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Risk allocation through securitization – Evidence from non-performing loans

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Abstract

Employing a unique and hand-collected dataset of securitization transactions by European banks, this paper analyzes the relationship between true sale loan securitization and the issuing banks' non-performing loans to total assets ratios (NPLRs). We provide evidence for an NPLR-reducing effect during the boom phase of securitizations suggesting that banks (partly) securitized NPLs as the most risky junior tranche. In contrast, we find the reverse effect during the crises period indicating that issuing banks demonstrated 'skin in the game'. A variety of sensitivity analyses provides further important implications for the vital debate on reducing NPL exposures and regulating securitization markets.

Keywords: European Banking, Non-performing Loans, Risk Allocation, Securitization
JEL Classification: G21,G28,G32

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1 Introduction

Due to the Global Financial Crisis (GFC) from 2007/08 and the European Sovereign Debt Crises (ESDC) from 2009 many European banks suffer from large amounts of non-performing loan (NPL) exposures on their balance sheets. Thus, while the gross amount of NPLs within the European banking sector amounted to a peak of more than one trillion Euro in 2012/13, the Statistical Data Warehouse of the European Central Bank (ECB) reports that the NPL exposure has decreased only marginally to an amount of approximately €820 billion at the end of 2018.

The negative consequences of large NPL exposures on bank balance sheets are twofold. On a micro-level, banks exhibiting large amounts of NPLs may suffer from lower capital and profitability ratios, higher funding costs and stronger capital requirements, which limit them to grant new loans. Depending on the individual business models, these banks may additionally be incentivized to a gambling of resurrection-strategy, i.e. they tend to take on more profitable but more risky loans in order to reestablish financial soundness, which may further increase their NPL exposures (European Central Bank, 2017; European Commission, 2018). On a macro-level, long-term economic growth may be impeded and financing shocks may occur if banks reduce their loan supply due to large NPL exposures. Moreover, an increase in the banks' systemic risk due to NPLs may also deteriorate the resilience and the sustainability of the entire European banking market.

As a response, both, national authorities and European institutions have jointly released specific proposals and initiatives[1], which should extend the scope of guidance for European banks concerning the reduction of NPLs. Among the instruments proposed, especially *loan securitization* was stressed as an effective way to transfer NPLs out of the banks' balance sheets (European Central Bank, 2017).

The European securitization market, however, has still not fully recovered from its drying-up due to the GFC and the beginning of the ESDC. During these crises, the European securitization market was characterized by a strong information asymmetry between issuing

[1]In June 2016, the European Council presented a *roadmap to complete the Banking Union* emphasizing harmonization in the field of insolvency law to reduce NPLs. Furthermore, a *guidance to banks on non-performing loans* was published by the ECB in March 2017. This guidance serves as a guideline for measures, processes and best practice strategies for banks to tackle NPLs. Similarly, in July 2017, the European Systemic Risk Board (ESRB) announced a report on *resolving non-performing loans in Europe* while the European Economic and Financial Affairs Council edited an *action plan to tackle non-performing loans in Europe*. Finally, in March 2018, the European Commission published a comprehensive bundle of instruments that should help reducing NPL exposures at European banks.

banks and asset-backed security (ABS) investors. Under this framework, failures in valuating (complex) securitization transactions made by rating agencies provoked a severe decline in investor-confidence towards loan-backed securities (Basel Committee on Banking Supervision, 2008; International Monetary Fund, 2008, 2009; Acharya et al., 2009; Michalak and Uhde, 2012; di Patti and Sette, 2016; Association for Financial Markets in Europe, 2018a). In this context, it is even argued that securitization was one of the main triggers of the GFC (Acharya and Richardson, 2009; Crotty, 2009; Fligstein and Goldstein, 2010).

Banking regulating authorities and several further (trans-)national institutions have responded to the collapse of the securitization market with extensive regulatory and legal reforms. In Europe, these reforms aim to revitalize the securitization market[2] by stipulating simple, transparent and standardized (STS) securitization transactions. It is expected that such STS securitizations will increase transparency and thus, will reduce the high level of post-crises information asymmetry on the European securitization market (European Union, 2017b). In addition, it is emphasized that the recovery of the European securitization market strongly depends on the recalibration of regulations, such as due diligence requirements for institutional investors in securitization transactions as well as liquidity and regulatory capital requirements, and also new risk-retention rules for securitizing banks (Association for Financial Markets in Europe, 2017, 2018b).

While a huge strand of related empirical papers has examined bank-specific and macroeconomic determinants of NPLs[3], so far researchers have paid no attention to the impact of securitization on the issuing banks' NPL exposures directly (see Section 2). The paper at hand aims at reducing this gap. We employ a sample of 648 true sale loan securitization transactions

[2]At the supranational level, the Basel Committee on Banking Supervision (BCBS) proposed *revisions to the securitization framework* in December 2014. In July 2015, the BCBS and the International Organization of Securities Commissions (IOSCO) jointly presented a set of *criteria for identifying simple, transparent and comparable securitizations*. At the EU level, the European Commission passed two important legislative regulations on (i) securitization transactions and (ii) capital requirements in December 2017. *First*, Regulation (EU) 2017/2402 of the European Parliament and of the Council of 12 December 2017 lays down a general framework for securitization and creates a specific framework for simple, transparent and standardized securitization. These regulation amends Directives 2009/65/EC, 2009/138/EC and 2011/61/EU and Regulations (EC) No 1060/2009 and (EU) No 648/2012. *Second*, Regulation (EU) 2017/2401 of the European Parliament and of the Council of 12 December 2017 proposes prudential requirements for credit institutions and investment firms (European Union, 2017a,b) and amends Regulation (EU) No 575/2013. Moreover, the Association for Financial Markets in Europe has additionally published numerous press releases, discussion letters (e.g., Association for Financial Markets in Europe, 2018b) and publications (e.g., Association for Financial Markets in Europe, 2017), which promote the revitalization of the European securitization market.

