaulted loan's

account status changes to performing or redeemed in the next period and 0 if it continues to be in default.[6]

Table I.7: Restructuring and modification

This table contains the estimates of logit regressions analyzing the recovery probabilities. Columns (1) and (2) refer to the recovery of NPLs, and (3) and (4) refer to the recovery of defaulted loans (Equation I.1). We provide all variable definitions in Appendix I.B. Odd numbers refer to the regressions with originator and time fixed effects, even numbers to regressions with originator-time fixed effects. We include fixed effects for the year of loan origination in all regressions. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	(1) NPL Recovery	(2) NPL Recovery	(3) Default Recovery	(4) Default Recovery
Retention	0.316***	0.338***	0.373*	0.338^{+}
	(5.194)	(5.502)	(2.330)	(1.827)
Interest Rate	-0.069***	-0.067***	0.039	0.020
	(-7.649)	(-7.084)	(0.360)	(0.188)
Log Loan Balance	-0.040*	-0.042*	-0.068	-0.087*
	(-2.294)	(-2.498)	(-1.474)	(-2.223)
Loan to Value	-0.005***	-0.005***	-0.009***	-0.008***
	(-4.168)	(-4.423)	(-3.716)	(-3.340)
Time to Maturity	0.000	0.000	0.002*	0.002*
	(0.177)	(0.647)	(2.137)	(2.210)
Constant	-1.595	-0.931	-2.094	-1.350
	(-1.280)	(-0.723)	(-1.360)	(-1.364)
Observations	492,284	491,887	65,236	64,868
Adj. Pseudo R^2	0.040	0.046	0.098	0.110
Fixed Effects				
Loan Origination Year	Yes	Yes	Yes	Yes
Originator	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Originator x Year	No	Yes	No	Yes
Clustered SE	Deal	Deal	Deal	Deal

We estimate the recovery of NPLs $Y_{i,t} = P(NPLRecovery_{i,t}=1|X_{i,t})$ and the probability of default recovery $Y_{i,t} = P(DefaultRecovery_{i,t}=1|X_{i,t})$ with a logit regression model based on Equation I.1.

We provide the results in Table I.7. Focusing on the recovery of NPLs, we find a highly significant and economically very meaningful effect of retention on modification and renegotiation incentives, indicating that the probability of recovery is 40% higher for retention loans.

[6] As a robustness check, we consider loans as recovered from NPL (or default) only if the account status changes from non-performing (defaulted) to performing but not to redeemed. The results remain statistically significant but become economically slightly more pronounced.

The negative signs of the coefficients of *Interest Rate* and *Loan To Value* suggest that riskier loans have a lower probability of recovery. Additionally, if the outstanding amount of the loan is higher, then recovery is a greater challenge. Completing the image, we find evidence that retention also helps to increase the probability of recovery from default by 40% as indicated by the odds ratio. These effects suggest that for retention loans, originators try to maintain costumer-relationships and reconstitute their creditworthiness.

Additionally, to show that the higher probability of recovery from non-performing or default is due to loan modification and restructuring attempts by the originator, we analyze the restructuring arrangements of the loans. While we do not observe that loan restructuring arrangements are generally more likely for retention loans, we find that restructuring arrangement are more effective for retention loans. We analyze the effectiveness with a linear probability model. To do so, we include an interaction term of retention and an indicator variable for having a restructuring arrangement in place in the analyses of recovery from non-performing and defaults (similar to Table I.7). The coefficient of this interaction term indicates that the probability of recovery from non-performing increases by 7.9 percentage points ($p<0.01$) and that the probability of recovery from defaults increases by 6.8 percentage points ($p<0.1$) if restructuring arrangements are agreed on for retention loans.

In conclusion, the results in this section present a comprehensive understanding of the economic importance of retention to prevent losses from NPLs. Ultimately, retention helps to reduce credit risk in many ways due to increased effort in the monitoring and workout process. Having shown that retention mitigates moral hazard, we analyze whether selection into securitization for no-retention deals is also a problem by investigating the loan characteristics at securitization.

5 Skin in the game and selection into securitizations

A possible concern is that retention loans and no-retention loans could already have different loan characteristics at the time of securitization. To mitigate this endogeneity problem, first, we included several observable loan characteristics as control variables in the previous regressions. Second, we only considered high-documentation loans, for which a selection based on unobservables is expected to be less of a concern (Demiroglu/James, 2012; Jiang et al., 2014; Rajan et al., 2015). Subsequently, we return to the beginning of the loan securitization process and compare observable loan characteristics of retention loans and no-retention loans, similar to Demiroglu/James (2012) based on Equation I.5 to analyze the possible selection problem based on observable characteristics.

$$P(Retention_{i,t} = 1 \mid X_{i,t}) = \beta_0 + \delta \cdot Controls_{i,t} + \psi_{t \times o} + \psi_{i,year}. \quad \text{(I.5)}$$

As in the previous analyses, $Controls_{i,t}$ represents a set of loan-level control variables of loan *i* at time *t*, consisting of *Time To Maturity, Interest Rate, Loan To Value*, and *Loan Balance*. To analyze the loan characteristics at securitization, we include only the first observation of each loan in the subsequent analysis. We do not find evidence that retention loans and no-retention loans differ substantially at securitization (see Table I.8).

Table I.8: Selection based on loan characteristics

Subsequently, we present results of logit regressions (Equation I.5), in which retention is the dependent variable. We provide all variable definitions in Appendix I.B. Column (1) refers to the regressions with originator and time fixed effects, column (2) to regressions with originator-time fixed effects. We include fixed effects for the year of loan origination in all regressions. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	(1) Retention	(2) Retention
Interest Rate	-0.003 (-0.031)	-0.041 (-0.449)
Log Loan Balance	-0.025 (-0.370)	0.084 (1.172)
Loan to Value	0.005 (1.606)	0.000 (0.090)
Time to Maturity	0.002* (2.036)	0.001 (1.378)
Constant	0.474 (0.295)	0.757 (0.469)
Observations	2,440,207	1,807,146
Adj. Pseudo R^2	0.325	0.396
Fixed Effects		
Loan Origination Year	Yes	Yes
Originator	Yes	Yes
Year	Yes	Yes
Originator x Year	No	Yes
Clustered SE	Deal	Deal

In summary, we find no evidence of systematic selection of riskier loans for securitization, which is not surprising since the selection of bad quality loans for securitizations is prohibited, and we only consider high-documentation loans, for which a selection problem is expected to be less of a concern. This gives additional support to our finding that higher monitoring effort after securitization for retention loans is not based on different loan characteristics that exist prior to securitization. In the last set of analyses, we investigate whether our findings are reflected in an improved loan performance for retention loans.

6 Skin in the game and the decomposition of losses

In the previous analyses, we find a positive impact of retention on monitoring and during the workout process. Such improved incentives should ultimately lead to better loan performance in terms of lower economic losses. Against this background, we first investigate the effect of retention on loan losses. Afterwards, we decompose this effect to examine the elements of loss. The empirical literature reports that non-securitized loans are of better quality and default less often than securitized loans do (e.g., Ghent/Valkanov, 2016). Similarly, we find that retention is associated with a reduction in losses,[7] which is in line with the existing literature (e.g., Begley/Purnanandam, 2017). Our main contribution to this strand of literature, however, is the decomposition of losses. To paint this picture, we start our analyses by investigating the total loss amount from each loan. As the loss is the product of the default indicator, exposure at default, and loss given default, we disentangle the loss for each of these three factors by analyzing whether there are systematic differences for retention versus no-retention loans. Equation I.1 describes the regression models; in this set of analyses, our dependent variables are the *Loss*, an indicator variable *Default* if a loan will default at *t*+1, the *Exposure At Default*, and the *Recovery Rate* as the complement of the loss given default (=1–*RecoveryRate*).

$$\begin{aligned} &Y_{i,t} = Loss_{i,t} \;\; or \;\; Y_{i,t} = P\left(Default_{i,t+1} = 1 \mid X_{i,t}\right) \;\; or \\ &Y_{i,t} = ExposureAtDefault_{i,t} \;\; or \;\; Y_{i,t} = RecoveryRate_{i,t}. \end{aligned} \tag{I.6}$$

To analyze the default rates, we run logit regressions; all other regressions are run as OLS. For the analyses with *Exposure At Default* as the dependent variable, we control for loan size by including the original loan volume instead of loan balance (at default) because of collinearity. For *Exposure At Default* and *Recovery Rate*, we restrict the sample to defaulted loans.

We present the results in Table I.9. For deals with retention, the results suggest that the average loss per loan and year is about € 112 (= € 28 per quarter) lower in deals with retention. Decomposing the mechanism of retention to reduce losses, first, we find that retention helps to reduce the default rate. This effect is not only statistically significant, but also economically

[7] Until the introduction of the EU securitization regulation in 2019, there was no rule regarding the overall performance of securitized loans. While the overall loan performance in deals issued after 2018 is now benchmarked against the performance of balance sheet loans, deals issued earlier are not affected by this rule. Hence, the loss reduction effect of retention is of special interest for investing in EU deals issued before 2019 and non-EU deals. Furthermore, regulators faced with the decision to introduce or abolish retention requirements rely on a persuasive evaluation of the desired effects of originators having skin in the game.

meaningful since the odds of defaulting are 1.5 times lower for retention loans.[8] In line with expectations, the results further show that riskier loans in terms of LTV and interest rates are more likely to default. Second, we find that retention has a substantial effect on the exposure at default, which decreases by around € 16,000, controlling for *Original Loan Balance*. Third, the slightly significant coefficient of the recovery rate suggests that retention may have a large positive impact on the recovery rate, as well (about 11 percentage points). We conclude from these findings that not only is the avoidance of defaults more effective in retention deals, but also that once a loan defaults, having skin in the game provides incentives to the originator to carry out a cost-intensive workout process to avoid final losses. More precisely, in the face of extremely likely losses, the originator tries to reduce them, such as through a more successful foreclosure or examination of future recovery payments.

7 Instrumental variable approach

To infer the causal effect of retention, we construct an instrument analogous to Ashcraft et al. (2019). While they provide evidence for the impact of skin in the game on the performance of commercial mortgage backed securtities (CMBS) deals on tranche level, we analyze the impact of skin in the game on the performance and originators' behavior for RMBS deals at the loan level as in the previous sections. The results of the OLS/logit regressions and the propensity score matching (see Appendix I.C) indicate that retention loans are less exposed to moral hazard and perform better, and these findings hold after controlling for loan characteristics, year of loan origination fixed effects, and originator-time fixed effects.

[8] A potential concern is that larger loans could have lower PDs, and, thus, the coefficient of retention in column (3) and (4) could be biased if retention was positively correlated with loan size. However, we find that retention and loan size are slightly negatively correlated.

Table I.9: Decomposition of losses

This table contains the estimates of pooled OLS and logit regressions (Equation I.1). Columns (1) and (2) refer to the analysis of the loss amount and (3) and (4) refer to the default status in t+1 (pooled logit), (5) and (6) refer to the exposure at default (EAD) and (7) and (8) refer to the recovery rate (RR). For EAD, the sample is restricted to defaulted loans. For RR, the sample is restricted to defaults with completed workout process. We provide all variable definitions in Appendix I.B. All regressions are run with originator and time fixed effects (odd numbers) or originator-time fixed effects (even numbers). We include fixed effects for the year of loan origination in all regressions. Standard errors are clustered on deal level. t statistics are presented in parentheses. The signs denote as follows: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

	(1) Loss	(2) Loss	(3) Default	(4) Default	(5) EAD	(6) EAD	(7) RR	(8) RR
Retention	-29.524*	-27.989*	-0.433*	-0.411*	-12,391.7	-16,560.2*	11.559^{+}	10.949
	(-2.196)	(-2.122)	(-2.234)	(-2.113)	(-0.997)	(-2.291)	(1.711)	(1.651)
Interest Rate	2.997*	3.436*	0.241***	0.230***	734.98	-5,429.31***	0.268	0.229
	(2.081)	(2.204)	(7.096)	(6.891)	(0.399)	(-7.121)	(0.891)	(0.899)
Log Loan Balance	23.608**	24.278**	0.092^{+}	0.085			-0.972	-1.096
	(3.135)	(3.129)	(1.751)	(1.539)			(-1.621)	(-1.520)
Loan to Value	0.202*	0.188*	0.025***	0.026***	290.90***	403.31***	0.004	0.001
	(2.570)	(2.401)	(8.126)	(7.052)	(3.486)	(4.215)	(0.396)	(0.051)
Time to Maturity	0.001	0.001	-0.001	-0.001	118.08***	135.58***	0.005	0.003
	(0.055)	(0.092)	(-1.039)	(-1.376)	(4.161)	(5.649)	(0.854)	(0.702)
Original Loan Volume					0.501***	0.160***		
					(21.335)	(3.962)		
Constant	-333.690***	-347.818***	-13.277***	-10.835***	152,764.7	-155,345.7**	92.958***	99.443***
	(-3.528)	(-3.968)	(-12.836)	(-10.601)	(0.819)	(-3.357)	(10.442)	(16.457)
Observations	24,801,006	24,801,006	15,552,589	14,761,628	33,058	33,058	8,365	8,365
Adj.R^2/Adj. Pseudo R^2	0.001	0.002	0.082	0.096	0.885	0.964	0.783	0.793
Fixed Effects								
Loan Origination Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Originator	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Originator x Year	No	Yes	No	Yes	No	Yes	No	Yes
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal	Deal	Deal

Although we, first, analyze only high-documentation loans and, second, we do not find substantial differences between retention loans and no-retention loans at the time of securitization, one might argue that there might still be endogeneity concerns; for example, the assignment decision might be driven by unobservable loan characteristics such as soft information obtained during the screening and monitoring process. If this information impacts the assignment decision and is correlated with our dependent variables for the originators' behavior and loan performance, then the OLS/logit results might be biased. Against this background, our performance results could be explained by two mechanisms of retention. On the one hand, the assignment to a no-retention deal after credit risk assessment in the screening and monitoring process might be more likely for loans that are expected to perform worse. In this case, the assignment to a no-retention deal is an indication of future poor performance but not its cause. On the other hand, an originator of a no-retention deal has weaker screening and monitoring incentives, leading to poorer performance, which might drive our results. In this case, the relationship between retention and originators' behavior, as well as loan-level performance, is causal.

To differentiate between the two explanations and to avoid potential selection bias, we construct an instrument for each deal *d* of originator *o* issued at time *t*. The IV, analogous to Ashcraft et al. (2019), is the moving average of the percentage of no-retention deals by the same originator including all deals other than *d*, issued within a window surrounding one year before and one year after the issuance of deal *d*. We adopt the variation of the "access" to no-retention deals across time and originators, which we measure with the instrument. Even though the percentage of new no-retention deal issues diminishes over time due to the introduction of the minimum retention rules in 2011, we can still observe the behavior and performance of earlier issuances. The effect, which we estimate using this instrument, is the impact of the originators' opportunity to assign loans with expected poor performance to a no-retention deal, and therefore to avoid losses from having skin in the game. We expect that the greater the percentage of no-retention deals is, the better the originator's monitoring of loans assigned to a retention deal instead will be, and the better their performance.

Regarding a potential violation of the exclusion restriction, it would be problematic if there were time-variant originator-specific characteristics, which are on the one hand correlated with the originator's share of no-retention deals and on the other hand correlated with unobserved variables that correlate with our dependent variables. The introduction of the minimum retention rules is correlated with the probability that a deal has retention; however, it is not correlated with our dependent variables via unobserved factors. We employ the same setting as for our

OLS regressions, especially regarding sample restrictions, control variables and fixed effects. Since our instrument varies over time and originator, we can still implement originator fixed effects, time fixed effects, and originator-time fixed effects.[9] Table I.10 shows the second stage results of the IV regressions of our loan-level analyses. For the first stage we find that the F-values are at least 26.4, which suggests that our instrument is very strong in all specifications. We find that the signs of the coefficients from the IV setting remain the same as from our OLS regressions for all analyses, and in most cases the results remain statistically significant. Overall, the IV results confirm the findings of the OLS/logit regressions and of the propensity score matching, indicating that retention has a beneficial causal impact on the originator's behavior.

8 Conclusion

The theoretical and empirical literature indicate that agency problems with securitized loans lead to a different treatment compared to balance sheet loans. Theoretical literature also suggests that a lack of skin in the game induces moral hazard and that retention mitigates this problem by increasing the originators' monitoring effort (Chemla/Hennessy, 2014). We test this prediction and show that a proper security design can mitigate agency problems along the credit process substantially. Against the background that the current regulation does rather focus on reducing adverse selection than moral hazard, we show that moral hazard is an important driver of poor loan performance if there is no harmonization of interests, meaning that originators do not have skin in the game. First, we show that retention increases monitoring effort, resulting in a higher probability of rating updates and collateral revaluations, as well as higher rating quality. Second, we show that originators prevent retention loans from becoming non-performing. We not only provide evidence that the probability of becoming non-performing decreases in retention deals, but also that the delinquency amount and the time in arrears decrease. Third, a recovery of NPLs and defaulted loans is significantly more likely if they are part of a retention deal since restructuring arrangements are more effective in these deals. These findings suggest that retention substantially reduces moral hazard. Fourth, we find that retention loans and no-retention loans hardly differ in terms of riskiness at the time of securitization, indicating that the banks' behavior *after* securitization is decisive for the difference in losses. Fifth, these improved originator incentives result in lower losses, which are a result of a lower

[9] Note that the instrument is dependent on the year of deal issuance, whereas the fixed effects are dependent on the time of the observations, which avoids confounding the fixed effects and our instrument.

default rate, exposure at default, and loss given default. This is beneficial to investors and helps to restore trust in the securitization market.

Summing up, we transfer theoretical arguments regarding the difference between balance sheet and securitized loans to retention and no-retention loans, and we provide empirical evidence that the security design can mitigate agency problems in the securitization market substantially. In fact, our analyses provide detailed information on the type and magnitude of changes in the originators' behavior. We offer a comprehensive image of the benefits of retention – providing insights into how ABS should be designed to ensure trust and proper actions. To facilitate the effectiveness of the retention mechanism, regulators should simplify the access to this crucial information by establishing a database, including the retention type, the retention amount and the retaining entity since the investors currently have to search for the retention information in the deal prospectus manually. This database could, e.g., be managed by the securitization reposities of the loan-level initiative.

While we show that retention improves the effort compared to the absence of retention, due to data restrictions, it remains unknown whether this level of effort is comparable to the effort that an originator would take for balance sheet loans. Future research could thus analyze how a given originator, at a given point in time, treats three loans that are equal in all characteristics, except that one remains on the balance sheet, one is securitized in a no-retention deal, and one in a retention deal.