[3]Previous studies empirically investigate the determinants of NPL exposures on (i) an individual European country-level (Salas and Saurina, 2002; Çifter et al., 2009; Louzis et al., 2012; Macit, 2017), (ii) the European Monetary Union (EMU)-level (Messai and Jouini, 2013; Makri et al., 2014; Dimitrios et al., 2016) and (iii) the EU-level (Klein, 2013; Jakubík et al., 2013; Škarica, 2014; Çifter, 2015). In addition, Nkusu, 2011 (Global); Beck et al., 2015 (Global); Ghosh, 2015 (United States) and Zhang et al., 2016 (China) analyze the determinants of NPLs employing a non-European sample.

issued by 57 stock-listed banks across the EU-12 plus Switzerland[4] over the period from 1997 to 2010. Based on this unique and hand-collected dataset, we investigate if securitization was an effective instrument to allocate NPLs to capital market investors until the European securitization market dried up in 2010 and risk-retention guidelines were proposed in 2011. Our analysis extends previous empirical studies as follows. *First*, to the best of our knowledge, this is the first study that empirically investigates whether credit (risk) securitizations may have an impact on an issuing bank's NPL exposure directly. *Second*, in order to gain a deeper understanding of the loan risk allocation process of securitizations, we control for different time periods (boom, crisis and non-crisis periods) and perform further important sensitivity analyses. *Third*, while previous empirical studies examine bank-specific and/or macroeconomic determinants of NPLs, we adopt these determinants as control measures but extend them by regulatory variables.

We theoretically argue and empirically show that the impact of loan securitization on NPL exposures is not intuitively negative. It rather depends on the design of the loan risk allocation process of a securitization transaction under the framework of capital market imperfections. Accordingly, we provide evidence for a reduction of the issuing banks' non-performing loans to total assets ratios (NPLRs) through securitization during the boom phase of securitization activities in Europe. In contrast, we find the reverse effect for the crises period. Our baseline result remains robust when controlling for endogeneity concerns and a potential persistence in the time series of the NPL data. Moreover, results from sensitivity analyses reveal that the NPLR-reducing effect is stronger for opaque securitization transactions, for issuing banks exhibiting higher average levels of NPLRs and for banks operating from non-PIIGS countries. In addition, a reduction of NPLRs through securitization is observed for issued collateralized debt obligations, residential mortgage-backed securities, consumer and other unspecified loans as well as for non-frequently issuing, systemically less important and worse-rated banks. In sum, the analysis at hand offers essential insights into the loan risk allocation process through securitization and

[4]The EU-12 covers Austria, Belgium, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden and the United Kingdom. Issuing banks from Finland and Luxembourg are excluded since we are not able to assign securitization transactions to respective originating banks for these countries. In addition, we extend our sample by Switzerland for two reasons. *First*, although Switzerland is not part of the EU/EMU the interrelation between the Swiss and the European banking market is very distinctive. *Second*, two of the most important banks of Switzerland, namely UBS and Credit Suisse, issued a couple of large securitization transactions over the period from 1997 to 2010. To verify our results, we exclude Swiss bank holdings from our baseline regressions as a robustness check. However, since results do not remarkably differ from respective baseline regressions, we do not present them in this paper but provide them on request.

provides important implications for the vital debate on reducing NPL exposures and the process of revitalizing and regulating the European securitization market.

The remainder of the paper is organized as follows. Section 2 presents and discusses theoretical arguments and empirical evidence as regards the risk allocation process during a securitization transaction. Section 3 describes the entire set of regression variables and introduces the empirical methodology. The regression results are reported and discussed in Section 4. While Section 4.1 presents results from our baseline analyses and robustness checks, Section 4.2 discusses results from a large variety of sensitivity analyses. Finally, Section 5 summarizes and provides important policy implications.

2 Theoretical background

Loan (risk) securitization allows a bank to convert illiquid loans and inherent risks into liquid and tradable securities. Hence, securitization is typically employed as an instrument to diversify and restructure loan portfolios and as well as an alternative funding source beyond deposits and traditional capital market financing (e.g., Michalak and Uhde (2012)). During a true sale securitization transaction, the originating bank transfers an underlying portfolio of loans and inherent risks out of its balance sheet to the asset side of a legally separated Special Purpose Vehicle (SPV). In turn, the SPV sells ABSs to capital market investors who receive contractually governed interest and redemption payments from the underlying loan agreements as fixed cash flows.

The underlying reference loan portfolio of a true sale transaction is structured into different tranches, which are sold separately to the investors (e.g., DeMarzo (2004)). Typically, a true sale securitization follows a three-tier security structure with junior, mezzanine and senior tranches. Investment returns (cash flows from interest and redemption payments) and risks (likely loan losses) are allocated among the different tranches according to their seniority following a strict subordination principle and a '*waterfall principle*'. Accordingly, investors in different tranches bear losses from defaults of underlying loans to a different extent. The senior tranche has the first call on cash flows from the underlying loan portfolio, whereas the junior tranche has the last claim on these returns. Consequently, while the probability of loan portfolio losses is the smallest in senior tranches, the largest part of expected portfolio losses (e.g., from NPLs) is allocated to the junior tranche. The junior tranche is the most information-sensitive tranche

and is also known as the first-loss piece (FLP). It is the smallest of all tranches, concentrates most of the loan default risk and thus, receives the highest investment return if loan defaults do not occur.

Although a true sale loan securitization enables originators to transfer NPLs to capital market investors by means of the junior tranche, the impact of securitization on NPLs is not intuitively negative, but rather depends on the loan risk allocation process during a securitization transaction (Greenbaum and Thakor, 1987; Instefjord, 2005; Krahnen and Wilde, 2006). Basically, a high level of interest-alignment between the issuing bank and investors is necessary to guarantee that the different tranches are successfully sold to the market (Hartman-Glaser et al., 2012). This alignment is achieved when issuing banks tailor the risk-return properties of the different securitization tranches to the risk tolerance of potential investors (Franke et al., 2012). Accordingly, banks may transfer NPLs by means of the junior tranche only if capital market investors are willing to bear the highest loan risk and in turn, receive a risk-adequate and superior investment return. Additionally, it is required that potential investors must be able to sufficiently value the risk-return structure of the highest-risk securitization tranche before they make their investment decision. Under the framework of imperfect capital markets, however, information asymmetries between securitizing banks and potential investors describe a major impediment to the risk allocation process (Albertazzi et al., 2015). Thus, as securitizing banks usually have better information on the underlying loans than investors, this creates room for adverse selection and moral hazard (Vermilyea et al., 2008; Hartman-Glaser et al., 2012).

Investors can reduce the information gap by '*screening*', i.e. they collect further information on the risk-return structures of the different securitization tranches, especially with the help from rating agencies. Doing so, investors are faced with increasing transaction costs while at least the GFC has impressively revealed that ratings cannot remove information asymmetries completely. Hence, as information asymmetries have become even more severe during and in the aftermath of the crisis, investors further have lost confidence towards banks and rating agencies (Caprio et al., 2008; Acharya et al., 2009; Acharya and Richardson, 2009; Benmelech and Dlugosz, 2010). Taking this into account, rational investors may assume a '*lemons market*' and thus, may generally demand an additional risk premium from loan-backed securities, which should compensate for future unexpected losses. Obviously, it depends on the investor's market power if and to what extent she will negotiate such a risk premium.

A securitizing bank may try to reduce this penalty or prevent from reputation risk by providing credit enhancement. Next to overcollateralization and explicit or implicit recourse arrangements (Vermilyea et al., 2008; Guo and Wu, 2014; Begley and Purnanandam, 2016), credit enhancement is typically achieved by risk-retention (Franke et al., 2012; Hartman-Glaser et al., 2012; Albertazzi et al., 2015). Accordingly, retaining the most risky loans with the highest default probabilities (like NPLs) as the FLP serves as a quality and reputation signal towards less informed investors in imperfect capital markets (Gorton and Pennacchi, 1995; Riddiough, 1997; DeMarzo, 2004; Malamud et al., 2010; Franke et al., 2012; Hartman-Glaser et al., 2012; Albertazzi et al., 2015). In addition, the issuing bank signals '*skin in the game*' by retaining the FLP on its balance sheet (Franke et al., 2012; Albertazzi et al., 2015).

Previous empirical studies, that investigate the allocation of loan risk through securitization, are scarce and provide mixed evidence. Initially, studies provided by Shivdasani and Wang (2011) and Benmelech et al. (2012) show that there is no difference in terms of the underlying quality and performance between securitized and non-securitized loans. However, Downing et al. (2009), Piskorski et al. (2010), An et al. (2011) as well as Krainer and Laderman (2014) empirically demonstrate that banks securitize more risky loans and retain loans with a lower default risk on their balance sheets suggesting that banks may exploit their information advantage during a securitization transaction. In contrast, Jiang et al. (2014) provide mixed evidence when differentiating between the ex ante and ex post relationship between loan securitization and loan performance. The authors show that loans with a higher *ex ante* probability of sale are associated with higher delinquency rates (higher default rates), whereas the *ex post* performance of securitized loans is higher (lower delinquency rates) as compared to retained loans. Similarly, studies provided by Downing and Wallace (2005), Albertazzi et al. (2015) as well as Kara et al. (2019) find that especially less risky loans are securitized, whereas loans with a high default risk are retained. It is further revealed that the exposure of retained high-risk loans grows with the extent of information asymmetry as perceived by potential investors in ABS transactions. Accordingly, findings from these studies support theoretical predictions that information asymmetries may incentivize securitizing banks to retain the most risky tranche as a quality or reputation signal and to demonstrate '*skin in the game*'.

Two further empirical studies are most related to our analysis since they investigate the relationship between securitization transactions and bad loans or non-performing assets. To begin with, Affinito and Tagliaferri (2010) employ annual data of securitized loans from Italian

banks for the period from 2000 to 2006. Implementing a mean-difference comparison over time and splitting the securitization sample into different time periods, they provide evidence of a decrease in '*bad loans*'[5] due to securitization. In addition, using data from 230 U.S. banks for the period from 2001 to 2007, Casu et al. (2011) examine the impact of securitization on the issuing banks' asset risk exposures. Asset risk is measured by two different ratios, i.e. the risk-weighted assets to total assets and the non-performing assets to total assets ratio. The study reveals that the securitization of mortgage loans, home equity lines of credit and other consumer loans reduces the issuing banks' levels of asset risk.

3 Empirical methodology

3.1 Data and sources

In order to empirically investigate the impact of credit (risk) securitization on European banks' NPLRs, our analysis focuses on annual bank-specific, country-specific macroeconomic and regulatory data. Figure 1 illustrates the development of the NPLR for our sample of European banks. Figures 2 - 5 as well as Tables 1 and 2 provide a detailed overview of the securitization data as used in this study. Notes on the entire set of regression variables and respective data sources as well as corresponding descriptive statistics are reported in Tables 3 and 4. Finally, the correlation matrix is presented in Table 5[6].

3.1.1 Non-performing loan ratio

According to the ECB, we define a loan as non-performing (or impaired) if the agreed repayment arrangements are outstanding for 90 days or more (European Central Bank, 2017). The amount of a bank's NPLs reflects an important part of a bank's loan risk exposure and thus, the quality of a bank's loan portfolio (Hughes and Mester, 1993; Ghosh, 2015; Zhang et al., 2016). Furthermore, it is argued that NPLs may serve as a proxy for a bank's (credit) risk-taking behavior (Casu et al., 2011).

We employ the ratio of the accounting value of a bank's non-performing loans to total assets (*NPLR*) as our dependent variable. The consolidated balance sheet data of NPLs and total assets of a bank i in year t is retrieved from the *BankScope* database compiled by *FitchRatings*

[5] According to the Bank of Italy, NPLs of Italian banks are classified as 'unlikely-to-pay exposures', 'overdrawn and/or past-due exposures' and 'bad loans', which are defined as exposures to debtors who are insolvent or in substantially similar circumstances.

[6] We do not present the full correlation matrix including all 25 variables in this paper but provide it on request.

and provided by *Bureau van Dijk*. A decrease in the NPLR due to true sale securitizations, indicates that the issuing bank securitizes more NPLs than loans of higher quality since both, performing and non-performing loans are included in the bank's total assets in the denominator of the NPLR. In contrast, the NPLR will increase due to true sale securitizations, if an issuing bank dominantly transfers performing loans (as included in the bank's total assets) rather than NPLs out of its balance sheet.

As shown by Figure 1, the NPLR from our sample of European banks slightly decreased between 1997 and 2007 on average. Since then, the NPLR has sharply increased as a result of the GFC from 2007/08 and the ESDC, which has begun in 2009.