Table I.10: Instrumental variable approach: Percentage of no-retention deals

This table contains the estimates of the second stage of the two-stage-least square instrumental variable regressions. The instrument is the moving average of the percentage of no-retention deals by the same originator including all deals other than *d*, issued within in a window surrounding one year before and one year after the issuance of deal *d*. The analyses follow the previous pooled-OLS-regressions. We provide all variable definitions in Appendix I.B. All regressions are run with originator and time fixed effects (odd numbers) or originator-time fixed effects (even numbers). We include loan level control variables and fixed effects for the year of loan origination in all regressions. Standard errors are clustered on deal level. *t* statistics are presented in parentheses. The signs denote as follows: $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

	(1) Rating Change	(2) Rating Change	(3) Valuation Change	(4) Valuation Change	(5) NPL	(6) NPL	(7) Time to NPL	(8) Time to NPL	(9) Time in Arrears	(10) Time in Arrears
Fitted Retention	0.025	0.050	0.070	0.078^{+}	-0.015**	-0.014**	-868.853	-5,065.621^{+}	-84.837***	-79.566**
	(1.044)	(1.438)	(1.578)	(1.843)	(-2.977)	(-2.887)	(-0.814)	(-1.714)	(-3.442)	(-2.982)
Constant	-0.157	-0.014	1.290***	0.849***	-0.051***	-0.061***	1460.124	5224.732	-145.597*	-114.948^{+}
	(-1.432)	(-0.505)	(12.073)	(10.670)	(-3.592)	(-5.187)	(1.239)	(1.611)	(-2.242)	(-1.872)
Observations	6,526,992	6,526,992	22,630,706	22,630,706	24,905,049	24,905,049	36,828	36,828	599,982	599,982
Adjusted R^2	0.247	0.328	0.623	0.698	0.019	0.020	0.469	.	0.109	0.122
Loan Level Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects										
Loan Origination Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Originator	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Originator x Year	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal	Deal	Deal	Deal	Deal

Table I.10 Cont.

	(11) Delinquency Amount	(12) Delinquency Amount	(13) NPL Recovery	(14) NPL Recovery	(15) Default Recovery	(16) Default Recovery
Fitted Retention	-3,000.854*	-3,012.623*	0.058***	0.061***	0.011**	0.009**
	(-2.516)	(-2.369)	(6.147)	(6.145)	(2.787)	(2.814)
Constant	6772.700*	2308.801	0.288**	0.449***	-0.002	-0.024
	(2.335)	(0.872)	(3.269)	(4.749)	(-0.049)	(-0.566)
Observations	489149	489149	492,286	492,286	109,489	109,489
Adjusted R^2	0.078	0.130	0.044	0.050	0.063	0.073
Loan Level Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects						
Loan Origination Year	Yes	Yes	Yes	Yes	Yes	Yes
Originator	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Originator x Year	No	Yes	No	Yes	No	Yes
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal

	(17) Loss	(18) Loss	(19) Default	(20) Default	(21) EAD	(22) EAD	(23) RR	(24) RR
Fitted Retention	-28.095*	-23.675+	-0.005+	-0.004	-9,561.59	-11,027.26*	1.669	2.284
	(-2.017)	(-1.793)	(-1.664)	(-1.455)	(-1.511)	(-1.978)	(0.682)	(0.938)
Constant	-334.317***	-350.817***	-0.021***	-0.020***	239,435.47	-19,299.77	104.444***	105.747***
	(-3.540)	(-3.977)	(-4.696)	(-5.131)	(1.303)	(-1.639)	(11.727)	(12.441)
Observations	24,801,006	24,801,006	21,999,440	21,999,440	33,061	33,061	8,365	8,365
Adjusted R^2	0.001	0.002	0.016	0.018	0.885	0.964	0.774	0.786
Loan Level Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects								
Loan Origination Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Originator	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Originator x Year	No	Yes	No	Yes	No	Yes	No	Yes
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal	Deal	Deal

Appendix I.A Regulatory retention rules

The EU has five permitted retention types, which we briefly describe below. Equity retention is the retention of the first loss piece and, if essential to reach 5% of the nominal value, parts of the tranche above. Vertical slice retention is the retention of 5% of each issued tranche. Seller's share retention is the retention of 5% of the nominal value of each securitized exposure (for revolving securitizations only). For deals, in which the number of securitized exposures is at least 100, random selection is the retention of 5% randomly selected exposures, which would have been securitized otherwise. First loss retention is the retention of at least 5% of every securitized exposure.

For comparison, in the US the introduction of risk retention was announced in the Dodd Frank Act in 2010 and specified by the SEC in December 2014. Besides vertical and horizontal slice retention, the US permits a linear combination of them, L-shaped retention. However, the EU decided against integrating L-shaped retention into the regulation since it is more complicated to implement (EBA, 2016). In addition to the differences in the permitted retention types, there exist other distinctions between the EU and US retention rules. In the US, the fair value of the deal is relevant for the calculation of the retention amount, while the rules in the EU refer to the deal's nominal value. In the absence of market prices, the fair value approach allows for valuation flexibility. However, the disclosure requirements are stricter in the US, such as regarding the disclosure of risk parameters. It is noteworthy that the retention requirements in the US exclude qualified residental mortgages. For the definition of qualified residential mortgages, which account for many deals in the US market, see Section 15G of the Dodd Frank Act (Dodd Frank Act, 2010; SEC 2014; Krahnen/Wilde, 2018).

Appendix I.B Variable definitions

Variable	Description	EDW Variable AR
CollateralRevaluation	Indicator variable equal to 1 if a loan's collateral value changes between *t* and *t*+1	136
Default	Indicator variable equal to 1 if a loan will default at *t*+1	166
DefaultRecovery	Indicator variable equal to 1 if a loan is in default at *t* and will become performing or be redeemed at *t*+1	166
DelinquencyAmount	Maximum volume in arrears given a loan is delinquent (in €)	169
ExposureAtDefault	Outstanding balance at *t* if a loan will default at *t*+1 (in €)	67
InterestRate	Current interest rate (in %)	109
InternalRating	Internal rating of a loan, measured by a set of indicator variables for each rating class of a deal's rating system	17
LoanBalance	Current loan balance (in thousand €)	67
LoanToValue	Current ratio of loan balance and collateral value (in %)	141
Loss	Default volume minus cumulative recoveries (in €)	177, 181
NPL	Indicator variable equal to 1 if a loan status is non-performing and the time in arrears is greater than 30 days	166
NPLRecovery	Indicator variable equal to 1 if a loan is non-performing at *t* and will become performing or will be redeemed at *t*+1	166
OriginalLoanVolume	Loan volume at loan origination	66
RecoveryRate	Cumulative recoveries within 2 years after default divided by default volume	177, 181
RatingQuality	Deal's rating system's ability to predict defaults within the next 12 months (AUC or pseudo R^2, measured in %)	17
ΔRatingQuality	Surplus of a deal's rating system's ability to predict defaults within the next 12 months compared to a naïve rating system (measured in %-points)	17
RatingUpdate	Indicator variable equal to 1 if a loan's rating changes between *t* and *t*+1	17
Retention	Indicator variable equal to 1 for retention loans (loans securitized in a deal with retention) and retention deals	-
TimeInArrears	Number of months a loan is delinquent (conditional on delinquency)	1, 57, 166
TimeToMaturity	Number of months until loan maturity	56

Note: Variable names "AR" and the definitions in the EDW database are provided within the ECB loan-level initiative. See the RMBS data template here: https://www.ecb.europa.eu/paym/coll/loanlevel/transmission/html/index.en.html.

Appendix I.C Propensity score matching

Subsequently, we present the average treatment effects on the treated (ATT) resulting from a propensity score matching analogous to all previous loan-level analyses. We match loans by their one nearest neighbor (with replacement), resulting from all controls and indicators: interest rate, loan balance, LTV, time to maturity, loan origination year, originator, and time. All results are in line with the OLS/logit estimators.

Variable	Retention	No Retention	Difference	*t*-stat
Rating Update	0.1211	0.0642	0.0569	27.54
Collateral Revaluation	0.4816	0.4585	0.0239	12.52
NPL	0.0230	0.0383	-0.0153	-63.72
Time in Arrears	28.24	29.27	-1.04	-0.97
Delinquency Amount	1250	2945	-1695	-3.40
NPL Recovery	0.3160	0.2352	0.0808	27.3
Default Recovery	0.0307	0.0158	0.0148	6.03
Loss	15.41	55.57	-40.16	-9.42
Default	0.091	0.123	-0.0316	-5.86
EAD	150,753	194,280	-43,526	-0.76
RR	91.97	58.73	33.24	3.87

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II. THE IMPACT OF RISK RETENTION ON THE PRICING OF SECURITIZATIONS

Martin Hibbeln and Werner Osterkamp

Abstract

We examine whether investors of securitizations anticipate screening and monitoring incentives of originators. Theoretical literature suggests that equity retention leads to a maximization of screening efforts; thus, equity retention should result in a reduction of credit spreads if investors anticipate these incentives. Implementing an instrumental variable approach, we infer the causal effect of retention on spreads. Using a unique data set of securitizations, we find for information sensitive tranches, for which screening and monitoring incentives have the greatest impact, that investors require an additional risk premium of 120 basis points if originators do not retain a material share of securitizations. Furthermore, deals with vertical slice retention have a significantly higher risk premium compared to deals with equity retention.

Keywords: security design; asset-backed securities; retention; credit spreads

JEL classification: D82, G01, G21, G24

1 Introduction

Theory suggests that pooling and tranching of securitizations are important mechanisms to reduce problems of asymmetric information (DeMarzo, 2005). In addition, the optimal security design implies retention of the first loss tranche by the originator ("*equity retention*"), which leads to a maximization of screening and monitoring efforts. Nevertheless, in real-world securitizations many originators have used the originate-to-distribute (OTD) model without retaining a share of the transaction. Thus, originators might *screen* laxly if they know that they can sell loans through securitizations without participating in later defaults. Moreover, originators have reduced incentives to *monitor* the borrowers after selling the loans. The high practical relevance of screening and monitoring incentives for securitizations has been shown for the subprime crisis, to which the OTD model significantly contributed. On the basis of pre-crisis securitizations, the empirical literature finds that on the one hand mainly low-quality loans were securitized and on the other hand securitization led to reduced screening incentives (Keys et al., 2010; Purnanandam, 2011; Titman/Tsyplakov, 2010; Griffin/Maturana, 2016), confirming the theoretical arguments. However, whether investors have to bear the costs of low screening and monitoring incentives is not clear. Particularly after the subprime crisis, it would be plausible that investors anticipate reduced incentives of originators, which leads to higher credit spreads if information asymmetry is high, resulting in lower profits for originators. Against this background, our main research questions are: Do investors consider asymmetric information in pricing securitizations? Do different types of investors have different preferences for mitigating incentive problems?

Based on European securitizations from 2009 to 2019, we find evidence that investors indeed consider asymmetric information in pricing securitizations. If the originator retains at least 5% of the deal, the risk premium is reduced by 26 to 39 basis points (bp). For information sensitive tranches, where screening and monitoring incentives have the greatest impact, we find that investors even require an additional risk premium up to 123 bp if originators of mortgage backed security (MBS) deals do not retain a material share of securitizations. To investigate if this effect is causal, we implement an instrumental variable (IV) approach according to Ashcraft et al. (2019). This methodology suggests that a causal interpretation of our OLS results is feasible.

However, not only the existence of retention has an impact on the risk premium but also the type of retention. In line with theoretical predictions, investors of information sensitive

tranches demand a substantially lower risk premium in the case of equity retention instead of vertical slice retention, which is an equally weighted retention of each issued tranche.

This study makes the following contributions: first, to our knowledge, this is the first study which analyzes the effect of the EU minimum retention requirements on credit spreads. Second, our results suggest that investors anticipate screening and monitoring incentives of originators and choose the required risk premium on the basis of the degree of asymmetric information. Third, we provide insights into the magnitude of the risk premium due to asymmetric information for securitizations. Overall, this study improves the understanding of how information asymmetry is priced by investors.

The paper proceeds as follows. Section II.2 provides a review of related literature. Section II.3 contains the deduction of hypotheses about the influence of information asymmetries on the risk premium of securitizations. In Section II.4, we describe our data set and Section II.5 presents the results regarding the introduction of the minimum retention requirements. In Section II.6, we compare different types of retention. Section II.7 concludes.

2 Related Research

The theoretical literature discusses the relevance of asymmetric information in securitizations extensively. Theory suggests that pooling, tranching, and retention are important features to reduce costs of asymmetric information. If the market consists of informed and uninformed traders, there are benefits of pooling loans before originators sell them since this leads to a reduction of the adverse selection problem of uninformed traders (Subrahmanyam, 1991; Gorton/Pennacchi, 1993). However, the pooling destructs information because the informational advantage of informed investors diminishes. Against this background, it can be beneficial to split the pooled loans in information sensitive and insensitive tranches. Thus, informed investors can still profit from their informational advantage and remain in the market (Boot/Thakor, 1993). However, it is not only important to consider asymmetric information between investors but also private information of the originator about the quality of the loans.

Focusing on asymmetric information between originators and investors, it can be beneficial for originators to signal a high quality of pooled assets by retaining a portion of the issue, the equity tranche (DeMarzo/Duffie, 1999). The above-mentioned information destruction effect of pooling is nevertheless a problem, so that in this setting the originators can also benefit if they sell assets separately instead of pooling them to attract informed investors. However, pooling also has a risk diversification effect, which allows to issue a highly information insensitive

tranche. Due to this effect, a combination of pooling and tranching can indeed be optimal if originators retain the information sensitive tranche (DeMarzo, 2005).

Additionally, theoretical literature regarding retention suggests that the originator has skin in the game if the originator retains the equity tranche, which may improve incentives or even be a close approximation of the optimal security design (Hartman-Glaser et al., 2012; Chemla/Hennessy, 2014; Vanasco, 2017). Nevertheless, models show that a flat-rate retention is socially suboptimal because of its information destruction effect (Guo/Wu, 2014; Vanasco, 2017). Instead, the originator can signal a high quality of the securitized loans with the extent of retention (Hartman-Glaser, 2017; Vanasco, 2017). Moreover, the theoretical literature suggests that ratings in their capacity as public information increase wealth by reducing costly retention but also reduce loan quality (Daley et al., 2020).

The theoretical literature which focuses on the benefits of different types of retention is scarce though. Comparing retention of the equity tranche, the mezzanine tranche, and vertical slice retention, the screening effort is generally maximized if originators retain the equity tranche. Only if the probability of downturn is high (implying the equity tranche to likely default) and if the mezzanine tranche or vertical slices are quite thick, these types of retention can dominate the equity retention (Fender/Mitchell, 2010). In addition, choosing vertical slice retention instead of equity retention might be an attempt of the originator to limit the level of its skin in the game (Krahnen/Wilde, 2017).

Despite the theoretical arguments regarding reduced screening incentives (see also Pennacchi, 1988; Parlour/Plantin, 2008), many originators practiced the OTD model without retaining a significant share in the pre-crisis period. In retrospect, it has proved true that the OTD model indeed led to lax screening of subprime mortgage loans (Keys et al., 2010) and to the origination of low-quality loans (Purnanandam, 2011). Additionally, for collateralized loan obligations (CLOs), banks with access to the securitization market have lower monitoring incentives (Wang/Xia, 2014). Moreover, borrowers, whose loans are sold in the secondary market, performed significantly worse than their peers (Berndt/Gupta, 2009), confirming the theoretical arguments. These findings are particularly valid for originators which have performed poorly before origination because reputational concerns are hardly taken into account by them (Titman/Tsyplakov, 2010). There seems to be a negative connection between reputation and the retention amount: the longer an originator is active in the securitization market, the thinner is the retained equity tranche, which is in line with reputational concerns (Albertazzi et al., 2015).

Securitizations seem to induce further incentive problems. Despite loan modifications can reduce average losses in securitizations (Maturana, 2017), securitized mortgages are less likely

to be renegotiated and more likely to default than other mortgages (Agarwal et al., 2011; Kruger, 2018). Besides, during the 2000s misreported securitized loans were substantially more likely to become delinquent than correctly reported loans (Griffin/Maturana, 2016). For CLOs, though, the performance of securitized loans was not substantially different from unsecuritized loans. The reason might be that the underlying loans of CLOs are typically syndicated at origination, which implies that the originator retains a material fraction of the underlying loans (Benmelech et al., 2012).

Empirical research also underlines that the extent of retention can be interpreted as commitment to monitoring assets even though they are securitized (Albertazzi et al., 2015). Consistent with that finding, there is a negative relationship between time to sale of securitized mortgages and their probability of default. Therefore, delaying the sale of mortgages into securitization is a signal of loan quality (Daley/Green, 2016; Adelino et al., 2019). Furthermore, first loss pieces receive higher cash flows if a deal is more complex. Hence, one can argue that originators holding the first loss piece and investors of information sensitive tranches can profit from deal complexity (Ghent et al., 2019). If the originator is affiliated to the sponsor, securitized mortgages tend to default less frequently, yields of MBS are lower and credit enhancements are stronger (Demiroglu/James, 2012).

Recent literature shows that retention leads to superior loan performance (Furfine, 2019) and to reduce losses (Begley/Purnandam, 2017; Agarwal et al., 2018; Ashcraft et al., 2019; Flynn et al., 2020). The EU demands comparable standards for risk assessment in securitizations and balance sheet loans. However, the EU does not regulate the originators' behavior after securitization, which leaves discretionary freedom for moral hazard (see Article 408 CRR (EU) No. 2013/575 and Article 52a AFM RL (EU) No. 2013/231). Only with the enactment of the EU securitization regulation in 2019, the regulation shifted from ex ante credit risk to performance after securitization (Article 6 EU Securitization Regulation (EU) No. 2017/2402). In the absence of a regulation for moral hazard after securitization, however, retention is the only mechanism that improves the originators' incentives and ensures appropriate behavior. Particularly, retention improves monitoring and the handling of non-performing (NPLs) and defaulted loans (Hibbeln/Osterkamp, 2020).

The most closely related papers to ours are by Flynn et al. (2020) and Begley/Purnanandam (2017). Begley/Purnanandam (2017) argue that an above-median amount of a retained equity tranche decreases yield spreads and helps to improve the pool's performance and default rates. However, there are several differences to our approach. They examine the relationship between retention and spreads based on a pre-crisis US data set from 2001, 2002 and 2005 consisting of

379 deals, whereas we analyze a post-crisis data set with 3251 tranches of European securitizations from 2009-2019, containing the introduction of the EU minimum retention requirements. While they focus on equity retention, we take other retention types into account and differentiate between the impact on information sensitive versus insensitive tranches. They observe much lower amounts of retention (mean 1.25% and median 0.75%).