3.1.2 Securitization transactions

We employ a unique sample of 648 true sale loan securitization transactions issued by 57[7] stock-listed[8] banks across the EU-12 plus Switzerland over the period from 1997 to 2010. The securitization data is hand-collected from circulars and presale reports provided by *Moody's*, *Standard & Poor's* and *FitchRatings*. Our data contains detailed information on securitizing banks, issue dates, structures, types and volumes of securitization transactions as well as the underlying reference portfolios.[9]

The geographical distribution of securitizing banks in Europe is shown in Table 1. The descriptive statistics of the true sale securitization transactions in our sample is reported in Table 2. As illustrated by Figures 2 and 3, the sample period ranges from the beginning of European securitization activities in 1997 to the degeneration and drying up of the securitization market in 2010. Figures 2 and 3 reveal that the growing importance of securitization in Europe is reflected by increasing volumes and numbers of securitization transactions as well as a growing share of participating banks. Volumes, numbers and shares reach their respective peaks in 2007.

[7]Note that our initial sample of 58 securitizing banks is reduced by one bank (SNS Reaal NV / SRH NV) due to missing NPL data on a consolidated level.

[8]Following Altunbas et al. (2009) and Uhde et al. (2012), we consider stock-listed banks only due to the following reasons. *First*, using stock-listed banks only, we rule out heterogeneity from different accounting standards, loan portfolio management techniques and business policies and ensure a high degree of comparability among our sample banks. *Second*, loan selling to external capital market investors is not allowed for the majority of European non-stock-listed banks. *Third*, most European non-stock-listed savings banks use alternative loan risk management tools. In particular, they build internal credit pools on a group-level to diversify loan portfolio risk instead of selling securitized loans on capital markets.

[9]We address the so-called *survivorship bias* by focusing on the identification of the ultimate originator of a credit (risk) securitization transaction. Note however, that due to mergers and acquisitions within the European banking industry, some banks in our sample (1997–2010) no longer existed when the data was collected in January 2008 and March 2011. We address this problem by omitting those securitization transactions from banks, that were announced or issued during the time period between the announcement of an M&A and the final closing of the legal M&A transaction. From this point in time, we identify the acquirer or combined company as the ultimate originator of the securitization transaction.

Since then, a sharp decline has been observed, which is due to the GFC from 2007/08 and the beginning of the ESDC in 2009. Some of the banks in our sample securitize more than once during the sample period.[10] Accordingly, Figures 4 and 5 present the ten most frequently issuing banks in our sample with regard to the number of securitization transactions (TA) and the volume of securitization transactions (Vol).

3.1.3 Control variables

Related empirical studies suggest two major groups of determinants, which may explain changes in a bank's NPL exposure next to securitization (Louzis et al., 2012; Klein, 2013; Messai and Jouini, 2013; Makri et al., 2014; Ghosh, 2015; Dimitrios et al., 2016). *On the one hand*, these studies identify bank-level determinants as indicators to capture the variability of NPL levels. *On the other hand*, several macroeconomic determinants are likely to influence NPL exposures as well (Nkusu, 2011; Škarica, 2014; Beck et al., 2015). We employ these well-accepted determinants of NPLs and additionally control for the impact of the banking regulatory framework.

Bank-specific data is obtained from the *BankScope* database compiled by *FitchRatings* and provided by *Bureau van Dijk*. We lag measures of a bank's capital environment and management efficiency to mitigate possible simultaneity and multicollinearity issues, especially with regard to further bank control variables. Macroeconomic control variables are retrieved from the *World Development Indicator* (WDI) database, *Thomson Reuters Eikon*, the *ECB Statistical Data Warehouse* as well as the *Swiss National Bank* (SNB). Banking regulatory data is collected from Demirgüç-Kunt and Detragiache (2002), Demirgüç-Kunt et al. (2015), national central banks, *World Bank's Banking Regulation Surveys* as well as Barth et al. (2001, 2004, 2008, 2013a).

Bank-specific variables

Among the bank-specific control variables, we initially employ a bank's capital environment as a measure of financial strength and the ability to sustain future losses by means of capital buffers. A bank's level of capitalization is included as the one-year lagged ratio of the accounting value of total equity divided by total assets per year ($Capital_{t-1}$). Related literature provides countervailing predictions concerning the relationship between a bank's capital environment and its NPLR. Following the *moral hazard* hypothesis provided by Keeton and Morris (1987) as well

[10] If a bank issues more than one securitization transaction per year, we aggregate the volumes of individual securitization transactions and calculate the cumulated volume per bank and year.

as Berger and DeYoung (1997), bank managers of undercapitalized banks may have an incentive to pursue excessive loan risk-taking along with an insufficient loan scoring and monitoring of borrowers (Wheelock and Wilson, 2000; Gambacorta and Mistrulli, 2004; Mehran and Thakor, 2011; Demirgüç-Kunt et al., 2013). In addition, the *gambling for resurrection* hypothesis suggests that undercapitalized banks may take on more profitable but more risky loans in order to reestablish financial soundness, especially under the notion of governmental aid (Keeley, 1990; Konishi and Yasuda, 2004). While both former hypotheses suggest higher NPL exposures at undercapitalized banks, it is also argued that even better capitalized banks may exhibit larger amounts of NPLs. Accordingly, if it is true that stronger capitalized (less leveraged) banks face weaker debt covenants, bank managers are less forced to negotiate future investment projects with debt holders. As a consequence, risky (loan) investments with a negative net present value are more likely due to higher shareholder pressure and a weaker disciplining and monitoring by debtholders (Jensen and Meckling, 1976; Calomiris and Kahn, 1991; Rajan and Zingales, 1995; Diamond and Rajan, 2001; Altunbas et al., 2011; Berger and Bouwman, 2013).

Management efficiency is employed as an additional bank-specific control measure. We include the one-period lagged cost-to-income ratio ($Management_{t-1}$). The ratio is built as the accounting value of a bank's total expenses divided by total income per year. It serves as a proxy for the quality of a bank's (risk) management (Louzis et al., 2012; Farruggio and Uhde, 2015). Results from previous empirical studies focusing on the relationship between management efficiency and a bank's NPL exposure are mixed. *On the one hand*, following the *bad management* hypothesis, Berger and DeYoung (1997) empirically show that the efficiency of the risk management and the quality of the loan portfolio may decrease if bank managers exhibit poor skills in loan scoring, estimating collateral-values and controlling and monitoring borrowers. As a consequence, managers with poor skills may stronger allocate loans with low or even negative net present values (Berger and DeYoung, 1997; Williams, 2004). *On the other hand*, following the *skimping* hypothesis it is suggested that the extent of resources, which is necessary to make and monitor loans, may have an impact on both, loan portfolio quality and cost efficiency (Berger and DeYoung, 1997). Hence, if banks reduce their (loan) risk management efforts, they operate more cost-efficiently, i.e. they exhibit lower short-term operating expenses. However, it is also shown that their loan portfolio quality may remain unaffected in the *short run*, whereas the future loan performance may decrease and loan risk may increase due to a declining quality of borrowers' creditworthiness in the *long run* (Berger and DeYoung, 1997).

Next to management efficiency, we include profitability (*Profitability*) as a further bank-specific control measure. This variable is constructed as the accounting value of a bank's return on average assets (ROAA) per year. Following the *bad management* and the *gambling for resurrection* hypothesis, we suggest that more profitable and well-managed banks may exhibit more accurate loan monitoring and loan scoring processes, may assess the value of collaterals more precisely and may be less prone to engage in risky (loan) investments (Berger and DeYoung, 1997; Williams, 2004).

We additionally employ the ratio of the accounting value of a bank's liquid assets to total assets per year as a proxy for a bank's liquidity position (*Liquidity*). Previous related studies reveal an ambiguous relationship between liquidity and NPLs. *On the one hand*, it is argued that a larger amount of liquid assets may allow for a more flexible and immediate rearrangement of the asset side of a bank's balance sheet, which extends the bank's loan investment opportunities. As a consequence, stronger liquidity may provide a better loan portfolio composition if loans are less correlated after having reinvested liquid capital (Demsetz, 2000; Wagner, 2007; Demirgüç-Kunt et al., 2013). *In contrast*, it is also proposed that larger liquidity buffers may encourage banks to increase their (loan) risk exposure by taking on too risky (loan) investments (Cebenoyan and Strahan, 2004; Wagner, 2007).

Finally, we control for a bank's business model (*Business Model*). We construct this variable as the ratio of the accounting value of a bank's non-interest income to interest income per year. Building the measure this way, it indicates to which extent a bank engages in fee-based businesses (investment banking or trading activities) as compared to interest rate based activities (traditional deposit taking and lending business). The relationship between a bank's business model and its NPL exposure is not distinct. *On the one hand*, engaging in fee-based activities - next to traditional banking - generates additional investment and income diversification opportunities (Louzis et al., 2012; Ghosh, 2015). Thus, as banks are less forced to generate profits from the interest-based business only, the incentive to pursue risky lending strategies may be lower. *On the other hand*, following Lepetit et al. (2008), banks with a dominant focus on fee-based activities may be more likely to accept losses from attracting new loan customers if losses can be compensated by the cross-selling potential between traditional and fee-based activities. Accordingly, banks with a higher reliance on fee-based businesses may charge lower lending rates and may underprice loan risk, which in turn should result in a larger NPL exposure (Lepetit et al., 2008).

Macroeconomic variables

Next to bank-specific determinants, we additionally employ measures of the country-specific macroeconomic environment. To begin with, the change of the slope of the yield curve (Δ *Yield Curve*) is included to control for the the impact of economic growth and business cycles on a bank's NPL exposure. As a leading indicator for future prospects of the economy (Estrella and Hardouvelis, 1991; Wheelock et al., 2009; Adrian et al., 2010), we calculate the slope of the yield curve as the annual change of the difference between the ten-year and two-year government bond yields per country and year. Corresponding to previous studies we expect that NPLRs may decrease during a prospering economy (Louzis et al., 2012; Gropp et al., 2014; Ghosh, 2015; Dimitrios et al., 2016).

We further employ the annual change in unemployment rates (Δ *Unemployment*), which is built as the number of unemployed persons divided by the labor force per country and year. We suggest that an increase in unemployment rates may decrease the ability of borrowers to meet their financial debt obligations, which in turn should increase the probability that a loan becomes non-performing (Lawrence, 1995; Salas and Saurina, 2002; Nkusu, 2011; Messai and Jouini, 2013; Makri et al., 2014; Ghosh, 2015; Dimitrios et al., 2016; Ghosh, 2017).

Annual stock market index returns per country and year are included to control for the impact of the development of domestic stock markets on NPLRs (*Stock Market*).[11] In line with related studies, we argue that prospering stock markets may increase financial wealth, may raise the value of shares used as collaterals and may improve the ability of borrowers to service their loan obligations (Nkusu, 2011; Beck et al., 2015).

Finally, we control for the impact of a country's banking market structure on NPLRs. We calculate the Herfindahl-Hirschman index (HHI) per country and year as a structural measure of banking market concentration (*Concentration*). Previous studies reveal countervailing effects of banking market concentration on a bank's NPLR. Advocates of the *concentration-stability* view stress the *franchise value* hypothesis provided by Keeley (1990). In this context it is suggested that monopolistic banks may engage in less risky (loan) investments in order to protect their monopoly rents and higher franchise values, which in turn should reduce NPL exposures (Park and Peristiani, 2007; Jiménez et al., 2013). Furthermore, it is argued that monopolistic banks

[11]The main domestic stock market indices include ATX (Austria), BEL20 (Belgium), CAC 40 (France), DAX 30 (Germany), ATHEX Composite (Greece), ISEQ Overall (Ireland), FTSE MIB (Italy), AEX (Netherlands), PSI 20 (Portugal), IBEX 35 (Spain), OMX Stockholm 30 (Sweden), SMI (Switzerland) and the FTSE 100 (United Kingdom).

may have a better access to borrower-specific information (Marquez, 2002), may be able to identify high-quality (less risky) creditors on their own (Chan et al., 1986; Marquez, 2002), may have advantages in providing loan monitoring services (Uhde and Heimeshoff, 2009) and hence, may exhibit a higher loan portfolio quality as compared to non-monopolistic banks. In contrast, advocates of the *concentration-fragility* view propose that banks in concentrated banking markets may typically charge higher loan interest rates. As a consequence, borrowers have to take on more risky investments in order to compensate the higher loan interest rate payments, which in turn may increase the likelihood of loan defaults (Stiglitz and Weiss, 1981; Boyd and De Nicoló, 2005; Berger et al., 2009; Jiménez et al., 2013).