Flynn et al. (2020) establish a theoretical model, which suggests that spreads are lower in deals with equity retention and confirm the results empirically. While they only focus on US deals in 2017 and 2018, we establish an IV approach to provide further evidence on the causal effect of retention on spreads.

There are some further related analyses in the context of syndicated loans. A syndicated loan is originated by a lead bank that is responsible for ex-ante due diligence and for ex-post monitoring of the borrower. Due to the large loan amount, the lead bank retains only a fraction of the loan whereas the rest is sold to other participant banks. The reduced degree of ownership results in incentives to syndicate low quality loans and to reduce monitoring effort. The empirical literature supports this argument as a smaller lead share, which implies increased information asymmetry between the lead and participant banks, results in a higher risk premium demanded by the participant banks (Gorton/Pennacchi, 1995; Ivashina, 2009). The situation is very similar to securitizations with vertical slice retention because in both situations the lead investor has to bear a fixed percentage of losses. However, for syndicated loans the asymmetric information effect of the lead share on loan spreads is opposed by a diversification effect as a higher retention implies an increased concentration risk. On the contrary, for securitizations there is no opposing diversification effect because the retained fraction does not relate to a large single loan but to a pool of smaller loans. Thus, for securitizations it is more straightforward to measure the effect of asymmetric information.

3 Hypotheses Development

As supposed by the literature, we expect that ownership is an important mechanism for inducing screening and monitoring incentives (see also Leland/Pyle, 1977). If investors anticipate low incentives, they demand a risk premium for asymmetric information, so that credit spreads are high in these situations. Thus, we expect that credit spreads are lower if the originator retains a material share of the securitization. Decomposing this relationship, we expect a stronger effect of retention on credit spreads for information sensitive tranches because an originator's skin in the game and harmonized interests are more relevant to those investors. Digging

deeper into this effect, we first implement an IV approach based on the instrument of Ashcraft et al. (2019). Some originators have access to both, deals with and without retention, at the same time. Thus, they can decide to securitize undesired exposures into deals without retention, so that they do not have skin in the game. In other words, if an originator issues a deal with retention, and if the originator has access to deals without retention at this time, the originator can select the higher-quality loans for the deal with retention. As a consequence, this leads to lower risk in the deal with retention. We therefore expect spreads to be lower if the access to deals without retention is easy.

However, there are different types of retention, particularly equity and vertical slice retention, which possibly lead to different incentives for originators. As mentioned above, the theoretical literature finds that equity retention should lead to a maximization of screening and monitoring efforts. This only seems plausible as long as we consider incentives in an unconditional framework, though. Whereas it seems not be of great importance to distinguish between normal market and downturn scenarios for single loans, it is highly relevant for securitizations. Due to the tranching of securitizations, there are very different investment opportunities, e.g., investors can buy information sensitive or information insensitive tranches, which have a very different sensitivity to the state of the economy. In a normal state of nature, the probability of default of AAA tranches is very unlikely; the risk of these tranches is mainly systematic so that a default of these tranches typically only occurs in economic downturns (Coval et al., 2009).[10] However, if we focus on situations of economic downturn scenarios, the equity tranche is very likely to default completely. Thus, incentives of originators are very low when the impact of monitoring is most relevant from the perspective of AAA tranches. On the contrary, if originators choose vertical slice retention, they still have incentives to monitor the underlying loans, even in situations where many loans and, thus, the equity tranche defaulted because they maintain skin in the game. Consequently, equity retention seems to be favorable regarding screening incentives on the one hand, but vertical slice retention appears favorable regarding monitoring incentives from the perspective of AAA investors on the other hand. Summing up, which effect is more relevant for investors of information insensitive tranches, and therefore which type of retention these investors prefer is unclear. These considerations lead to the following hypotheses:

[10] Due to this finding, Coval et al. (2009) call these securities “economic catastrophe bonds”.

(H1) Credit spreads are lower if a material fraction of the securitization is retained by the originator.

(H2) The effect of information asymmetry on credit spreads is higher for information sensitive tranches than for information insensitive tranches.

(H3) Credit spreads are lower if the originator has access to no-retention deals, in which it can put unwanted credit risk without having skin in the game (IV approach).

(H4) For information sensitive tranches, credit spreads are lower if the originator chooses equity retention instead of vertical slice retention.

(H5a) For information insensitive tranches, credit spreads are lower if an originator chooses equity retention instead of vertical slice retention due to screening incentives.

(H5b) For information insensitive tranches, credit spreads are higher if an originator chooses equity retention instead of vertical slice retention due to monitoring incentives.

4 Data

4.1 Sample selection

The data considered in this study rely on different sources. ConceptABS delivered data on European securitizations. These data contain deal and tranche level information, as well as ratings of the rating agencies Standard & Poors, Moody's, Fitch and DBRS. Sovereign ratings are directly obtained from Standard & Poors, Moody's, Fitch. For one of our main variables, the type of retention, we use hand-collected data from the respective investor prospectuses, which we obtain from asset backed security (ABS) data providers and Bloomberg. One major advantage of using these data is the visibility of the influence of minimum retention requirements of the EU, which have come into effect on January 1, 2011. As a consequence, the data from 2009 and 2010 contain a significant share of deals with no relevant amount of retention (or at least a potential retention is not apparent for the investors). On the contrary, issues after December 31, 2010 mostly include one of the permitted types of retention. The advantage of using European data is that we have a rich sample with observations with retention, which improves estimation results. Another advantage is that the originator usually clearly reports information about retention in the prospectus due to the regulatory rules and the respective data are more consistent leading to high data quality.

We focus on floating rate ABS and MBS tranches and exclude collateralized debt obligation (CDO) deals because CDOs are actively managed and therefore the interest rate reflects not only the risk of the underlying assets but also the ability of the CDO manager in selecting

undervalued tranches. The initial data set consists of 4278 floating rate ABS and MBS tranches. We exclude all tranches where the prospectus is not available because important data are missing. After this data cleaning, we have a final sample of 3251 tranches from 1016 deals. The total nominal value of these tranches is € 1322 billion.

4.2 Variable measurement

4.2.1 Retention

We extract the information about retention directly from the prospectuses. As the regulatory rules heavily influence the retention data, we briefly present the retention requirements subsequently. The rationale behind the discussion to establish retention requirements is to "provide a sponsor with an incentive to monitor and control the quality of the assets being securitized and help align the interests of the sponsor with those of investors in the ABS" (SEC, 2012),[11] and is thus in line with the theoretical literature. However, this does not mean that the literature implies the necessity of regulatory rules since it is possible that originators voluntarily choose retention as a consequence of investors who anticipate differing interests.

The minimum retention requirements of the EU were first formulated in Article 122a of the Capital Requirements Directive (CRD) and have come into effect on January 1st, 2011 (EU, 2009). Due to these rules, a European institution is only allowed to invest into a securitization position if the originator (or sponsor or original lender) has disclosed that the originator will retain a material net economic interest of at least 5% of the nominal value of the securitization. Thus, the regulatory rules do not imply that European originators have to retain a material net economic interest but ignoring these requirements means that European institutional investors are not allowed to invest in these securities. Consequently, these rules are also relevant for originators outside the EU. However, some deals originated after 2011 are still without retention. Article 405 of the Capital Requirements Regulation (CRR (EU) No. 575/2013) replaces Article 122a CRD in 2013 and complements an additional retention type. Since 2019, Article 6(3) of the European securitization regulation defines the retention requirements. There are 5 permitted types of retention:

a) Equity: Retention of the first loss tranche and, if necessary, to achieve at least 5% retention of the nominal value on an ongoing basis, other consecutive tranches.
b) Vertical slice: Retention of at least 5% of every single tranche that is sold to investors.

[11] This argument is mentioned in the regulatory US and European documents.

c) Seller's share: Retention of at least 5% of the nominal value of the pooled revolving assets. This option is mainly relevant for revolving master trust structures.
d) Random selection: Retention of at least 5% of the nominal amount on the basis of randomly selected assets that would otherwise have been securitized in the securitization. This option is only allowed if the potential securitization consists of at least 100 assets at origination.
e) First loss retention of every exposure: Retention of at least 5% of the first loss of every securitized exposure.

In the United States, the regulators permit a so-called L-shaped risk retention besides equity and vertical slice retention. This is a combination of equity retention (horizontal component) and vertical slice retention (vertical component), both together at least 5%. The European Banking Authority (EBA) discussed the introduction of the L-shape retention for the EU; though, the EBA advised against its introduction due to a lack of effectiveness and a complicated implementation for originators (EBA, 2016).

European ABS prospectuses are written in English or in Spanish. In most cases, we find information about the retention in the deals' prospectus with the following key words: retain, retention, subordinated loan, 122a CRD, 405 CRR, and Article 6(3). For Spanish prospectuses, we also use the key words retendrá, retención, préstamo subordinado, Real Decreto 771/2011, reglamento 575/2013. Based on these data, we generate two variables: On the one hand, we obtain an indicator variable *Retention* that indicates whether the originator retains a material fraction of the transaction or not. On the other hand, we create a variable containing the concrete type of retention, e.g., equity or vertical slice retention. To have consistent data before and after the introduction of the minimum retention requirement, we assume that an originator has a material net economic interest only if it retains is at least 5%. If there is no information about retention in the prospectus or if the retention is less than 5%, we assign the category "no qualified retention".

4.2.2 Tranche level and deal level variables

Begley/Purnanandam (2017) consolidate variables (weighted by tranches' volume) on deal level. Our level of analysis, however, is the tranche level. They argue that most effects are captured by rating class and sponsor fixed effects, which seems to be true for the pre-crisis period (see also Fabozzi/Vink, 2012). Nevertheless, in the post-crisis period, investors take also other factors into account, or re-adjust the weighting of factors that are already included in credit ratings. We find that our subsequently described control variables improve the explana-

tory power of models that just include credit ratings by about 14 percentage points. Additionally, depending on the specification of this preliminary analysis, the control variables are statistically significant and economically meaningful. We therefore use several subsequently explained control variables in our analyses.[12]

On tranche level, we extract information on risk premium, credit rating, credit enhancements, liquidity, and maturity. The risk premium is measured as the credit spread at deal origination, first, because it is difficult to obtain reliable secondary market spreads, second, because the issuance spread is of utmost importance from the originators' perspective. The credit rating is obtained from S&P, Moody's, Fitch, and DBRS ratings. These ratings are converted to a point scale where an increase of 1 point reflects a rating which is one notch worse. From the rating AAA onwards, which corresponds to 1, each decrease in rating notches matches to a one-point increase in our scale – meaning AA+ is 2, AA is 3 and C is 21. In most cases, there is more than one rating so that the average rating is computed from the point scales. As a measure for the credit enhancement, we use the subordination level of each tranche. Consistent to Fabozzi/Vink (2012), this level is computed as the percentage of total liabilities that is subordinate to the tranche. Our proxy variable for the liquidity are the tranche's and the deal's logarithmic nominal value in Euro. Maturity is measured as the weighted average life (WAL) of the tranche.

On deal level, we use information about deal complexity, the segment, sovereign rating, and type of retention. We use the number of tranches as a proxy variable for the deal complexity. The segmentation variable has two possible values, indicating ABS or MBS deals. The sovereign rating is the rating of the country of collateral at the time of origination, i.e. the country where the main part of the underlying collateral is located, and not the country of origination. This is due to the fact that the quality of the security is mainly reflected by characteristics of the underlying assets and not of the originator. The scale of sovereign rating coincides with the credit ratings scale: the higher the value, the worse the sovereign rating.

4.3 Descriptive statistics

Summary statistics of our sample are presented in Tables II.1, II.2, and II.3. To provide some insights into the composition of the data, we show the distribution across years, credit

[12] Another central aspect of Begley/Purnanandam (2017) is to examine the impact of no-documentation loans (opaque deals) on spreads and performance. No-documentation loans are another source of information asymmetry between investors and originators. These loans do not occur in our data set because in our sample period these are not permitted in the EU.

ratings, asset classes, and country of collateral in Table II.1. We find that AAA tranches are the predominant rating category. Further findings are that MBS represent 78% of the observations. Moreover, the most active securitization markets in Europe (concerning the underlying collateral) are the United Kingdom and the Netherlands with a joint share of more than 60% of the total number of observations.

Table II.1: Summary statistics: Composition of the data set

The sample comprises 3251 European floating rate tranches issued between 2009 and 2019. Panel A and B describe the distribution of tranches across years and ratings. Panel C and D report summary statistics of asset classes and country of collateral.

	Obs.	Percentage
Panel A: Year		
2009	312	9.60
2010	213	6.55
2011	368	11.32
2012	279	8.58
2013	224	6.89
2014	241	7.41
2015	333	10.24
2016	299	9.20
2017	212	6.52
2018	315	9.69
2019	455	14.00
Panel B: Credit rating		
AAA	1292	39.74
AA	505	15.53
A	493	15.16
BBB	332	10.21
BB	195	6.00
B	139	4.28
CCC	44	1.35
CC	10	0.31
C	7	0.22
NR	234	7.20
Panel C: Asset class		
ABS	689	21.19
CMBS	292	8.98
RMBS	2270	69.82

	Obs.	Percentage
Panel D: Country of collateral		
Austria	9	0.28
Belgium	62	1.91
Finland	27	0.83
France	118	3.63
Germany	261	8.03
Greece	7	0.22
Ireland	133	4.09
Italy	301	9.26
Netherlands	648	19.93
Norway	26	0.80
Poland	2	0.06
Portugal	33	1.02
Spain	268	8.24
Sweden	16	0.49
United Kingdom	1340	41.22

In Table II.2, we present details about the distribution of several credit factors: S*pread*, *Subordination Level*, weighted average life (*WAL*), *Volume*, and *Number of Tranches*. There is a wide range of credit spreads from -100 bp to 1,150 bp, with typical values around 160 bp. The

distribution of the volume of tranches is highly right skewed with a median of € 119 million, a mean of € 406 million, and a maximum of € 47,000 million. Furthermore, a typical deal has between 3 and 7 tranches and a volume of € 1778 million; however, there are some very simple deals with only one tranche and highly complex deals with up to 18 tranches.

Table II.2: Summary statistics: Credit factors

This table reports summary statistics of 3251 floating rate tranches from 1016 ABS and MBS deals issued between 2009 and 2019. The table shows descriptive statistics of credit spreads (dependent variable) and credit factors (independent variables). Subordination level is the percentage of total liabilities that is subordinate to the tranche. WAL is the exposure weighted maturity of the loans. Tranche volume and deal volume are the nominal values in € millions. The credit spreads, subordination level, tranche volume, and WAL are reported on tranche level, and the number of tranches as well as the deal volume are reported on deal level.

	Obs.	Mean	Std. Dev.	Min.	q25	q50	q75	Max.
Spread (bp)	3251	164.7	137	-100	70.0	130	210	1150
Subordination Level (%)	3251	14.1	12.5	0	5.4	11.2	19	99
WAL (years)	3251	4.6	3.3	0	2.9	4.3	5	30
Vol. Tranche (€ millions)	3251	406.5	1146.3	1	23	119	453.9	47000
Vol. Deal (€ millions)	3251	1778.3	3508.4	29	401.4	750	1516.5	50500
No Tranches	3251	5.4	2.7	1	3	5	7	18

We present summary statistics regarding the type of retention in Table II.3. We find that the different regulatory types equity retention, vertical slice retention, sellers share, and random selection are actively used in securitizations. However, most originators choose equity retention. As expected, most observations without qualified retention are issued in 2009 and 2010, meaning that originators chose for 84% of these tranches not to retain a material net economic interest.

Finally, in Table II.4, we provide the correlation matrix of the rating variables and the credit factor variables. The correlation between rating and credit spreads implies that spreads are mostly determined by the credit rating of a tranche, but some of the control variables are also highly correlated with the credit spreads.

Table II.3: Summary statistics: Distribution of retention types

This table describes the usage of different types of retention. The category "no qualified retention" refers to observations where retention is less than 5% or retention is not reported in the investment prospectus.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
No Qualified Retention	298	142	13	22	19	10	21	1	0	0	0	526
Vertical Slice	2	0	45	18	23	37	50	41	34	144	217	618
Sellers Share	0	52	73	51	14	22	24	10	0	5	14	265
Random Selection	0	0	18	8	20	28	45	30	9	15	40	213
Equity Retention	12	19	219	180	148	144	193	217	169	151	177	1629

Table II.4: Correlation Matrix

This table presents the pairwise correlations of credit spreads, the credit factor variables and our control variable rating.

	Spread	Rating	Subordination Level	WAL	Vol. Tranche	Vol. Deal	No. Tranches
Spread	1						
Rating	0.50	1					
Subordination Level	-0.27	-0.42	1				
WAL	0.02	0.22	-0.15	1			
Vol. Tranche	-0.50	-0.49	0.25	-0.07	1		
Vol. Deal	-0.12	-0.08	-0.11	0.09	0.57	1	
No. Tranches	0.27	0.10	0.02	-0.03	-0.22	0.26	1

5 Minimum retention requirements and spreads

5.1 Quantifying the effect of retention on spreads

As postulated in hypothesis H1, we expect that credit spreads of tranches without qualified retention are significantly higher than for tranches where the originator chooses to retain a material fraction of the deal. To test this hypothesis, we use the specification in Equation II.1:

$$Spread_i = \beta_0 + \beta \cdot Retention_i + \delta \cdot Credit\ Factors_i + \chi \cdot Controls_i + \psi_t + \psi_s + \varepsilon_i, \quad \text{(II.1)}$$

where i indicates a specific tranche. We describe the *Credit Factors* and *Controls* in Section II.4 (see also Table II.1 and Table II.2). Regarding control variables, in all specifications, we include tranches' ratings and the sovereign rating of the country in which most of the collateral is located. Furthermore, to account for unobserved macroeconomic conditions and unobserved segment specific factors, we implement year fixed effects ψ_t and segment fixed effects ψ_s. Standard errors are clustered on deal level. We run this regression in six specifications. Models with even numbers contain both segments ABS and MBS, whereas in models with odd numbers

we restrict the segment to the large and homogenous subsample of MBS. We present the results in Table II.5. In our models, “no qualified retention” is the base category, so that the reported coefficients of retention present the spread difference in comparison to this category.

First, we report the results for the full sample, including ABS and MBS tranches. The results of models (1) and (2) show that credit spreads are about 26 to 39 bp lower if the originator retains a material fraction of at least 5% of the deal’s nominal value, which is both economically meaningful and statistically significant. This result is in line with our hypothesis H1 and applies in particular to the subsample of MBS (model (2)), which accounts for 78% of all observations. The advantage of using this reduced sample is that the risk assessment of investors might be more homogeneous for these observations.

As theory suggests, retention should especially matter to information sensitive tranches. Thus, we split our sample into information sensitive tranches (models (3) and (4)) and insensitive tranches (models (5) and (6)). For information sensitive tranches, both, statistical significance and economical meaning increase substantially. Especially for non-AAA MBS tranches, we identify a material spread reduction of 123 bp if the originator retains a material fraction of the deal. Considering that the average nominal amount of each non-AAA MBS tranche is € 427 million, this implies a premium for asymmetric information of around € 5.26 million for each of these tranches. These findings confirm our hypothesis H1 and are completely in line with theoretical arguments. The value of information sensitive tranches is very sensitive to the quality of the underlying assets. If screening and monitoring incentives are low, which is the case if the originator does not retain a material fraction of the deal, investors anticipate these diverging interests. As a consequence, they only invest if they are compensated for the risk of facing adverse selection and moral hazard problems in terms of a substantial additional risk premium.

Analyzing the subsample of AAA tranches (models (5) and (6)), we exclude the variable credit rating as an explanatory variable because all these tranches have the same rating. For these (almost) information insensitive tranches, the results are substantially different from the full sample and from information sensitive tranches: The coefficients of retention become statistically insignificant and economically meaningless. To sum up, we find a significant impact of retention on credit spreads, which is economically substantial for information sensitive (non-AAA) tranches but not for information insensitive (AAA) tranches, which is in line with hypotheses H1 and H2.

After the analyses of the causal effect of retention on spreads in the Sections 5.2, we investigate the effect of different types of retention, namely equity and vertical slice retention in Section II.6.

Table II.5: Quantifying the effect of retention on spreads

The table reports results of OLS regressions of credit spreads (in bp) on the indicator variable retention (see Equation II.1). The coefficient of retention represents the additional risk premium in comparison to "no qualified retention". Models (1) and (2) include all tranches, (3) and (4) restrict the sample to information sensitive tranches (no AAA), and models (5) and (6) restrict the sample to information insensitive tranches (only AAA). Models with even numbers contain both segments ABS and MBS, whereas models with odd numbers restrict the segment to MBS. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	All ABS&MBS	All MBS	No AAA ABS&MBS	No AAA MBS	Only AAA ABS&MBS	Only AAA MBS
	(1)	(2)	(3)	(4)	(5)	(6)
	Credit Spread	Credit Spread	Credit Spread	Credit Spread	Credit Spread	Credit Spread
Retention	-26.612*	-39.134*	-106.930***	-123.181***	8.533	8.093
	(-1.688)	(-1.962)	(-3.204)	(-3.529)	(1.358)	(1.033)
Subordination Level	-0.464*	-0.729***	-1.388***	-1.922***	0.993***	0.905***
	(-1.895)	(-2.647)	(-4.173)	(-4.939)	(3.485)	(2.861)
WAL	-3.140*	-2.948	-4.916***	-5.166***	3.845	4.481
	(-1.929)	(-1.595)	(-3.225)	(-2.921)	(1.212)	(1.274)
Log Vol. Tranche	-27.076***	-28.922***	-30.989***	-33.264***	-0.005	-0.223
	(-9.279)	(-8.353)	(-6.317)	(-5.549)	(-0.003)	(-0.116)
Log Vol. Deal	6.473	10.739*	4.870	12.682	-5.864***	-5.732**
	(1.213)	(1.786)	(0.568)	(1.318)	(-2.675)	(-2.451)
No Tranches	6.638**	4.876	7.511**	3.927	4.770***	4.448**
	(2.511)	(1.578)	(2.439)	(1.047)	(2.958)	(2.558)
Constant	458.325***	421.647***	576.644***	489.161***	143.214***	146.445***
	(5.553)	(4.744)	(4.777)	(3.946)	(3.484)	(3.405)
Observations	3251	2562	1959	1574	1292	988
R^2	0.393	0.384	0.301	0.311	0.442	0.444
Adjusted R^2	0.389	0.379	0.294	0.303	0.434	0.434
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Segment FE	Yes	-	Yes	-	Yes	-
Controls						
Sovereign Rating	Yes	Yes	Yes	Yes	Yes	Yes
Rating	Yes	Yes	Yes	Yes	-	-
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal

5.2 Instrumental variable approach: The access to no-retention deals

Previously, we quantified the spread reduction effect of retention due to asymmetric information and incentive problems – overall and depending on the position of the tranche in the subordination mechanism.

A potential concern regarding the causal effect of retention on spreads might be a selection bias: Although the pools of deals with and without retention do not seem to differ systematically in observables (Ashcraft et al., 2019), originators could assign systematically less risky (in terms of unobservable information) loans to deals with retention. By contrast, they assign bad

quality loans to deals without retention where they do not have skin in the game. Additionally, originators could also anticipate their future reduced monitoring effort. Summing up, our OLS results might be biased to the selection of distinct loans into the deals. Therefore, we subsequently implement an IV approach.

To show that retention influences the spreads of the tranches, we construct an instrument according to Ashcraft et al. (2019). In contrast to our study, Ashcraft et al. (2019) rather focus on the analysis of the tranche performance of US CMBS deals. Regarding spreads however, they only consider the tranches which are directly superior to the first loss piece in the subordination mechanism. Although they find a significant increase in tranche performance in the presence of retention, they do not find that this is reflected in the spreads. This might be due to the fact that they investigate a pre-crisis sample and investors did not care so much about the harmonization of interests than rather relied on the pool diversification and ratings of securitizations. Investors therefore might have not demanded an additional risk premium for securitizations without retention. On the contrary, we build our analyses on a post-subprime crisis sample. After that, however, investors are likely aware of incentive problems in securitizations which have been demonstrated by the literature (e. g., Titman/Tsyplakov, 2010; Keys et al., 2010). Because of this awareness it is reasonable to expect differing results in the post-crisis period, which we analyze.

The instrument according to Ashcraft et al. (2019) is "the moving average of the percentage of no-retention deals by the same originator including all deals other than *d*, issued within in a window surrounding one year before and one year after the issuance of deal *d*" (Hibbeln/Osterkamp, 2020). This instrument measures the originators' options to assign bad quality loans to a deal without retention to avoid losses. Regarding the validity of the instrument, the F-statistics of the first stage (see Table II.6) confirm that the instrument is relevant. To violate the exclusion restriction, there would need to be a time-variant variable in the error term, which is correlated with the instrument. While the introduction of minimum retention requirements correlates with the share of deals without retention, this regulation is unlikely to influence spreads via another variable. We also include originator fixed effects to assure that the exclusion restriction is fulfilled.

As described in H3, we expect the spread of a tranche *i* to be lower if the originator *o* has more options to assign loans to deals without retention, meaning that the share of deals without retention is high around the time of issuance of tranche *i*. Equation II.2 presents the second stage of the two stage least square (2SLS) IV approach. The setting is based on the regression of Equation II.1; however, we replace the variable of interest *Retention* with the fitted values

of *Retention*, resulting from first stage of the 2SLS estimation. Since the instrument is time-variant, we can still employ time fixed effects without absorbing the variation of retention.

$$Spread_i = \beta_0 + \beta \cdot Fitted\ Retention_i + \delta \cdot Credit\ Factors_i + \chi \cdot Controls_i + \psi_t + \psi_s + \varepsilon_i. \quad \text{(II.2)}$$

The results are presented in Table II.6. They confirm the previous OLS results regarding sign and significance, indicating that the previous results of retention on spreads are indeed causal. The size of the effect, however, is even more pronounced. For the information sensitive MBS subsample, the IV approach suggests an economically meaningful and statistically highly significant spread reduction of 384 bp. Summing up, the results confirm H3. It is worth mentioning that these results contrast with the findings of Ashcraft et al. (2019) for the US pre-crisis period. This indicates that investors of European securitizations are aware of the incentive problems after the subprime crisis. Comparing the OLS and the IV results, it seems like our OLS results underestimate the effect of retention on spreads.

Table II.6: Instrumental variable approach

The table reports the second stage of the 2SLS IV regression (Equation II.2), analyzing the impact of retention on credit spreads (in bp). The coefficient of fitted retention represents the additional risk premium in comparison to "no qualified retention". Models (1) and (2) include all tranches, (3) and (4) restrict the sample to information sensitive tranches, and models (5) and (6) restrict the sample to information insensitive tranches. Models with even numbers contain both segments ABS and MBS, whereas models with odd numbers restrict the segment to MBS. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	All ABS&MBS	All MBS	No AAA ABS&MBS	No AAA MBS	Only AAA ABS&MBS	Only AAA MBS
	(1)	(2)	(3)	(4)	(5)	(6)
	Credit Spread	Credit Spread	Credit Spread	Credit Spread	Credit Spread	Credit Spread
Fitted Retention	-72.060	-152.123**	-270.952***	-384.781***	-8.916	-16.131
	(-1.360)	(-2.115)	(-2.885)	(-4.061)	(-0.380)	(-0.363)
Subordination Level	-1.439***	-1.736***	-1.884***	-2.455***	0.532	0.252
	(-4.486)	(-4.306)	(-4.296)	(-4.806)	(1.145)	(0.438)
WAL	-3.426**	-3.135*	-6.117***	-6.698***	6.108*	7.011**
	(-2.378)	(-1.928)	(-4.066)	(-3.459)	(1.833)	(1.983)
Log Vol. Tranche	-23.397***	-24.664***	-28.355***	-28.698***	-1.476	-1.509
	(-9.014)	(-7.904)	(-6.041)	(-4.886)	(-0.837)	(-0.790)
Log Vol. Deal	12.497**	15.190***	9.851	11.259	-6.125*	-5.757
	(2.273)	(2.687)	(1.297)	(1.238)	(-1.784)	(-1.557)
No Tranches	8.196***	8.192**	11.673***	12.268***	5.698**	5.978**
	(2.998)	(2.406)	(4.053)	(3.465)	(2.308)	(1.985)
Constant	309.747***	275.909***	442.341***	400.856***	190.235***	194.392***
	(3.710)	(3.105)	(3.906)	(3.150)	(3.003)	(2.869)
Observations	3241	2558	1951	1572	1290	986
R^2	0.572	0.542	0.595	0.582	0.615	0.614
Adjusted R^2	0.534	0.499	0.543	0.526	0.535	0.526
First Stage F-Test	45.43	27.14	14.05	19.14	35.29	12.56
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Originator FE	Yes	Yes	Yes	Yes	Yes	Yes
Segment FE	Yes	-	Yes	-	Yes	-
Controls						
Sovereign Rating	Yes	Yes	Yes	Yes	Yes	Yes
Rating	Yes	Yes	Yes	Yes	-	-
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal

6 Comparison of equity and vertical slice retention

Subsequently, we compare the different effects of equity retention and vertical slice retention depending on information sensitive and information insensitive tranches. To compare vertical slice and equity retention, we restrict our data set to those deals which have any of these two retention types. Hence, deals with no qualified retention, seller's share, and random selection are excluded from the following analyses.

As postulated in hypothesis H4, we expect for information sensitive tranches that credit spreads are lower if the deal is equipped with equity retention instead of vertical slice retention. However, according to hypothesis H5a/H5b it is unclear whether investors of information insensitive tranches prefer equity retention (because of higher screening incentives) or vertical slice retention (because of higher monitoring incentives). Considering information insensitive AAA investors, there might be two opposing effects of screening and monitoring incentives. On the one hand, one can argue that information insensitive investors (in line with information sensitive investors) demand high screening incentives for the originator. Because theory suggests that equity retention maximizes these screening incentives, they prefer deals with a retained equity tranche. In conclusion, if this effect dominates, credit spreads of AAA tranches are expected to be lower for deals with equity retention. On the other hand, theory suggests that vertical slice retention could be beneficial for investors of information insensitive tranches due to higher monitoring incentives because even after severe losses to the asset pool and a complete default of the equity tranche, the originator maintains skin in the game. In such a situation, retention of the equity tranche does not induce incentives to monitor the remaining non-defaulted assets. On the contrary, retention of a vertical slice maintains the desired incentives for originators even in downturn scenarios. In other words, as the positions of originators and investors are more similar in case of vertical slice retention, their interests to reduce losses on an ongoing basis are more aligned. From a theoretical perspective, it remains unclear which of these two effects dominates. Consistent with the previous analyses, at first we analyze the entire sample (models (1) and (2)); to test hypotheses H4, we then only consider non-AAA tranches (models (3) and (4)); at last, analyzing H5a/b, we only take the information insensitive AAA tranches into consideration (models (5) and (6)). According to Section II.5.1, we use the following model specification

$$Spread_i = \beta_0 + \beta \cdot Vertical\ Slice_i + \delta \cdot Credit\ Factors_i + \chi \cdot Controls_i + \psi_t + \psi_s + \varepsilon_i, \quad \text{(II.3)}$$

where *Vertical Slice*$_i$ is an indicator variable that takes the value 1 if the originator chooses vertical slice retention instead of equity retention. The credit factors and control variables are described in Section II.4 (see also Table II.1 and Table II.2).

The results are presented in Table II.7. For the sample with all tranches, we find that credit spreads are 32 bp higher in the case of vertical slice retention than for equity retention. This effect increases by 7 bp for information sensitive tranches (39 bp). The coefficients are highly statistically and economically significant. The results for MBS deals are very comparable to the combined results for ABS/MBS tranches. Summing up, the results confirm that investors of

non-AAA tranches demand an additional risk premium if the originator chooses vertical slice retention instead of equity retention, which confirms our hypothesis H4.

Table II.7: Comparing vertical slice and equity retention

The table reports results of OLS regressions relating the indicator variable vertical slice and credit spreads (in bp) (Equation II.3). The coefficient of vertical slice represents the additional risk premium in comparison to equity retention. In these analyses, we exclude all deals with other retention types or no qualified retention. Models (1) and (2) include all tranches, (3) and (4) restrict the sample to information sensitive tranches, and models (5) and (6) restrict the sample to information insensitive tranches. Models with even numbers contain both segments ABS and MBS, whereas models with odd numbers restrict the segment to MBS. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	All ABS&MBS	All MBS	No AAA ABS&MBS	No AAA MBS	Only AAA ABS&MBS	Only AAA MBS
	(1)	(2)	(3)	(4)	(5)	(6)
	Credit Spread	Credit Spread	Credit Spread	Credit Spread	Credit Spread	Credit Spread
Vertical Slice	32.386***	29.804***	39.569***	37.264***	-3.145	-2.003
	(3.564)	(3.155)	(3.414)	(3.101)	(-0.573)	(-0.336)
Subordination Level	-0.294	-0.421	-1.191***	-1.693***	0.880**	0.831*
	(-1.241)	(-1.591)	(-3.389)	(-3.711)	(2.087)	(1.822)
WAL	-2.002	-1.512	-3.467	-3.350	7.482	8.724
	(-0.747)	(-0.491)	(-1.560)	(-1.271)	(1.308)	(1.427)
Log Vol. Tranche	-27.686***	-27.637***	-28.779***	-26.297***	2.137	0.939
	(-7.955)	(-6.986)	(-4.935)	(-3.514)	(0.725)	(0.286)
Log Vol. Deal	2.361	4.073	-0.722	-0.029	-12.930***	-11.425***
	(0.406)	(0.643)	(-0.082)	(-0.003)	(-4.453)	(-3.728)
No Tranches	4.104	3.165	2.393	0.475	6.219***	6.027***
	(1.104)	(0.777)	(0.579)	(0.099)	(3.379)	(3.404)
Constant	539.218***	405.821***	561.215***	354.910***	264.850***	263.526***
	(5.271)	(3.978)	(4.108)	(2.741)	(3.449)	(3.372)
Observations	2247	1826	1469	1216	778	610
R^2	0.421	0.416	0.333	0.338	0.490	0.496
Adjusted R^2	0.416	0.410	0.324	0.328	0.478	0.482
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Segment FE	Yes	-	Yes	-	Yes	-
Controls						
Sovereign Rating	Yes	Yes	Yes	Yes	Yes	Yes
Rating	Yes	Yes	Yes	Yes	-	-
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal

For insensitive tranches, we find coefficients which are close to zero and statistically insignificant (models (5) and (6)). As a result, we have to reject both, H5a & H5b. It seems like AAA-investors do not care about a deal's retention type. A possible explanation of that finding is that the two channels of screening and monitoring compensate one another.

7 Conclusion

In this paper, we provide evidence that investors consider asymmetric information in pricing securitizations. Consistent with theoretical arguments, we find that investors require a significant risk premium if the originator retains no material share of securitizations. This result is even more pronounced for investors of non-AAA tranches. Moreover, the credit spreads of these tranches are significantly higher if the originator chooses vertical slice retention instead of equity retention because the latter brings about higher screening and monitoring incentives. The effects for non-AAA MBS tranches are not only statistically significant but also economically meaningful with a risk premium of 123 bp due to asymmetric information, which is a premium of about € 5.26 million for the average non-AAA MBS tranche. Besides the quantification of the effect with OLS, we provide comprehensive evidence that the effect of retention on spreads is causal. We do so by implementing an IV approach using the access to no-retention deals. This approach provides a reliant validation of the causal effect. The magnitude of the IV approach suggest that the OLS results underestimate the effect of retention on spreads.

Our results have important implications, first, for originators and, second, for the regulation of securitizations. First, originators should be aware that investors require a material risk premium if the degree of asymmetric information is high. Thus, in their own interest they should structure the deals in a way to assure high screening and monitoring incentives. Second, regulatory rules should take into account that investors already strongly consider asymmetric information in pricing securitizations. On this subject, our results suggest that rules regarding the disclosure of information, e.g., about the type and magnitude of retention, could reduce the costs of asymmetric information and thus be most favorable. In this context, the regulators could foster the use of this important information by providing this information in a publicly available database instead of only requiring stating information in the investment prospectus. Finally, it might be beneficial to analyze the impact of different types of retention in a theoretical framework which is capable of considering the potentially opposing interests of investors of information sensitive and insensitive tranches to gain further insights regarding the consequences of asymmetric information for securitizations. For empirical research, the effect of an L-shaped retention on spreads, which is not allowed in the EU regulation but in the US, would be interesting because it combines the interests of investors of information sensitive tranches with those of information insensitive tranches, as well. Finally, to investigate potential benefits of vertical slice retention in a downturn scenario, it would be advantageous to have data available that covers an economic downturn after the introduction of the minimum retention rules.