Regulatory environment

Finally, we control for the banking regulatory environment per country and year. We initially include a capital regulation index (*Capital Regulation*) as suggested by Barth et al. (2013a). Based on different measures of regulatory requirements and capital stringency for domestic banks, the index is computed by using principal component analysis techniques. Higher values indicate stronger regulatory regulations. Since capital regulations are designed to strengthen a bank's capital buffer, financial soundness and stability, stricter capital regulation may encourage bank managers to pursue a more prudential investment behavior, which should have an NPLR-reducing effect (Furlong and Keeley, 1989; Barth et al., 2004; Kopecky and VanHoose, 2006; Uhde and Heimeshoff, 2009; Beltratti and Stulz, 2012). However, since a stricter capital environment increases a bank's regulatory costs of capital and negatively affects a bank's profits, freedom of action and investment opportunities, more stringent capital regulations may also encourage bank managers to engage in more risky (loan) investments in order to compensate future regulatory costs (Koehn and Santomero, 1980; Blum, 1999; Pasiouras et al., 2006, 2009; Laeven and Levine, 2009; Barth et al., 2013b).

Next to the capital regulation index, we additionally include the moral hazard index (*MHI*) per country and year as proposed by Demirgüç-Kunt and Detragiache (2002) and extended by Demirgüç-Kunt et al. (2015). The index is based on different design features of a country's deposit insurance system and is computed by employing principal component analysis techniques. The MHI measures the generosity of a country's deposit insurance regime. Higher values indicate a greater generosity. If banks are forced to financially participate in a deposit insurance system, bank managers may be encouraged to a more prudent (loan) investment

behavior (Gropp and Vesala, 2004; Uhde and Heimeshoff, 2009; Chernykh and Cole, 2011), which may result in smaller amounts of NPLs. In contrast, the existence of a safety net per se and a greater generosity may incentivize banks to moral hazard, i.e. a less prudent but more risky (loan) investment behavior, which may result in a higher NPL exposure. In addition, financially participating in a deposit insurance system may also incentivize bank managers to a more excessive risk-taking behavior in order to compensate the costs of the co-insurance (Demirgüç-Kunt and Detragiache, 2002; Demirgüç-Kunt and Huizinga, 2004; Ioannidou and Penas, 2010; Lambert et al., 2017).

3.2 Empirical model

We employ a linear model on panel data to empirically investigate the relationship between true sale loan securitization and the issuing banks' NPLRs:

$$\begin{aligned} y_{i,t} = \alpha_i &+ \gamma Securitization_{i,t} + \beta_1 Capital_{i,t-1} + \beta_2 Management_{i,t-1} + \beta_3 Profitability_{i,t} \\ &+ \beta_4 Liquidity_{i,t} + \beta_5 BusinessModel_{i,t} + \beta_6 \Delta YieldCurve_{i,t} + \beta_7 \Delta Unemployment_{i,t} \\ &+ \beta_8 StockMarket_{i,t} + \beta_9 Concentration_{i,t} + \beta_{10} CapitalRegulation_{i,t} + \beta_{11} MHI_{i,t} + \epsilon_{i,t}, \end{aligned} \quad (1)$$

where $y_{i,t}$ denotes the non-performing loan ratio ($NPLR$) of a securitizing bank i in a respective year t. $Securitization_{i,t}$ is the ratio of a bank's cumulated true sale loan securitization volume per year divided by total assets. The additional input parameters include bank-specific, country-specific macroeconomic and regulatory control variables as described in Section 3.1.3. $\epsilon_{i,t}$ represents an independently and identically distributed error term. α_i, γ and the βs are the regression coefficients to be estimated.

We employ a bank-specific fixed effects model and include time dummies to capture time-specific effects, such as institutional and regulatory changes or common shocks to the European banking market. Since the Hausman test (Hausman, 1978) is biased under heteroscedasticity, we implement a test of overidentifying restrictions as proposed by Arellano (1993) to verify that a fixed effects model is appropriate. The Arellano test clearly rejects the null hypothesis that the individual specific effect is uncorrelated with the independent variables at $\rho < 0.000$. Hence, employing a fixed effects model is adequate. In addition, a joint F-test rejects the null hypothesis that time dummies for all years are equal to zero at $\rho < 0.000$ suggesting the appropriateness of controlling for time fixed effects in our model.

Moreover, since some of our sample banks continuously securitize loans over the entire sample period while others do not, we cluster standard errors at the bank-level to control for heterogeneous securitization frequencies in our sample. Following Greene (2003), we utilize a modified Wald statistic for groupwise heteroskedasticity in the residuals while allowing for unbalanced panels in order to verify whether the use of clustered-robust standard errors enhances our model fit. The Wald test statistic rejects the null-hypothesis of homoscedasticity at $\rho < 0.000$ indicating that clustering at the bank-level is appropriate to address a possible downward bias and misspecification in the estimated standard errors.[12]

Finally, we control for multicollinearity concerns among our independent variables by computing two collinearity diagnostic measures. Both instruments, the mean variance inflation factor (VIF) of all right-hand side variables from our baseline regression (2.80) as well as the value of the conditional number (7.82) indicate that our results are not biased by multicollinearity issues.

4 Empirical Results

Table 6 presents the results from our baseline regressions. Results from sensitivity analyses are reported in Tables 7a - 7c.

4.1 Baseline regressions

In a first step, we investigate the relationship between true sale loan securitization and the issuing banks' NPLRs by employing a fixed effects model on panel data as described in Section 3.2. Subsequently, we estimate a dynamic panel model in order to control if endogeneity issues and a likely persistence in the time series of our NPL data may bias the results from our baseline model. Finally, it is analyzed if the impact of securitization on the issuing banks' NPLRs changes during different time periods, especially during non-crisis and crisis periods in Europe.

[12] Petersen (2009) shows that too few clusters may bias the results even when having clustered in the right dimension. In this case, the author proposes to address the time-dependence parametrically and cluster at the bank-level. Nevertheless, we implement double-clustered standard errors with 57 bank and only 13 time clusters in order to verify whether the clustered-robust standard errors are specified correctly. Since the results remain robust, we do not present the results in this paper but provide them on request.