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III. SIMPLE IS SIMPLY NOT ENOUGH – FEATURES VERSUS LABELS OF COMPLEX FINANCIAL SECURITIES

Martin Hibbeln, Werner Osterkamp, and Fabian Rendchen

Abstract

Based on a unique data set of European residential mortgage backed security (RMBS) deals with 31 million quarterly loan observations, we examine how design features and labels of complex financial securities affect tranches' spreads and loan performance. Exploiting the features required by the European Securitization Regulation and the STS (Simple, Transparent, Standardized) label, we find that the features of the security design and not the label are crucial for the loan performance. However, investors hardly consider the features but simply rely on the existence of the label.

Keywords: asset-backed securities; EU securitization regulation; simple, transparent, standardized (STS); loan performance; complex securities

JEL classification: D82, G01, G18, G21

1 Introduction

In the wake of the financial crisis, the securitization market froze due to asymmetric information and incentive problems, which called for regulatory interventions. However, several regulatory initiatives failed in their attempt to revive the securitization market. As a result, the European regulator saw an urge to mitigate the market failure with an extensive regulation, the European Union Securitization Regulation (EUSR), enacted in January 2019. The regulation's main objective is to revive the EU securitization market by removing the investors' negative perception of securitizations to re-establish trust in the securitization market. In this context, the EU aims to further reduce asymmetric information of securitizations. For this purpose, the EU implemented tightened minimum requirements for the features of the security design of all securitizations and, in addition, the optional STS (Simple, Transparent, Standardized) label, which indicates higher standards regarding simplicity, transparency and standardization (EC, 2015), in order to facilitate investors' risk assessment.

In this paper, we study how the design features and labels of complex financial securities affect I) the pricing of these securities and II) securitized loan performance. Exploiting the EUSR, which introduces the STS label and higher standards regarding the features of the security design, we investigate the following research questions: I) How does the regulation affect the pricing of securitizations? Are the improved design features or simply the label relevant for the tranches' credit spreads? II) Does the regulation affect loan performance? And if so, can the increased performance be attributed to the label or the features of the security design?

Our analyses are based on more than 31 million quarterly loan-level observations of 186 RMBS deals and on unique hand-collected data on 48 distinct features of the deals' security design. Answering the stated questions is relevant for investors, originators, and regulators: Especially those that are evaluating a potential adoption of a concept like STS (e.g., US regulators) might utilize the results to assess and design regulatory policies. We point out that the introduction of regulatory labels might lead to the problem of investors relying too much on a quality signal again – similar to ABS ratings before the subprime crisis (Coval 2009a, b; Mählmann 2012) – instead of analyzing the deals' riskiness. We stress that investors should focus more on the design features instead, as these drive loan performance. On the contrary, originators currently mainly benefit from receiving the STS label and not on improved design features because this label leads to lower financing costs. To be more specific, based on a variety of regression models (OLS, logistic, fixed effects and instrumental variables (IV)), we find that whereas the actual performance of RMBS tranches depends to a large extent on the concrete

design features, investors seem to simply focus on the STS design label. Although the obligatory requirements of the EUSR improved the loan performance, the spreads of deals containing these obligatory features (= *EUSR deals* or *non-STS deals*) have increased, indicating that investors do not price the design features and the performance appropriately. STS labelled deals, though, benefit from substantially reduced spreads. We provide evidence that this effect cannot be explained by the superior security design but by the STS label. We find a within-tranche decline of spreads at the time of receiving the label although the information about the design features has already been available in the investor prospectus. While the compliance with a higher number of *STS features* is not reflected in the deals' spreads, the *STS label* is important to investors: We estimate its value at € 2.3 million per annum for an average tranche. This corresponds to a spread reduction of 13% for STS deals compared to EUSR/non-STS deals.

Introducing the STS label, the EU incorporated the following considerations: A deal complying with the STS concept shall indicate that an investor is better able to analyze its riskiness. As a consequence, the EU did not intend that investors directly rely on the STS label as a quality signal of the underlying exposures, but it rather emphasizes the investors' responsibility to thoroughly analyze a deal before investing. However, our results suggest that investment decisions are not driven by the deal's security design features, but mainly by the design label. Overall, the improved security design should decrease asymmetric information and therefore search costs of investors. To identify the originators' obligations, we collect the requirements concerning the design features stated throughout the regulatory text. These consist of the *EUSR features*, which are obligatory for all EU securitizations issued after 2018, such as risk retention and the prohibition of cherry picking, as well as additional *STS features* for obtaining the STS label. While pursuing compliance of a deal with the STS features is optional, an STS deal must fulfill these additional features, e.g., the true sale of the assets (simplicity), the provision of historical performance data (transparency) and the hedging of interest rate and currency risk (standardization). We assess deals' compliance with each of the required features (EUSR, Simplicity, Transparency, Standardization) before and after the regulation's entry into force, counting the number of features a deal contains – in total up to 48 different features – and translate the degree of compliance into scorings.

Because the regulation entered into force recently, literature regarding the EUSR and STS concept is scarce. Subsequently, we provide a brief literature review on aspects relevant for the EUSR and our contribution to different strands of literature. The first related strand of literature focuses on the role of security design in securitizations. Theoretical literature discusses the link between security design and asymmetric information and suggests that poor security design and

subsequent informational differences between securitization parties can lead to exploiting informational advantages (Leland/Pyle, 1977; Boot/Thakor, 1993; DeMarzo/Duffie, 1999; DeMarzo, 2005). It also suggests that while pooling provides a risk diversification effect, retention decreases asymmetric information, harmonizes interests of originators and investors, and signals superior quality of the securitized loans (DeMarzo, 2005; Hartman-Glaser et al., 2012; Chemla/Hennessy, 2014; Guo/Wu, 2014; Hartman-Glaser, 2017; Vanasco, 2017; Hébert, 2018). Empirical post-crisis studies add that retention leads to an increased loan and tranche performance and a decrease in securitizations tranches' credit spreads (Begley/Purnanandam, 2017; Agarwal et al., 2018; Ashcraft et al., 2019; Flynn et al., 2020; Hibbeln/Osterkamp, 2020). Research on deal complexity provides further evidence for the positive impact of improved security design on loan performance (Furfine, 2014; Ghent et al., 2019). We contribute to the literature by evaluating the deals' security design induced by the EUSR and find support for the fact that the security design increases performance. However, investors do not seem to consider the design features when pricing securitizations but rather focus on the label.

The second strand of literature studies the effect of asymmetric information in securitization on loan performance and tranches' credit spreads. Between the time of loan origination and securitization, asymmetric information in the form of adverse selection incentivizes the selection of distinct loans, often of lower quality, for securitization (Gorton/Pennacchi, 1995; Downing et al., 2009; Titman/Tsyplakov, 2010; Purnanandam, 2011; Agarwal et al., 2012; Ghent/Valkanov, 2016). After loan securitization, asymmetric information in the form of moral hazard can lead to decreased monitoring incentives, lower rates of loan modifications and renegotiations, as well as a higher probability of re-defaults (Piskorski et al., 2010; Agarwal et al., 2011; Keys et al., 2012; Zhang, 2013; Wang/Xia, 2014; Ghent/Valkanov, 2016; Maturana, 2017; Kruger, 2018). Studies on the impact of regulatory transparency initiatives support these findings and suggest that a reduction of asymmetric information results in improved loan and pool performance (Ertan et al., 2017; Klein et al., 2020f). We contribute to the literature by showing that enhanced design features of complex financial securities, which mitigate asymmetric information, increase loan performance. However, the spreads are mostly influenced by the label, which is also established to alleviate asymmetric information, but not by the incentive structures in complex financial securities.

2 Institutional background and data

2.1 Institutional background

Following the global financial crisis, the issue volumes in the EU securitization market declined from its peak in 2008 by around 90% until 2013 (see Figure III.1). During this period, the Basel III framework of 2010 constituted the first regulatory concept to approach the shortcomings in securitization markets (BCBS, 2010). The EU introduced securitization-related regulatory changes with the Capital Requirements Directives (CRD) II and III in 2010 and 2011, mandating risk retention, disclosure requirements, and rules for the recognition of significant risk transfers (EU, 2009; EU, 2010; EU, 2013). Under the umbrella of CRD IV, the regulation on Credit Rating Agencies III (CRA III) extends these requirements in 2014 (EU, 2013). Contemporaneous to the EU's regulatory approaches on securitizations, the ECB addressed asymmetric information in securitizations by introducing the ABS loan-level initiative in 2013, in which the ECB established centralized and standardized disclosure of loan-level data for securitizations accepted as collateral in the Eurosystem credit operations (EBA, 2015). With the launch of the asset backed securities purchase program (ABSPP) in 2014 and the publication of guiding principles on ECB eligible securitization in 2015, the ECB extended the collateral requirements beyond regulatory criteria to increase the significance of high-quality securitizations (ECB, 2014; ECB, 2015). In 2014 and 2015, the European Banking Authority (EBA) and the Basel Committee on Banking Supervision (BCBS) put the concept of simple, transparent and standardized securitizations up for discussion (EBA, 2014; EBA, 2015; BCBS/IOSCO, 2015). The EBA's proposed STS concept[13] and the included requirements formed a major part of the first EUSR draft published in November 2015, and the final version of the EUSR was adopted in December 2017 and entered into force on January 1, 2019 (EU, 2017). In 2018, the EBA finalized their non-binding guidelines on STS criteria, providing market participants with a unified and consistent source of interpretations on requirements stated in the EUSR (EBA, 2018). Figure III.2 presents the timeline of the main events.

[13] Note that the STS label was also discussed under the name STC (simple, transparent, and comparable). For the sake of clarification and readability, we refer to the concept as STS in this paper.

Figure III.1: Development of EU RMBS issue volumes

This figure shows the freezing and subsequent low levels of EU RMBS issue volumes (in billion €) as a result of the global financial crisis 2007/08 and underlines the importance of reviving the EU securitization market (SIFMA, 2017; AFME, 2020).

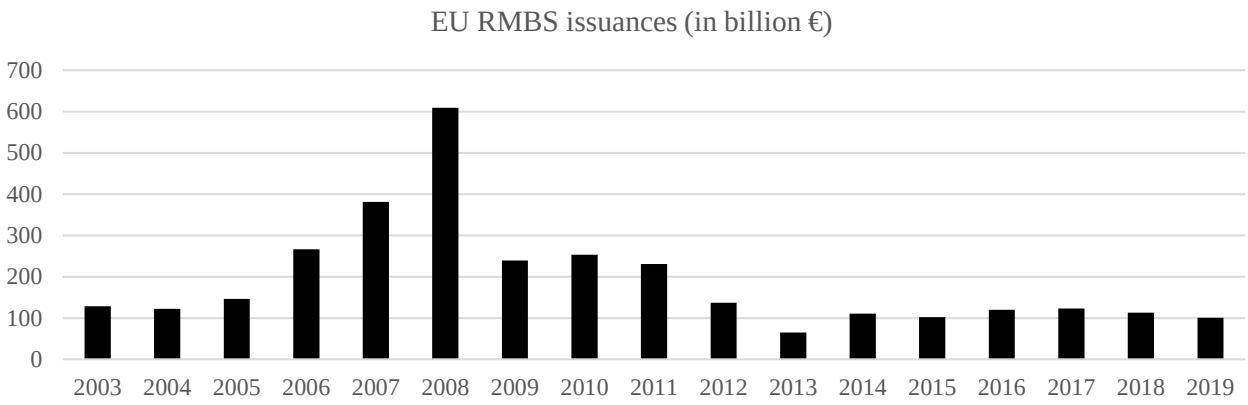
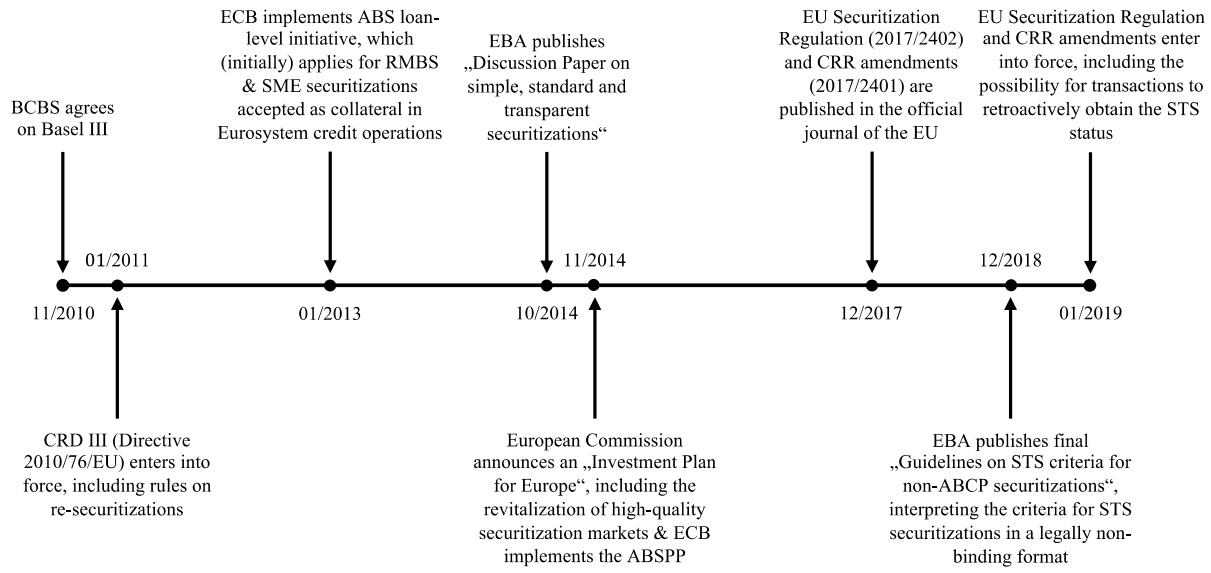


Figure III.2: Timeline of events

This figure shows the timeline of important regulatory-related events on securitizations in the EU after the financial crisis.



The EU's objectives for introducing the EUSR are outlined in the introductory section of the regulatory text: As a response to the limited functioning of the EU securitization market following the global financial crisis, the EU proclaims the revitalization of its securitization market as a part of the European Commission's "Investment Plan for Europe" (EU, 2017). The

inclusion of securitization markets into the investment plan for Europe highlights the importance of securitizations for the EU financial market: Securitizations not only serve as an additional funding source and improve the market participants' risk allocation, but also benefit households and companies by reducing financing costs. To realize a revitalization of the EU securitization market, the EU aimed to I) mitigate asymmetric information, II) reduce deal complexity, III) facilitate the investors' risk assessment, and IV) avoid regulatory arbitrage between its member states: I) Asymmetric information shall be mitigated by not only requiring transparency in the form of centralized and periodical disclosure of deal-, pool- and loan-level information and sanctioning non-compliance, but also addressing transaction-specific issues, including pool composition and loan-selection. Additional measures include the alignment of incentives between parties by obligating the originators to retain a material interest in the securitizations. This harmonization of interests between securitization parties is further supported by the inclusion of clear responsibilities for originators, sponsors, servicers and investors. The resulting reduction in asymmetric information also aims to improve investors' risk assessment of securitizations. To ensure the quality of the underlying securitized assets and to avoid the recurrence of the originate-to-distribute model, extended credit granting criteria are defined. II) Complex securitization structures shall be reduced in the EU by a ban on re-securitizations in general and the exclusion of synthetic securitizations from the STS status until further notice. III) The reduction of deal complexity and asymmetric information also aims to improve investors' risk assessment of securitizations. IV) To avoid arbitrage between the member states, the EU designed the EUSR as an EU-wide mandatory framework (EU, 2017).

We provide a collection of the EUSR and STS security design features in Appendix III.A, including features required by Article 3–9 and 20–22 of the EUSR (EU, 2017). Besides regulating the originating entities, the EUSR approaches problems in the securitization market also from the demand side. The regulation sets particular focus on increasing investors' demand for high-quality securitizations by mitigating asymmetric information and therefore search costs of the investors, especially with the STS label as a quality signal. However, the regulator points out that the STS label is not a substitute for the investors' risk assessment.

Our investigations are relevant for the design of complex financial securities as we disentangle the effect of labelling complex securities and the features required to receive the label. In addition, since not only the EU but also the BCBS discusses the STS label, non-EU regulators can benefit from our analysis and decide whether to implement certain design features or a label similar to the STS label into their own regulatory landscape. Because the EUSR and the STS label are only established in the EU, however, it is reasonable to investigate the impact with

European data. As a prerequisite of our investigation, we briefly present differences in the EU and US regulation of the securitization market: A first key difference is the strong government support of securitizations in the US, which does not exist in the EU (EC, 2015; SIFMA, 2017). The general response to the financial crisis in form of a gradual introduction of several regulatory initiatives was similar; the EU implemented aspects of the global voluntary Basel framework in the CRD frameworks whereas the US signed the Dodd-Frank Act (DFA) in July 2010, which determines regulatory objectives to be implemented in the following years (SEC, 2014). The main topics addressed during the gradual implementation in the EU and US between 2010 and 2019 are similar and include risk retention and disclosure requirements (SEC, 2014; US Congress, 2019). The EU introduced mandatory risk retention ahead of the US while the US was quicker to introduce a comprehensive regime on asset-level disclosure (US Congress, 2010; SEC, 2019; US Office of the Federal Register, 2019). In total, the current regulatory requirements on securitizations in the EU are more extensive than in the US.

2.2 Sample selection and variable measurement

Our sample consists of more than 31 million quarterly loan-level observations of about 3.9 million loans, which are securitized in 186 private-label RMBS deals and issued in the EU between 01/2015 and 12/2019. We track the loan-level data from the respective deal issuance until 02/2020. We restrict the sample to this particular period since it begins after the launch of the ECB's ABSPP in 2014, which impacts the pricing of securitizations, and ends before the SARS-CoV-2 pandemic, which is also relevant for both, the pricing of securitizations and loan performance. With an issue volume of € 100.3 billion and a market share of 46% in 2019, RMBS is the largest asset class in the EU securitization market (AFME, 2020). EU RMBS represent a relatively safe asset class, which is known to have a high loan performance. We focus on this market because of its importance and homogeneity in the underlying assets.

Before we discuss our variables in detail, we briefly summarize our empirical investigations: First, we scrutinize the overall effect of the EUSR on tranches' spreads. Second, we investigate the importance of the design features and receiving the label for the tranches' spreads. Therefore, we generate the variable *Total STS Features*, which measures the number of STS features a deal contains. We extract these features from the deals' documents and use the variable *Total STS Features* to identify the differences in security designs. Additionally, using the scoring variables, we disentangle the importance of the different parts of the regulation, namely the obligatory *EUSR* part, as well as the optional *Simplicity*, *Transparency*, and *Standardization* parts (the features). Third, we turn from tranche pricing to loan performance by analyzing the

overall effect of the EUSR on loan performance. Lastly, we compare the importance of features and the label for loan performance.

The first variables of interest in our analyses are indicators for the introduction of the regulation. The indicator variable *EUSR Deal/EUSR Label* takes the value 1 if a deal is issued after 12/2018 under the EUSR. The indicator variable *STS Deal/STS Label* takes the value 1 if a deal is an STS deal. Note that deals that have been issued in the pre-EUSR period can also receive the STS label after 12/2018. All STS deals are at the same time EUSR deals because the STS concept contains only additional features.

To investigate the features required by the EUSR in greater detail, we make use of several scoring variables. The variable *Total STS Features* measures the goodness of the deal's security design and reflects the number of STS (including EUSR) features a specific deal contains. The higher the scoring, the more of the features are implemented that are required to receive the STS label, which is only attributed to a deal if it contains all required STS features. To assess the scoring, we manually check if the deal fulfills the required features listed in Appendix III.A and generate indicator variables for the compliance with each of them. These indicators take the value 1 if the deal fulfills the respective required feature, and we assign the value 0 if the deal does not fulfill the feature or if the investors cannot observe its fulfillment in the deal's documents. Afterwards, we calculate the variable *Total STS Features* as the sum of all indicators for the features. It can take values between 0 in case a deal fulfills no features and 48 if a deal fulfills all STS features. In addition, we divide the *Total STS Features* variable into four segments to evaluate the compliance of a deal with each part of the regulation: an *EUSR Features* variable for the obligatory EUSR features, as well as the variables *Simplicity Features*, *Transparency Features*, and *Standardization Features* for all STS features. This procedure allows us to separately investigate the importance of the design features required by different parts of the regulation for deals issued before and after the regulation came into effect.

We measure performance with indicator variables for a loan being non-performing (*NPL*) or defaulting (*Default*). We derive these variables from the EDW variable *Account Status*, and for *Default* additionally from the variable *Default or Foreclosure*. As loan-level control variables, we consider the following loan characteristics: *Interest Rate* (in %), *Time To Maturity* (in months) and the *Loan To Value* (LTV) (in %) as measures of credit risk, and the *Loan Balance* (in T€) as a proxy for risk concentration (Ghent/Valkanov, 2016). We winsorize the loan-level control variables on the 0.5%-level to account for outliers.

In our tranche-level analyses on the pricing of RMBS, the dependent variable is the log transformation of the daily secondary market *Spread* of a tranche (in bp), and we control for

tranche- and deal-level characteristics at issuance. We use the tranches' *Subordination Level* (in %) as a measure of credit enhancement, the *WAL* (in years) as a measure of the time to maturity, the *Deal Size* (in million €) and the *Number of Tranches* as measures of deal complexity, and the *Tranche Size* (in million €) as a measure of tranche liquidity. We also control for the tranches' rating and the sovereign rating of the country in which the collateral is located. Regarding both, we collect the rating of the rating agencies DBRS, Fitch, Moody's and S&P, unify rating scales to values ranging from 1 (AAA) to 8 (CC) and generate the average rating.

2.3 Data description

Our data set relies on five different sources. The source of the loan-level data is European Data Warehouse (EDW), which is the leading European securitization repository established in the wake of the ECB's loan-level initiative. We receive the secondary market spreads from IHS Markit, and the tranche- and deal-level data for the analyses of spreads are provided by Concept ABS. We identify STS deals using the European Securities and Markets Authority (ESMA) list of STS notifications. For the scoring variables, we manually extract information from deals' prospectuses and documents.

Table III.1: Distribution of deal observations over time

This table displays the number of deal-level observations per year (Panel A), and the number of observations of non-STS loans and STS loans in the data set (Panel B). We identify STS deals with the ESMA list of STS notifications. Note that all deals issued after 2018 (and all STS Deals issued in 2018) are EUSR deals. We provide all variable definitions in Appendix III.B.

	Panel A: Observations of deals outstanding						
	2015	2016	2017	2018	2019	2020	Total
Pre-EUSR	34	73	113	149	149	149	149
Post-EUSR							
Non-STS Deal	0	0	0	0	15	15	15
STS Deal	0	0	0	7	22	22	22
Total	34	73	113	156	186	186	186

	Panel B: Observations of loans outstanding						
	2015	2016	2017	2018	2019	2020	Total
Pre-EUSR	1,784,980	6,173,791	12,916,402	21,577,050	29,443,316	29,970,983	29,970,983
Post-EUSR							
Non-STS Deal	0	0	0	0	219,920	325,964	325,964
STS Deal	0	0	0	133,050	889,559	908,469	908,469
Total	1,784,980	6,173,791	12,916,402	21,710,100	30,614,795	31,205,416	31,205,416

We observe approximately 498,000 loans with 1.2 million loan-quarter observations from 37 EUSR deals. Some deals issued in 2018 fulfilled the EUSR and STS requirements and received the STS label later on. Altogether, our STS subsample consists of about 350,000 loans with approximately 900,000 quarterly loan observations from 22 deals. We observe that originators that opted for issuing STS deals in the EUSR period issued only STS and no non-STS deals. Table III.1 shows our sample composition over the sample period.

Similar to Ertan et al. (2017), we exclude very small mortgages with original balances under € 1000, and potentially erroneous loans, for which the current balance is higher than the original balance. We also exclude loans with missing values in the relevant variables, as well as redeemed or repurchased loans. We exploit the variance in the performance variables *Default* and *NPL* for our investigations. Loans have rather low probabilities to become non-performing or to default due to the personal liability of many European mortgage debtors and the relatively stable economic state in the sample period. Regarding our explanatory variables *EUSR Deal/EUSR Label* and *STS Deal/STS Label*, the sample averages show that 20% (12%) are EUSR deals (STS deals). The variable *Total STS Features* is calculated for 162 of 186 deals since we do not have access to the required documents for the remaining 24 deals. The average number of EUSR and STS features is 32.4 out of 48. Table III.2 provides an overview of the score distribution. The descriptive statistics suggest that originators did not significantly improve the security design over time until the introduction of the EUSR, supporting the need for external requirements to induce security design improvements.

Our loan-level control variable *Interest Rate* is 2.8% on average and ranges from 0% to 6%. The average *Loan Balance* is about € 88,000. The average *LTV* is approximately 64%, indicating that the mortgages are fairly safe. However, there are also loans with a volume of up to 150% of the collateral value in the sample. The average *Time To Maturity* is 17 years with a minimum of three quarters. The descriptive statistics of our loan-level sample variables as well as the distribution of the variable *Total STS Features*, over time and depending on deal attributes, are also provided in Table III.2.

The second sample consists of the corresponding tranche- and deal-level data for 308 European floating rate RMBS tranches. It stems from Concept ABS and IHS Markit and includes the deals issued between 2015 and 2019. We track secondary market spreads of these deals in accordance with our loan-level sample, which ends after 02/2020. Overall, the sample consists of 150,162 spread observations. The predominant tranche rating is AAA (30% of the observations), most observations are tranches issued in 2018 (27%) and the majority of the collateral is

located in the Netherlands and Ireland (70%). Table III.3 provides an overview of the tranche-level data, which is the subsample of deals we can match between our data sources.

Table III.2: Descriptive statistics

Panel A of this table presents the summary statistics of our dependent and control variables, as well as of our explanatory variables of interest. We winsorize the loan level control variables on the 0.5%-level. The variables of interest are provided on deal-level, the others on loan-level. N refers to the number of deals or quarterly loan observations. Panel B provides the distribution of the scoring variables (dependent on the deal features). Summing up the average features does not equal to the Avg. Total STS Features due to the fact that the Feature STS Eligibility is not considered in this sum but in the variable Total STS Features. We provide all variable definitions in Appendix III.B.

Panel A: Descriptive statistics

	N	Mean	SD	Min	q50	Max
Dependent variables						
NPL (0/1)	31,205,415	0.0094	0.097	0	0	1
Default (0/1)	31,205,299	0.0011	0.033	0	0	1
Variables of interest						
EUSR Deal/Label (0/1)	186	0.20	0.40	0	0	1
STS Deal/Label (0/1)	186	0.12	0.32	0	0	1
EUSR Features	162	9.2	2.2	6	9	13
Simplicity Features	162	11.7	3.0	6	11	17
Transparency Features	162	1.3	1.6	0	1	5
Standardization Features	162	9.1	1.8	6	9	12
Total STS Features	162	32.4	7.5	21	31	48
Control variables						
Interest Rate (%)	31,205,416	2.8	1.2	0.2	2.6	6
Loan Balance (T€)	31,205,416	88.4	73.5	1	73.2	450
Loan to Value (%)	31,205,416	63.9	28.2	2.7	66.4	149
Time to Maturity (months)	31,205,416	206.7	98.7	9	207	465

Panel B: Distribution of the average scores over time

	Overall	2015	2016	2017	2018	2019
Avg. EUSR Features	9.3	7.8	7.9	8.3	9.6	13
Avg. Simplicity Features	11.7	10.6	11.1	10.9	12	14.3
Avg. Transparency Features	1.3	0.8	0.7	0.7	1.4	3.4
Avg. Standardization Features	9.1	8.4	8.8	8.3	9.3	11
Avg. Total STS Features	32.4	28.5	29.6	29.6	33.3	42.5
Pre-EUSR	29.4					
Post-EUSR/Non-STS Deal	36.3					
Post-EUSR/STS Deal	48					

Table III.3: Summary statistics: Composition of the tranche-level sample

The tranche-level sample comprises 308 European floating rate tranches issued between 2015 and 2019. We report the distribution of tranches across years and ratings as well as summary statistics of country of collateral, which is the reference for the control variable sovereign rating. We provide all variable definitions in Appendix III.B.

	Obs.	Percentage		Obs.	Percentage
Year			*Country of collateral*		
2015	50	16.23	Belgium	10	3.25
2016	54	17.53	France	31	10.06
2017	63	20.45	Germany	6	1.95
2018	83	26.95	Ireland	54	17.53
2019	58	18.83	Italy	25	8.12
Credit rating			Spain	18	5.84
AAA	93	30.19	Netherlands	164	53.25
AA	73	23.70			
A	55	17.86			
BBB	34	11.04			
BB	19	6.17			
B	9	2.92			
CCC	1	0.32			
NR	24	7.79			

The dependent variable in the tranche-level data, the tranche's secondary market *Spread*, has a mean of 136 bp and a maximum value of 2140 bp. Our explanatory variables are the indicator variables *EUSR Deal/EUSR Label* and *STS Deal/STS Label* as well as the scoring variables reflecting the design features. Regarding the control variables, the average *Subordination Level* is 10.9% and the *WAL* ranges from 1.2 to 27 years. The average *Deal Volume* is € 979.7 million with an average deal consisting of 5 tranches. The most complex deal consists of 11 tranches and the largest has a *Deal Volume* of 10,000 million €. Table III.4 provides the descriptive statistics of the tranche-level variables.

Table III.4: Summary statistics: Credit spreads and credit factors

This table reports summary statistics of 308 RMBS floating rate tranches issued between 2015 and 2019. The table shows descriptive statistics of secondary market's spreads (dependent variable) and credit factors at issuance (independent variables). We provide all variable definitions in Appendix III.B.

	Obs.	Mean	Std. Dev.	Min.	q25	q50	q75	Max.
Credit Spread	150,162	136.14	139.9	1.5	33	90	186.2	2140
Subordination Level	308	10.9	10	0	4.8	8	14.9	99
WAL	308	5.3	2.8	1.2	4.1	5	5.2	27
Vol. Tranche	308	385.7	836.9	2.5	11	43.8	404.3	6650
Vol. Deal	308	979.7	1164	149.9	353.5	608.4	1094	10,000
No. Tranches	308	5.2	1.9	1	4	5	6	11

3 The impact of design features and labels on tranche pricing

3.1 The regulation's effect on the pricing of securitizations

We begin our analyses with the investigation of the capital market-orientated research questions: How does the regulation affect the pricing of securitizations? Is the improved security design – the design features of the deal – or simply the label relevant for the tranches' credit spreads?

The aggregate effect of the regulation enforces improved design features, which are shown to decrease asymmetric information and in turn should be rewarded by the investors with smaller risk premia for all deals affected by the regulation. Therefore, for STS deals, the improved security design should lead to decreased spreads. However, for EUSR deals, two opposing effects might be determining the spreads. On the one hand, we expect the spreads of EUSR deals to decrease if the reduction of asymmetric information induced by the security design features is dominant (but the effect should be smaller than for STS because the improvement of the features is more modest). On the other hand, investors might evaluate the decision against issuing an STS deal as a negative signal. If the latter effect dominates, the spreads of EUSR deals could increase. To examine this, we run the following pooled OLS regression on tranche-level data:

$$\begin{aligned}\log Spread_{i,t} = \beta_0 &+ \beta_1 \cdot EUSR\ Deal_{d,t} + \beta_2 \cdot EUSR \times STS\ Deal_{d,t} \\ &+ \delta \cdot Controls_{i,t} + \psi_q + \psi_o + \varepsilon_{i,t}.\end{aligned} \tag{III.1}$$

The dependent variable is the log transformation of the secondary market *Spread* of tranche *i* at time *t*. Thus, the coefficients of the variables of interest *EUSR Deal* and *EUSR x STS Deal* present the relative change in spreads if the respective indicator variables change from 0 to 1. Including the indicator for *STS Deals* implies an interaction of *EUSR Deals* and *STS Deals* since all STS deals are also EUSR deals. We control for the *Subordination Level*, *Size* and *WAL* of a tranche, as well as for the *Deal Size* and *Number of Tranches* at issuance. We also control for sovereign rating of the country, in which the collateral is located, and the tranche's issuance rating; we include both variables as linear variables. To account for the effect of the ABSPP and other macroeconomic factors, we implement quarter fixed effects ψ_q. Additionally, we control for unobservable differences in originator characteristics using originator fixed effects ψ_o. With these fixed effects, we also control for country fixed effects since the originators only securitize loans from a single country in our sample. All variable definitions are provided in Appendix III.B. We cluster standard errors on deal level.

Table III.5: Pricing EUSR and STS deals

This table contains the estimates of pooled OLS regressions with the log transformation of spreads as dependent variable (see Equation III.1). The coefficients of *EUSR Deal* (*EUSR x STS Deal*) represent the relative change in spreads compared to non-EUSR deals (Non-STS EUSR deals). We include the tranche-level control variables, ratings and quarter and originator fixed effects in all regressions. In column (1), we consider all observations, and in column (2) and (3), we split the sample in AAA tranches and non-AAA tranches. We provide all variable definitions in Appendix III.B. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	(1)	(2)	(3)
Subsample	All	AAA	Non-AAA
Dep. Variable	Log Spread	Log Spread	Log Spread
EUSR Deal	1.441***	1.440***	1.553***
	(5.263)	(6.843)	(3.757)
EUSR x STS Deal	-0.563***	-0.340**	-0.975**
	(-3.145)	(-2.155)	(-2.241)
Log Vol. Tranche	-0.357***	-0.214***	-0.205
	(-11.294)	(-5.163)	(-1.541)
Log Vol. Deal	0.489***	0.361***	0.273*
	(7.441)	(5.335)	(1.850)
Subordination Level	-0.006	-0.021**	-0.011*
	(-1.324)	(-2.546)	(-1.842)
No Tranches	-0.050	0.049**	-0.084**
	(-1.324)	(2.195)	(-2.178)
WAL	0.040***	0.020	0.131***
	(3.081)	(1.497)	(4.332)
Constant	-0.502	-0.201	0.992
	(-0.407)	(-0.145)	(1.084)
Observations	150,162	97,643	52,519
Adjusted R^2	0.836	0.729	0.669
Controls			
Sovereign Rating	Yes	Yes	Yes
Rating	Yes	Yes	Yes
Fixed Effects			
Quarter	Yes	Yes	Yes
Originator	Yes	Yes	Yes
Clustered SE	Deal	Deal	Deal

The results are presented in Table III.5. In column (1), we consider the entire sample. The coefficients show that for *EUSR Deals,* spreads tend to be more than three times higher than for non-EUSR deals. *STS Deals,* however, have 43% lower spreads than *EUSR Deals*. This corresponds to an absolute increase in spreads by 112 bp for *EUSR Deals* whereas spreads of *STS Deals* decrease by 59 bp. Considering the average sample size of an RMBS tranche (€ 386 million), this translates into an annual additional risk premium of € 4.3 million for tranches

of deals which only fulfill the EUSR requirements. Issuing high-quality STS deals instead decreases this risk premium by € 2.3 million per annum. Second, we split the sample into non-AAA and AAA tranches because asymmetric information is of different importance to different investors. While non-AAA investors are sensitive to new information and harmonized interests, AAA investors can rather rely on the pool diversification effect and tranche subordination. Splitting the sample leads to a more differentiated image of the regulation's effect: While the spread increasing effect for *EUSR Deals* is only slightly more pronounced for non-AAA tranches, the spread reducing effect of *STS Deals* is 2.9 times higher for non-AAA tranches. To sum up, first, the regulation's impact on the originators' financing costs is substantial and, second, information sensitive non-AAA investors particularly pay attention to complying with STS.

3.2 Features or label – what does matter for pricing?

In the previous section, we investigated the overall effect of the regulation. Subsequently, we study if the regulation's effect on pricing is due to the required features or the design label as the previous findings could be due to three potential developments: First, the distinction between the deals could be explained by the increased demand for high-quality securitizations resulting from the STS *label*'s quality signal. Strengthening high-quality securitizations would be in line with the objectives of the EU. In this case, the spread reductional effect of the STS label should be especially pronounced when a deal receives the *label*.

Second, investors might seek deals with high-quality security design *features*, and, given the existence of two different quality groups, refrain from investments in EUSR deals because they suspect that these only fulfill the minimum requirements. Therefore, the spreads of EUSR deals have to increase significantly in comparison to STS deals to attract investments at all. Both considerations, however, do not explain why EUSR deals have higher spreads than non-EUSR deals since these do not have to meet the minimum requirements of the EUSR. It would rather be the case that the investors' attention is drawn to the importance of security design and that they demand the higher security design of STS deals. Investors seem to neglect the fact that the requirements concerning the security design of EUSR deals are stricter than for pre-EUSR deals. Since the design features are known to be an important factor in mitigating asymmetric information, investors should consider a high-quality security design when they price securitizations.