4.1.1 Linear fixed effects panel model

As reported in Table 6, the securitization measure (*Securitization*) enters regression specification (1) significantly negative at the one-percent level indicating that European banks allocate NPLs – rather than loans of higher quality – to ABS investors through true sale loan securitizations. Our general finding corresponds to previous related studies for the Italian and the U.S. banking market (Downing et al., 2009; Affinito and Tagliaferri, 2010; Casu et al., 2011), which provide evidence that even bad loans and high-risk assets are allocated to ABS investors. Moreover, our result supports predictions from the agency theory suggesting that securitizing banks may exploit their information advantage concerning the underlying loan default risk of a securitization tranche. Accordingly, we do not find that information asymmetries may incentivize issuing banks to retain the most risky loans as a quality and reputation signal or to demonstrate 'skin in the game' towards less informed ABS investors (Greenbaum and Thakor, 1987; DeMarzo and Duffie, 1999; Cantor and Rouyer, 2000; DeMarzo, 2004; Instefjord, 2005; Jiangli et al., 2007; Malamud et al., 2010; Franke et al., 2012; Hartman-Glaser et al., 2012; Albertazzi et al., 2015).

Turning to the bank-specific control variables, Table 6 initially reports that $Capital_{t-1}$ enters the regression significantly positive at the ten-percent level. The positive impact corresponds to previous empirical findings for the U.S. banking sector (Ghosh, 2015, 2017) suggesting that better capitalized banks may exhibit weaker debt covenants and hence, may face a less disciplining effect and weaker monitoring through debt holders. As a consequence, and along with stronger shareholder pressure, managers from better capitalized banks may be less forced to negotiate future investment projects with debt holders and thus, may pursue a more risky (loan) investment strategy that increases their NPL exposures (Jensen and Meckling, 1976; Calomiris and Kahn, 1991; Rajan and Zingales, 1995; Diamond and Rajan, 2001; Altunbas et al., 2011; Berger and Bouwman, 2013).

As further shown, the coefficient of *Profitability* turns out to be significantly negative at the one-percent level. Our result is in line with empirical findings provided by Louzis et al. (2012), Klein (2013), Messai and Jouini (2013), Ghosh (2015, 2017) as well as Dimitrios et al. (2016). It is argued that more profitable and well-managed banks may be less prone to engage in risky (loan) investments. In addition, following the *bad management* and the *gambling for resurrection* hypothesis, more profitable banks may have more effective loan monitoring and loan scoring processes. Furthermore, their managers may have greater skills to assess the value

of collaterals more precisely, which in sum increases the loan portfolio quality (Berger and DeYoung, 1997; Williams, 2004).

Finally, *Liquidity* enters the regression significantly negative at the one-percent level indicating that an increase in liquidity reduces the NPLR. This finding confirms theoretical predictions that more liquid banks can rearrange their loan portfolios more flexibly and immediately, which should result in a less risky loan portfolio composition (Wagner, 2007; Demirgüç-Kunt et al., 2013).

Turning from bank-specific to macroeconomic control variables, it is initially shown that the change of the slope of the yield curve (Δ *Yield Curve*) has a significantly negative impact on the issuing banks' NPLRs. As expected, the negative coefficient reveals that NPL exposures from our sample of banks may decrease during a prospering economy in Europe. Our finding supports previous empirical evidence provided by Salas and Saurina (2002), Nkusu (2011) Louzis et al. (2012), Klein (2013), Messai and Jouini (2013), Makri et al. (2014), Ghosh (2015, 2017), Beck et al. (2015) as well as Dimitrios et al. (2016).

Introducing the change in Δ *Unemployment*, this variable enters the regression significantly positive at the one-percent level. This result points to the fact that unemployment may decrease the ability of borrowers to meet their financial debt obligations, which in turn should increase the probability that a loan becomes non-performing (Nkusu, 2011; Louzis et al., 2012; Klein, 2013; Messai and Jouini, 2013; Makri et al., 2014; Ghosh, 2015, 2017; Dimitrios et al., 2016).

As further shown, *Stock Market* has a significantly negative impact on the banks' NPLRs, which is also found by Nkusu (2011) and Beck et al. (2015). The negative impact may be explained by the fact that prospering stock markets increase financial wealth, raise the value of shares used as loan collaterals and thus, improve the ability of borrowers to service their loans (Nkusu, 2011; Beck et al., 2015).

Referring to the impact of the banking market structure, it is shown that *Concentration* enters the regression significantly negative at the five-percent level. Our finding supports the *concentration-stability* view proposing that monopolistic banks, which operate in more concentrated markets, may engage in less risky (loan) investments in order to protect their monopoly rents and higher franchise values (Keeley, 1990; Park and Peristiani, 2007; Jiménez et al., 2013). Furthermore, monopolistic banks may have better access to borrower-specific information (Marquez, 2002), advantages in providing loan monitoring services (Uhde and

Heimeshoff, 2009) and a more efficient borrower selection process of high-quality borrowers resulting in a better loan portfolio quality (Chan et al., 1986; Marquez, 2002).

Next to bank-specific and macroeconomic determinants, we finally control for the banking regulatory environment. Introducing the capital regulatory index (*Capital Regulation*), this variable enters the regression significantly negative at the five-percent level. Our result is in line with related studies (Furlong and Keeley, 1989; Barth et al., 2004; Kopecky and VanHoose, 2006; Uhde and Heimeshoff, 2009; Beltratti and Stulz, 2012), arguing that stricter capital regulations may encourage bank managers to pursue a more prudential (loan) investment strategy, which in turn should reduce NPL exposures.

Finally, the coefficient of the moral hazard index (*MHI*) turns out to be significantly positive. This finding reveals that a greater generosity of a country's deposit insurance system may incentivize European banks to moral hazard in lending, i.e. banks may follow a less prudent but more risky (loan) investment behavior, which may increase their NPL exposures (Demirgüç-Kunt and Detragiache, 2002; Demirgüç-Kunt and Huizinga, 2004; Ioannidou and Penas, 2010; Lambert et al., 2017).

4.1.2 Dynamic panel model

In a next step, we control for the robustness of the results from the linear fixed effects panel model. In particular, it is investigated if our findings are biased due to a likely persistence in the time series of our NPL data or due to a probable endogeneity between the NPL measure, the loan securitization measure and the bank-specific control variables. Accordingly, we implement a one-step system Generalized Methods of Moments (system-GMM) estimator as provided by Arellano and Bond (1991) and generalized by Arellano and Bover (1995) as well as Blundell and Bond (1998)[13].