Third, it is possible that the investors might interpret opting for non-STS deals as a negative quality signal or they might even have private information about the deals' riskiness and expected performance available. If their information reveals that EUSR deals are riskier than pre-EUSR *and* STS deals, our findings of increasing spreads for EUSR deals would be a rationally explained by demanding higher risk premia because of a worse quality. However, comparing pre-EUSR and EUSR deals, it is not plausible that EUSR deals should be of worse quality as these deals have to meet the regulation's higher minimum requirements regarding the security design. If the pool quality is worse in EUSR deals, this should be reflected in loan performance.

To investigate these explanations, in the next analyses, we further scrutinize the effect of receiving the STS label itself. We find a within-tranche spread reductional effect when the deal receives the STS label, which underlines the importance of the STS label. Afterwards, we analyze whether investors consider a high-quality security design measured with our scoring variables. We point out that the investors rely on the label rather than on the design features. To rule out that the label can be used as an indicator for an improved performance (and maybe investors have information on loan performance, which is not contained in our observable variables), we investigate the regulation's effect on loan performance in Section III.4. We show that loan performance is increased by the regulation, which contradicts the consideration of worse quality of EUSR deals. This hints to the fact that investors misappraise EUSR deals, their underlying security design and misprice their pool risk because they assume that EUSR deals are of worse quality, which we find they are not.

Regarding the first potential explanation, we subsequently investigate the within-tranche effect of officially receiving the STS label, indicated by an STS notification for the respective deal. Therefore, we only consider the subsample of deals, which received the STS label after issuance. This accounts for 93 tranches and the median time between deal issuance and receiving the STS label is 14 days. As we are interested in the within-tranche effect of receiving the STS labels, we implement a fixed effects model on tranche-level (Equation III.2). By including tranche fixed effects λ_i, we control for all time-constant tranche-specific characteristics in general and for the security design *features* in particular. We include the indicator variable *STS Label*, whose value changes from 0 to 1 on the day the deal receives the label. The coefficient of *STS Label* compares the relative difference of the tranche's spread before and after receiving the STS label. To control for time-variant macroeconomic factors, we include quarter fixed effects ψ_q.

$$\log Spread_{i,t} = \beta_1 \cdot \; STS\ Label_{d,t} + \lambda_i + \psi_q + \varepsilon_{i,t} \,. \tag{III.2}$$

The results are displayed in Table III.6 and we find that the tranche's average spread after receiving the STS label is about 13% lower than before receiving the label. Again, the effect of STS substantiates for the information sensitive non-AAA tranches. These within-tranche findings are in line with the previous within-originator analyses but less pronounced: In this within-tranche analysis, we investigate the effect of receiving an STS label controlling for the tranche characteristics and considering only deals, which fulfill the requirements of the STS concept. As the security design of a deal is determined at issuance, these deals have a high-quality security design from the day of issuance. Table III.6, though, shows that receiving the STS label has a substantial effect on credit spreads, which cannot be attributed to an improved security design.

Table III.6: Pricing the label

This table contains the estimates of fixed effects regressions with the log transformation of spreads as dependent variable (see Equation III.2). The estimates of *STS Label* refer to the relative change in spreads when the respective deal receives the STS label. We include tranche and quarter fixed effects in all specifications. In column (1), we consider all observations, and in column (2) and (3), we split the sample in AAA tranches and non-AAA tranches. We provide all variable definitions in Appendix III.B. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	(1)	(2)	(3)
Subsample	All	AAA	Non-AAA
Dep. Variable	Log Spread	Log Spread	Log Spread
STS Label	-0.144*	-0.039	-0.166***
	(-1.872)	(-0.430)	(-2.727)
Constant	4.653***	5.433***	3.389***
	(41.121)	(27.002)	(25.452)
Observations	150,162	97,643	52,519
Adjusted Within R^2	0.269	0.309	0.524
Fixed Effects			
Tranche	Yes	Yes	Yes
Quarter	Yes	Yes	Yes
Clustered SE	Deal	Deal	Deal

The previous analyses suggest that the STS label is important for the pricing of securitizations. However, coming back to the larger sample including deals without a change from non-STS to STS, it remains unanswered whether the results are solely driven by the assigned label or whether the improved security design is also responsible for lower spreads. Therefore, we analyze if the spread adjusting effects of the regulation are solely driven by the label or also by the design features. If we do not find a spread reductional effect for the design features, we substantiate the view that the demand for the *STS label* influences the spreads. This would mean

that investors do not seem to consider the design features sufficiently. In addition, it would oppose to the regulators' objectives to facilitate the investor's risk assessment with the requirements of STS deals. Importantly, investors, which relied on a (rating-)label instead of pursuing risk analyses, played an important role in development of the subprime crisis. Hence, the regulators' goal is to prevent a repetition of the past and strengthen the risk analysis instead. The next analyses help to explore the achievement of these objectives.

Ideally, we would establish a model, in which we separately analyze the influence of all 48 distinct required features, but with such specifications come severe problems: Some features have zero variance (e.g., Risk Retention, which is already obligatory from the start of our sample period) while others are highly correlated or only appear jointly (e.g., features 15 and 16 in Appendix III.A: True Sale and No Severe Clawback Provisions). This makes it difficult to distinguish the individual variables' effect. Another problem is the resulting high number of indicator variables because in combination with the necessary fixed effects, they worsen the relation between independent variables and number of deal clusters. These considerations make statistical inference difficult and led us to refrain from interpreting such analyses in this paper. Nevertheless, decomposing the previous findings is especially relevant for the regulation's evaluation. To differentiate between the effect of the label and the effect of the security design features, we implement the regression displayed in Equation III.1 and add the *Total STS Features.* Second, we add the scoring variables *EUSR Features*, *Simplicity Features*, *Transparency Features*, and *Standardization Features*, separately. Third, we also perform a regression including all scoring variables combined with the indicators for *EUSR Labels (Non-STS)* and *STS Labels*. We estimate the models as described in Section III.3.1 and present the results in Table III.7. In all regressions, spreads are higher for deals with *EUSR Labels*. Interestingly, we find that the scoring variables for the STS part of the regulation do not have a spread reductional effect, which would be expected considering the arguments of decreased asymmetric information due to improvements in the security design. Thus, our results suggest that investors care about the label but not the underlying design features.[14] This observation is of importance because it hints to investors only relying on the STS label rather than performing their own analysis.

[14] To rule out that only AAA investors price the label whereas non-AAA investors consider the security design, we split the sample in two parts again. We do not find differences to the results for the entire sample.

Table III.7: Pricing features or pricing the label

This table contains the estimates of pooled OLS regressions with the log transformation of spreads as dependent variable. The model corresponds to Equation III.1, but in addition to indicators for *EUSR* and *STS Labels* we consider several scoring variables for the features of the security design: the *Total STS Features* (column 1), different scoring variables for EUSR features as well as simplicity, transparency, and standardization features (columns 2–5) as well as the combination of these scoring variables (column 6). The coefficients of the scoring variables represent the relative change in spreads if the deal fulfills one additional requirement of the respective category. We include the control variables, ratings and quarter and originator fixed effects in all regressions. We provide all variable definitions in Appendix III.B. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable	Log Spread	Log Spread	Log Spread	Log Spread	Log Spread	Log Spread
EUSR Label	1.427***	1.176***	1.476***	1.488***	1.359***	0.846**
	(5.652)	(4.732)	(4.976)	(5.743)	(5.458)	(2.382)
EUSR x STS Label	-0.743***	-0.569***	-0.623**	-0.755***	-0.676***	-0.344
	(-3.639)	(-3.472)	(-2.443)	(-3.855)	(-3.730)	(-1.368)
Total STS Features	0.013**					
	(2.285)					
EUSR Features		0.056***				0.081**
		(2.966)				(2.060)
Simplicity Features			0.011			-0.034
			(0.564)			(-0.971)
Transparency Features				0.045**		-0.012
				(2.290)		(-0.208)
Standardization Features					0.047	0.031
					(1.532)	(0.745)
Log Vol. Tranche	-0.358***	-0.360***	-0.360***	-0.359***	-0.358***	-0.361***
	(-11.857)	(-11.895)	(-11.946)	(-11.834)	(-11.704)	(-11.734)
Log Vol. Deal	-0.051	-0.056*	-0.049	-0.053	-0.048	-0.059*
	(-1.518)	(-1.699)	(-1.429)	(-1.579)	(-1.380)	(-1.704)
No Tranches	0.044***	0.044***	0.043***	0.044***	0.045***	0.045***
	(3.486)	(3.454)	(3.469)	(3.500)	(3.488)	(3.406)
WAL	0.496***	0.506***	0.487***	0.497***	0.473***	0.489***
	(7.256)	(7.444)	(6.805)	(7.443)	(7.337)	(6.994)
Constant	-1.056	-1.227	-0.629	-0.721	-0.575	-0.782
	(-0.804)	(-1.019)	(-0.414)	(-0.622)	(-0.456)	(-0.466)
Observations	156,146	156,146	156,146	156,146	156,146	156,146
Adjusted R^2	0.834	0.835	0.833	0.834	0.834	0.836
Controls						
Sovereign Rating	Yes	Yes	Yes	Yes	Yes	Yes
Rating	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects						
Quarter	Yes	Yes	Yes	Yes	Yes	Yes
Originator	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal

4 The impact of design features and labels on loan performance

4.1 The regulations effect on loan performance

In this section, we focus on the performance of securitized loans: Does the regulation affect loan performance? First, we consider the aggregate effect of the regulation. Afterwards, we disentangle the effect of the label and design features in Section III.4.2.

Considering the regulation as a whole, we compare deals affected by the regulation with deals issued beforehand. Ex ante, the effect of the regulation on loan performance is also ambiguous. On the one hand, the EU claims in the introductory part of the regulation that it does not aim to reduce pool risk but only the risks emerging from low quality security designs; though, the required improvements in the security design aim to align originators' and investors' incentives and may therefore result in superior loan performance via the mitigation of asymmetric information. On the other hand, some required design features, which come along with the mitigation of incentive problems, can be considered to target the pool risk, e.g., the prohibition of cherry picking. Besides these considerations, it might be possible that investors have private information about inferior loan quality in EUSR deals available and therefore require the additional risk premia for EUSR deals in comparison to STS deals and pre-EUSR deals, which we demonstrated in Section III.3. In this case, the performance of EUSR deals should be significantly worse than STS deals and pre-EUSR deals. Thus, we examine the effect of the EUSR on loan performance measured by the indicator variables *NPL* and *Default*. We compare the loan performance for EUSR deals with the base category of deals issued before the regulation as stated in Equation III.3.

$$P(NPL_{i,t}=1 \mid X_{i,t}) = \beta_0 + \beta_1 \cdot EUSR\ Deal_{d,t} + \delta \cdot Controls_{i,t} + \psi_t + \psi_o + \psi_{i,year}$$
$$\text{and} \qquad \text{(III.3)}$$
$$P(Default_{i,t}=1 \mid X_{i,t}) = \beta_0 + \beta_1 \cdot EUSR\ Deal_{d,t} + \delta \cdot Controls_{i,t} + \psi_t + \psi_o + \psi_{i,year}.$$

Our variable of interest *EUSR Deal* indicates if loan i at time t in deal d securitized by originator o is part of an EUSR deal. *Controls* is a vector consisting of the loan-level control variables *Time To Maturity, Interest Rate, Loan To Value*, and *Log Loan Balance*. We provide variable definitions in Appendix III.B. Since the variable of interest *EUSR Deal* is constant over time for each deal, we cannot make use of deal fixed effects. However, we include year-of-loan-origination fixed effects $\psi_{i,year}$ and time fixed effects ψ_t. Originator fixed effects ψ_o allow us to investigate within-originator heterogeneity. Controlling for the originator is important to mitigate confounding problems emerging from originator specific factors like market positions, margins, and costs. With these fixed effects, we implicitly also control for country fixed

effects since the originators only securitize loans from a single country in our sample. We estimate the model as pooled logit and cluster standard errors on deal level.[15] Columns (1) and (2) of Table III.8 present the results. We find that the likelihood of becoming NPL is two times lower for EUSR deals than for pre-EUSR deals and that defaults are even less likely. The results for the control variables provide us with further findings that are in line with expectations: Loans, which are riskier in terms of LTV, and loans with higher interest rates perform worse. On top of that, we check whether our results are different if we exclude our control variables because the results might be driven by systematic differences in loan characteristics considered in our controls. Without controlling for loan characteristics, the coefficients for EUSR (not displayed) become economically even more meaningful and statistically more significant, which hints to the fact that originators might assign loans based on loan characteristics to the different types of deals.

As the regulation increases performance controlling for the originator, our previous results hint towards within-originator heterogeneity. A possible explanation is the circumvention of security design *features* by accessing deals issued in the pre-EUSR period. This might occur in two different ways: Originators can shift risk from their balance sheet to securitizations, or, anticipating that they will issue EUSR deals with enhanced security design features in the future, they can shift risk from future EUSR deals to pre-EUSR deals in order to circumvent the features. In either way, a necessary condition is the originator's access to pre-EUSR deals.

For further investigations of the potential circumvention of the features, we exploit the originators' access to deals issued before the enactment of the EUSR by implementing an IV setting. We construct the instruments in accordance to Ashcraft et al. (2019), whose analyses focus on the access to deals without risk retention: First, we measure the originators' accessibility of non-EUSR deals by computing the share of non-EUSR deals of all deals of the originator in a moving window from one year before to one year after the issuance of the deal d. Second, we measure the accessibility with an indicator variable, which takes the value 1 if an originator has access to a non-EUSR deal in the above-mentioned time window. If the originator uses non-EUSR deals to remove undesired exposures, the performance in EUSR deals should be higher if the access to non-EUSR is easy. Nevertheless, it should be noticed that the IV

[15] We also considered implementing a difference-in-differences (DID) setting in order to investigate the causal effect of the regulation. In such a case, the indicator variable *EUSR Deal* would constitute the post indicator and another indicator for *STS Deals* for treated (STS) deals. However, in this case two crucial DID assumptions would be violated: Since originators can choose to issue STS deals, the exogeneity assumption of the treatment is violated; moreover, because there are no treated deals, which are STS but not EUSR deals, the common support assumption would also not be fulfilled.

approach does not allow for conclusions regarding the misuse of non-EUSR deals for unwanted balance sheet exposures, and we cannot investigate this since we do not have data on balance-sheet loans available.

Discussing the IV assumptions, the F-tests of excluding the instruments suggest that the instruments are both very strong ($F > 120$ in all specifications). In order to meet the exclusion restriction, we implement originator and time fixed effects. The fact that all originators are subject to the EUSR requirements helps to ensure the exclusion of this instrument.

The IV setting corresponds to the model presented in Equation III.3 but instruments the indicator *EUSR Deal* with the different measures of access to pre-EUSR deals. In all specifications, we include year of loan-origination, time and originator fixed effects to comply with the exclusion restriction, and we cluster standard errors on deal level. We estimate the IV regressions as two stage least squares (2SLS) and present the results in columns (3)–(6) of Table III.8.[16]

We find that the IV estimators of the instrumented *EUSR Deal* indicator are highly significant. Although the coefficients appear to be rather small in comparison to the results of the logit regressions, the effects are economically meaningful if we take the sample averages of *NPLs* and *Defaults* into account. This provides evidence that EUSR deals are particularly better performing if the access to non-EUSR deals is easy. Thus, the IV results suggest that originators circumvented the features of the EUSR deals to remove undesired risks from future EUSR deals. The results underline that the investors' negative perception of securitizations due to asymmetric information and incentive problems in the period prior to the regulation was reasonable. More importantly, our results suggest that improving the design features was necessary and that the performance-oriented features of the EUSR are effective in mitigating problems inherent in the securitization market. In the subsequent section, we provide insights on the relevance of the regulation's different features and identify the parts which are most important for loan performance.

[16] As a robustness check, we use IV probit as the estimation method. The results confirm the negative signs of the 2SLS estimation and are statistically highly significant.

Table III.8: Loan performance in EUSR deals

This table contains the estimates of pooled logit regressions in column (1) and (2) (see Equation III.3) as well as the corresponding IV 2SLS setting (columns 3–6). The dependent variables are the performance measures (indicators for *NPL* and *Default*). The estimates of the *EUSR Label* indicator display the change in performance in comparison to non-EUSR deals. We instrument this indicator with the access to non-EUSR deals, measured with an indicator for the originators' access to non-EUSR deals (columns 3 and 4) and the share of non-EUSR deals (columns 5 and 6). For columns 3–6, we provide the adj. R^2 of the 2SLS estimation. We include originator and time fixed effects as well as fixed effects for the year of loan origination, and we provide all variable definitions in Appendix III.B. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable	NPL	Default	NPL	Default	NPL	Default
Instrument/Estimation	Logit	Logit	Non-EUSR Deals (0/1)		Share Non-EUSR Deals	
EUSR Deal	-0.859*	-1.732***	-0.007308**	-0.000339***	-0.006489***	-0.000212^{+}
	(-2.479)	(-5.516)	(-3.221)	(-3.308)	(-3.534)	(-1.801)
Interest Rate	0.111*	0.103	0.001022	0.000037	0.001019	0.000037
	(2.284)	(1.149)	(1.593)	(0.828)	(1.588)	(0.822)
Log Loan Balance	-0.008	-0.009	-0.000091	-0.000007	-0.000096	-0.000007
	(-0.342)	(-0.218)	(-0.414)	(-0.557)	(-0.435)	(-0.594)
Loan to Value	0.009***	0.019***	0.000075***	0.000005**	0.000075***	0.000005**
	(6.786)	(6.096)	(4.485)	(3.269)	(4.491)	(3.274)
Time to Maturity	0.000	0.000	0.000003	0.000000	0.000003	0.000000
	(0.540)	(0.044)	(1.140)	(0.535)	(1.132)	(0.521)
Constant	-9.919***	-13.352***	-0.023991***	-0.000416*	-0.023889***	-0.000417*
	(-17.621)	(-21.967)	(-6.027)	(-2.402)	(-6.031)	(-2.406)
Observations	31,147,450	17,977,621	31,169,215	26,792,557	31,156,623	26,782,638
Adj. Pseudo R^2/Adj. R^2	0.126	0.098	0.023	0.001	0.023	0.001
First Stage F-Test			947.17	789.54	260.16	124.37
Fixed Effects						
Loan Origination Year	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Originator	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal

4.2 Features or label – what does matter for performance?

We have shown that the regulation leads to increased loan performance, which is why we now disentangle the effect and investigate if this is due to the label or the design features. To decompose the previous findings, we proceed analogously to Section III.3.2 as follows: First, we add the indicator for *STS Labels* and the variable *Total STS Features* to the model in Equation III.3 to disentangle the effect of the label and the security design (see Table III.9, column 1–2). Second, we separately include the scoring variables *EUSR Features*, *Simplicity Features*, *Transparency Features*, and *Standardization Features*, respectively (column 3–10). Third, we consider all scoring variables together (column 11–12). To avoid endogeneity concerns, we

include originator and time fixed effects, as well as fixed effects for the year of loan origination, and we cluster standard errors on deal level. As in the previous analyses, the originator fixed effects also control for country specific effects as each originator operates only in one country in our sample.

The coefficients of the scoring variables present the change in performance if a deal fulfills one additional requirement.[17] A question stated in Section III.3 remained open: Do investors possess private information about differences between pre-EUSR, EUSR and STS deals, which might indicate that EUSR deals are of worse quality than STS and pre-EUSR deals? To analyze this consideration, we implement both indicator variables as well as the variable *Total STS Features.* We do not find evidence that loans in deals with *STS Label* perform better than with *EUSR Label.* Instead, we find that loans in deals with *EUSR Label* have a significantly superior performance, showing that EUSR loans outperform loans in pre-EUSR deals. In specifications in column (3) and (4), the *EUSR Features* absorb the effect of the *EUSR Label* indicator, which suggests that the EUSR features are more important than whether or not a deal is issued under the new regulation. Concerning the STS features and the STS label, we do not find a noteworthy performance increasing effect.

[17] In order to compare the relative importance of the components, we also run a specification with all scoring variables normalized to 100%. In these specifications, the EUSR requirements are still the most important factor for performance in terms of both, economic and statistical significance.

Table III.9: Design features and labels – what does matter for performance?

This table contains the estimates of logit regressions with the performance measures as dependent variables. The model corresponds to Equation III.3, but we add the different scoring variables (columns 1–8) as well as the combination of all scoring variables (columns 9 and 10) to the indicator variable *EUSR Label*. In columns (11) and (12), we use the *Total STS Features* variable. In columns (13) and (14), we provide estimates of analyses, in which we add the indicator for *EUSR x STS Labels.* In all regressions, we include loan-level controls, originator and time fixed effects as well as fixed effects for the year of loan origination. We provide all variable definitions in Appendix III.B. Standard errors are clustered at the deal level. *t* statistics are presented in parentheses. Statistical significance is denoted as follows: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dep. Variable	NPL	Default	NPL	Default	NPL	Default	NPL	Default	NPL	Default	NPL	Default
EUSR Label	-1.553*	-1.412*	-0.420	-0.109	-1.974**	-1.337***	-1.718^{+}	-2.829*	-1.243***	-1.305***	-1.435^{+}	-1.991**
	(-2.040)	(-2.320)	(-1.032)	(-0.198)	(-3.213)	(-5.023)	(-1.878)	(-2.220)	(-3.451)	(-3.665)	(-1.875)	(-3.234)
EUSR x STS Label	-0.909	-2.454	0.724	0.952	-1.248*	-2.922**	-1.234	-4.925*	-0.524^{+}	0.091	-0.738	-1.709
	(-0.997)	(-0.947)	(1.494)	(1.116)	(-2.297)	(-3.071)	(-1.007)	(-2.210)	(-1.794)	(0.069)	(-0.855)	(-1.152)
Total STS Features	0.031	0.066										
	(0.464)	(0.501)										
EUSR Features			-0.324**	-0.444**							-0.430***	-0.680***
			(-2.647)	(-2.716)							(-3.565)	(-5.403)
Simplicity Features					0.213^{+}	0.301^{+}					0.235**	0.169^{+}
					(1.871)	(1.904)					(2.676)	(1.847)
Transparency Features							0.207	0.942^{+}			0.351	1.507***
							(0.613)	(1.771)			(1.424)	(4.963)
Standardization Features									0.002	-0.242	-0.059	-0.714**
									(0.031)	(-0.951)	(-0.787)	(-3.014)
Loan to Value	0.012***	0.021***	0.012***	0.021***	0.012***	0.022***	0.012***	0.021***	0.012***	0.021***	0.013***	0.023***
	(6.906)	(6.704)	(7.557)	(7.171)	(7.960)	(7.573)	(6.994)	(6.869)	(6.873)	(6.594)	(9.145)	(8.698)
Interest Rate	0.081	0.047	0.078	0.043	0.083	0.052	0.080	0.049	0.080	0.045	0.079	0.051
	(0.990)	(0.367)	(0.946)	(0.336)	(1.015)	(0.414)	(0.981)	(0.384)	(0.981)	(0.359)	(0.964)	(0.400)
Log Loan Balance	0.049*	-0.031	0.050*	-0.032	0.047*	-0.035	0.048*	-0.039	0.049*	-0.032	0.047*	-0.048
	(2.410)	(-0.665)	(2.452)	(-0.670)	(2.454)	(-0.780)	(2.436)	(-0.899)	(2.376)	(-0.687)	(2.538)	(-1.165)
Time to Maturity	-0.000	0.000	0.000	0.000	0.000	0.000	-0.000	0.000	-0.000	0.000	0.000	0.000
	(-0.146)	(0.290)	(0.045)	(0.371)	(0.002)	(0.364)	(-0.162)	(0.251)	(-0.128)	(0.331)	(0.225)	(0.404)
Constant	-10.769***	-15.395***	-7.018***	-9.601***	-12.773***	-16.825***	-10.036***	-14.176***	-9.695***	-11.017***	-9.386***	-4.121
	(-4.568)	(-3.611)	(-5.793)	(-6.187)	(-7.293)	(-8.434)	(-11.143)	(-15.512)	(-11.458)	(-4.034)	(-7.229)	(-1.481)
Observations	21,800,202	14,701,052	21,800,202	14,701,052	21,800,202	14,701,052	21,800,202	14,701,052	21,800,202	14,701,052	21,800,202	14,701,052
Adj. Pseudo R^2	0.119	0.103	0.121	0.106	0.120	0.105	0.119	0.105	0.119	0.103	0.124	0.111
Fixed Effects												
Loan Origination Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Originator	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE	Deal	Deal	Deal	Deal	Deal	Deal	Deal	Deal	Deal	Deal	Deal	Deal

Overall, we find that the features contained in the obligatory EUSR requirements are important for the loan performance whereas this does not seem to be the case for the STS features and the STS label. Although we show that improvements in the features of the security design increase loan performance, investors do not value these factors (as discussed in Section III.3.2) but rather rely on the STS label. The results also underline that the higher spreads of EUSR deals compared to both, STS and pre-EUSR deals, are unlikely to be due to investors' private information regarding the pool risk as we show that the ex-post performance in EUSR deals is higher. Thus, we can reject the consideration that investors knowingly penalize EUSR deals with higher spreads because they have private information about the deals' pool quality and riskiness. The findings substantiate the interpretation that investors simply rely on the label, even though the originators' behavior and therefore loan performance are driven by the features of the security design, which in turn are neglected by the investors. A possible explanation is a general demand shift towards STS deals, which could be induced by the investors' conjecture that the decision against issuing STS deals is a negative quality signal since the findings lack to explain why the spreads of EUSR deals should be higher than pre-EUSR deals. We provide evidence for the mispricing of EUSR deals because their security design and performance is superior compared to pre-EUSR deals whereas their risk premia are higher. These results imply that investors should adjust their pricing and focus more on the features of the security design and the risk assessment of the deals instead of relying on the label because the features of the security design – and not the label – are relevant for the originators' behavior and loan performance.

5 Conclusion

The problems of securitizations that led to the financial crisis resulted in a frozen EU securitization market. Since then, issue volumes remain below their pre-crisis level. Because the EU identified asymmetric information emerging from the security design as the main problem and aims to revive the securitization market, it introduced a regulatory framework, which increases the requirements concerning the features of complex financial securities and establishes the STS label for high-quality securitizations. Exploiting the new regulatory requirements of the EUSR and the STS framework, we study the impact of improved features of the security design versus quality labels on tranches' spreads and on loan performance.

We find that many investors rather rely on the STS label instead of considering an improved security design when pricing RMBS tranches. On the contrary, the actual performance

is substantially better for deals with improved design features (instead of the label); particularly the minimum EUSR requirements have a large positive impact on loan performance. Surprisingly, we do not only observe decreased spreads of STS labelled deals but also increased spreads of non-STS deals compared to deals issued before the introduction of the EUSR. This observation is inconsistent with the observation that pre-EUSR deals are inferior not only regarding the features of the security design but also regarding the ex-post performance in terms of non-performing loans and defaults. Overall, our results suggest that investors neglect a proper risk assessment of complex securities and misinterpret the issuance of deals with STS label as a signal of superior performance as opposed to deals without STS label as a signal of inferior performance.

Our findings have important implications for regulators, investors, and originators of complex securities. For regulators, our results indicate that the introduction of an extensive regulation can effectively mitigate asymmetric information in securitization markets. However, a regulation implementing not only improved features of the security design but also assigning quality labels can come at the cost of investors relying too much on the label instead of performing a proper risk assessment. For investors, our results imply that they should put more emphasis on the analysis of the security design as this substantially influences the originators' incentives; for example, we find that especially the minimum EUSR requirements mitigate issues inherent in securitizations and improve loan performance. Originators, though, should notice that currently not the features of a proper security design but rather receiving the STS label is crucial for signaling high asset quality, leading to spread reductions and lower financing cost. For example, spreads declined on average by 13% within tranche after receiving the STS label; issuing STS deals can, thus, reduce originators' annual financing costs by about € 2.3 million.

Appendix III.A: EUSR and STS features

In this table, we present all relevant design features of the regulation. We create indicator variables for each of the 48 features. For each section (*EUSR*, *Simple*, *Transparent*, *Standardized*), we create a scoring variable, which sums up to the values 13 for *EUSR* (+1 for *STS eligibility*), 17 for *Simple*, 5 for *Transparent*, and 12 for *Standardized* if a deal contains all features. To receive the overall score, we sum up all scoring variables.

Panel A: EUSR (and basic STS) features

		Feature	Description	Art. in EUSR
EUSR	1	Limited Sale to Retail Clients	Sale of securitization positions to retail clients only if certain criteria fulfilled	3
	2	Requirements for SSPEs	SSPE not established in certain third countries	4
	3	Risk Retention	Retention of a material net economic interest in the securitization of not less than 5% on an ongoing basis	6
	4	No Cherry Picking	Originators shall not select assets to be transferred to the Securitization Special Purpose Entity (SSPE) with the aim of rendering losses on the assets.	6 (2)
	5	No Re-Securitizations	Ban on re-securitizations except for a “legitimate purpose”	8
	6	Origination in Ordinary Course	Same credit-granting criteria for securitized and non-securitized exposures	9 (1, 3)
	7	Thorough Credit Assessment	Sound and well-defined credit granting criteria and established processes for approving, amending, renewing and refinancing credits	9 (1, 3)
	8	RMBS: Information Verified by Lender	Verification of residential mortgage debtors’ information	9 (2)
	9	Information on Underlying Exposures	Loan-level reporting	7 (1) a
	10	Prospectus	Prospectus or deal summary providing information on the main features of the securitization	7 (1) b i
	11	Transaction Documents	E.g. asset sale agreement, derivatives agreement	7 (1) b ii-vi
	12	Reporting	Investor reports, significant events, inside information	7 (1) e-g
	13	Due Diligence	Verification of information, performance of risk-assessment, monitoring, stress testing of the securitization	5
STS	14	STS eligibility	Originator, Sponsor & SSPE established in EU	18

Panel B: Simplicity features

		Feature	Description	Art. in EUSR
Simplicity	15	True Sale	Title to the underlying exposures acquired by SSPE by means of a true sale	20 (1)
	16	No Severe Clawback Provisions	No possibilities of invalidation of the transfer of title for certain reasons	20 (1-2)
	17	Trigger Events for Transfer of Underlying Exposures After Closing	Trigger events in case of deterioration of the seller's credit quality standing, breaches of contractual obligations or insolvency of the seller	20 (5)
	18	No Encumbrance of Underlying Exposures	Underlying exposures committed to other counterparties cannot be freely transferred and are therefore prohibited	20 (6)
	19	No Active Portfolio Management	Sale and purchase of assets only under certain circumstances e.g. purchase due to replenishment purposes	20 (7)
	20	Same Eligibility Criteria Before and After Closing	Eligibility criteria for underlying exposures remain the same	20 (7)
	21	Homogeneity of Underlying Exposures	Underlying exposures shall be homogeneous in terms of asset type, leading to similar cashflow, contractual, credit-risk and prepayment characteristics.	20 (8)
	22	Assessment of Borrower's Creditworthiness Defined in Directives	Assessment of a borrower's creditworthiness shall follow the requirements provided in the EU directives 2008/48/EG or 2014/17/EU.	20 (10)
	23	Underlying Exposures Transferred After Selection Without Undue Delay	Immediate transfer to the SSPE after selection for securitization pool	20 (11)
	24	Contain Obligations that are Contractually Binding and Enforceable	Contracts have to be enforceable in court	20 (8)
	25	Not Include Transferable Securities	No inclusion of classes of securities that are negotiable on the capital market	20 (8)
	26	No Exposures to Credit Impaired Debtors at Selection	No credit score indicating that likelihood of payments not being made is higher than for comparable exposures	20 (11) a, c
	27	No Exposures to Credit Impaired Debtors at Origination	Not on credit registry of persons with adverse credit history	20 (11) b
	28	No Exposures in Default	No exposures in which the obligor is past due more than 90 days	20 (11)
	29	Defined Periodic Payment Streams	E.g. instalments consisting of interest and repayment of a principal	20 (8)
	30	At Least One Payment Made	Rental, principal, interest or any other kind of payment	20 (12)
	31	Originator's or Original Lender's Expertise	Expertise in originating exposures of a similar nature to those securitized	20 (10)

Panel C: Transparency features

		Feature	Description	Art. in EUSR
Transparency	32	Performance Data	Historical default and loss performance data of similar exposures to those securitized covering a period of at least 5 years	22 (1)
	33	Asset Audit	External verification of a sample of the underlying exposures including verification that disclosed information is correct	22 (2)
	34	Liability Cashflow Model	Outline of the contractual relationship between the underlying exposures and the payments flowing between the originator, sponsor, investors, other third parties and the SSPE	22 (3)
	35	STS Notification	Notice of STS status including key information of the securitization	7 (1) d, 27 (1)
	36	STS Verification Report	Possibility of mandating a third party authorized by the competent authority to verify compliance with STS criteria	28

Panel D: Standardization Features

		Feature	Description	Art. in EUSR
Standardization	37	Interest and Currency Risk Hedged	Hedging shall cover a major share of the risk under different scenarios.	21 (2)
	38	No Derivatives in the Pool of Underlying Exposures	Use of derivatives only for hedging purposes	21 (2)
	39	Generally Used Market Rates for Interest Payments Under the Assets and Liabilities	Referenced to generally used market rates, sectoral rates and shall not be based on complex formulae or derivatives	21 (3)
	40	Clear Rules in the Event of Conflicts Between Classes of Noteholders	Problems shall be resolved in a timely manner, voting rights clearly defined and allocated, fiduciary duties of deal parties clearly identified.	21 (10)
	41	Technical Instructions in Case of an Enforcement or Acceleration Notice	Cash only trapped in SSPE if operationally necessary, sequential amortization of principal receipts, no automatic liquidation	21 (4)
	42	Sequential Repayment as Fallback	Performance triggers leading to switch from pro-rata to sequential amortization at least related to credit quality of underlying exposures	21 (5)
	43	Early Amortization Provisions or Triggers for Termination of the Revolving Phases	In case of credit quality or exposure value deterioration, insolvency related event, if not sufficient new underlying exposures.	21 (6)
	44	Deal Documents Specify Obligations, Duties and Responsibilities of Servicer, Trustees and other Service Providers	Provide transparency to investors in terms of potential disruptions to cashflow collections and servicing	21 (7) a
	45	Deal Documents Specify Replacement Measures for Servicer, Derivative Counterparties, Liquidity Providers and Account Bank	Continuous functioning of the deals in case of default or insolvency of certain parties	21 (7) b-c
	46	Expertise of the Servicer	Expertise in servicing exposures of a similar nature to those securitized	21 (8)
	47	Servicing Based on Well Documented and Adequate Policies, Procedures, Risk-Management Controls	Servicer is subject to prudential and capital regulation and supervision in the union or proofs the existence of adequate measures.	21 (8)
	48	Servicing of Non-Performing Exposures	Definitions, remedies, and actions regarding non-performing exposures	21 (9)

Appendix III.B: Variable definitions

Panel A: Deal Level EUSR data (hand-collected)		
Variable	**Description**	
EUSR Deal/EUSR Label	Indicator variable equal to 1 if a deal is an EUSR deal	
STS Deal/STS Label	Indicator variable equal to 1 if a deal is an STS deal	
EUSR Features	Number of fulfilled EUSR requirements	
Simplicity Features	Number of fulfilled simplicity requirements	
Transparency Features	Number of fulfilled transparency requirements	
Standardization Features	Number of fulfilled standardization requirements	
Total STS Features	Number of fulfilled STS requirements	
Panel B: Loan-level data (European Data Warehouse)		
Variable	**Description**	**EDW Variable AR**
Default	Indicator variable equal to 1 if a loan will default at *t*+1	166
Interest Rate	Current interest rate (in %)	109
Loan Balance	Current loan balance (in thousand €)	67
Loan To Value	Current ratio of loan balance and collateral value (in %)	141
Non-Performing Loan (NPL)	Indicator variable equal to 1 if a loan status is non-performing and the time in arrears is greater than 30 days	166
Time To Maturity	Number of months until loan maturity	56
Panel C: Deal- and tranche-level data (ConceptABS & IHS Markit)		
Variable	**Description**	
Spread	Tranche's risk premium at *t* (in bp). This variable corresponds to the variable *midspread* from IHS Markit	
Subordination Level	Percentage of total liabilities that is subordinate to the tranche (in %)	
Weighted Average Life (WAL)	Weighted time to maturity of all loans securitized in the pool	
Volume Tranche	Nominal value of the tranche (in million €)	
Volume Deal	Nominal value of the deal (in million €)	
Number of Tranches	Number of tranches the deal consists of	

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