[13]Since the initial GMM-method of Arellano and Bond (1991) produces inefficient estimations for samples with a small time dimension (T) and high persistence in the data (Louzis et al., 2012; Klein, 2013; Ghosh, 2015), we employ the extension provided by Arellano and Bover (1995) as well as Blundell and Bond (1998). The system-GMM estimation involves the simultaneous estimation of two equations (differenced and level) and lagged levels used as instruments. As a result, the system-GMM estimation decreases potential estimation errors in finite samples and any asymptotic inaccuracies through the difference estimator (Ghosh, 2015).

We estimate this model with robust standard errors clustered at the bank-level and include time dummies:

$$
\begin{aligned}
y_{i,t} = \alpha &+ \delta y_{i,t-1} + \gamma Securitization_{i,t} + \beta_1 Capital_{i,t-1} + \beta_2 Management_{i,t-1} \\
&+ \beta_3 Profitability_{i,t} + \beta_4 Liquidity_{i,t} + \beta_5 BusinessModel_{i,t} + \beta_6 \Delta YieldCurve_{i,t} \\
&+ \beta_7 \Delta Unemployment_{i,t} + \beta_8 StockMarket_{i,t} + \beta_9 Concentration_{i,t} \\
&+ \beta_{10} CapitalRegulation_{i,t} + \beta_{11} MHI_{i,t} + \epsilon_{i,t},
\end{aligned} \tag{2}
$$

where $y_{i,t}$ is the non-performing loan ratio ($NPLR$) of bank i in a respective year t. $y_{i,t-1}$ denotes the one-year lagged dependent variable. $Securitization_{i,t}$ represents the ratio of a bank's cumulated securitization volume per year divided by total assets. The additional input parameters include bank-specific, country-specific macroeconomic and regulatory control variables as described in Section 3.1.3. The independently and identically distributed error term is represented by $\epsilon_{i,t}$. α, δ, γ and the βs denote the parameters to be estimated.

We instrument the country-specific macroeconomic and regulatory determinants in IV-style (instrumented by themselves) and consider them as *strictly exogenous* regressors (Louzis et al., 2012; Klein, 2013). In contrast, the assumption of *strict exogeneity* is too restrictive and probably violated (if NPLs reversely cause feedback effects) with regard to the securitization measure and the bank-specific control variables. In particular, strict exogeneity is violated by severe feedback effects if it is assumed that banks exhibiting higher NPLRs may have a stronger incentive to securitize loans. As a consequence, the causality may run bidirectional and both variables might be correlated with the error term, which may bias the regression results (Beck et al., 2015; Ghosh, 2015). Against this background, we allow for feedback effects from NPLs to banks' securitization activities by considering *Securitization* as a *strictly endogenous* explanatory variable. Accordingly, we instrument the securitization measure with GMM-conditions by using second lag orders and longer for the transformed equation, and first order lag conditions for the levels equation to control for endogeneity concerns (Roodman, 2009). In addition, following Louzis et al. (2012), bank-specific balance sheet variables can be considered as forward-looking, decision-making instruments of a bank's management. Thus, the management of balance sheet items could be affected by the expected future level of NPLs, whereas future random shocks to NPLs may not be taken into account due to their unpredictability. Against this background, the bank-specific variables are expected to be correlated with past and contemporaneous errors but

not with future realizations of the error term suggesting partial endogeneity (weak exogeneity) of the bank-specific variables (Louzis et al., 2012). Accordingly, we define the bank-specific determinants (including the lagged dependent variable) as *weakly exogenous* or *predetermined* explanatory variables and instrument them with GMM-conditions by using their lagged values as instruments.[14] Moreover, in order to control for instrument proliferation, we restrict the instrument count by collapsing the instrument set (Roodman, 2009).[15]

Employing the one-step system-GMM estimator produces results as reported in Table 6, regression specification (2). The one-year lagged NPLR measure ($NPLR_{t-1}$) exhibits a high coefficient value of 0.9174 which points to a time persistence in our series of NPL data. However, as subsequently shown, the coefficient of the securitization measure is still significant while its value has only marginally decreased as compared to our baseline findings from the linear model in regression (1). Accordingly, and since results for the control variables are qualitatively reiterated even when employing a dynamic estimator, we rule out that our baseline results from the linear fixed effects model are severely biased by time persistence in our NPL data or (partial) endogeneity between the NPL measure, the loan securitization measure and the bank-specific control variables.

4.1.3 Risk allocation through securitization during crisis and non-crisis periods

Finally, we control for the robustness of our baseline results and analyze if the NPLR-decreasing effect varies during different time periods of securitization activities in Europe. Following Farruggio and Uhde (2015) as well as Uhde et al. (2012) and referring to Figure 2, we define (i) the beginning of European securitization activities as the *onset stage* (1997-2001), (ii) the boom phase of securitization transactions as the *boom stage* (2002-2007) and (iii) the degeneration and drying up phase of the securitization market due to the GFC and ESDC as the *crises stage* (2008-2010). Subsequently, we build three time dummy variables ($Dummy_{onset}$, $Dummy_{boom}$ and $Dummy_{crises}$), which take on the value of one for the years of

[14] We introduce Arellano-Bond tests for first (AR(1)) and second (AR(2)) order autocorrelation of the residuals in order to control for the consistency of our dynamic panel estimation using GMM. The moment conditions in our framework are valid if there is no serial correlation in the idiosyncratic errors. The Arellano-Bond tests assume that rejecting the null hypothesis of no first order serial correlation does not imply a model misspecification, whereas a rejection of the null hypothesis at higher orders of serial correlations indicates an invalidity of the moment conditions (Beck et al., 2015; Ghosh, 2015, 2017). As shown in Table 6, our dynamic panel framework satisfies the requirements concerning the AR(1) and AR(2) tests suggesting that our dynamic panel regression results are consistent.

[15] As a result, the number of instruments (40) used in the dynamic panel estimation is kept far below the number of groups (57) and hence, satisfies the rule of thumb. Moreover, the Hansen test of overidentifying restrictions meets the preferable p-value range (between 0.1 and 0.25) as proposed by Roodman (2009) and thus, suggests that the instruments are appropriate.

the respective stage, and zero otherwise. Finally, interaction variables from multiplying the securitization measure with each time dummy variable are built. The results from employing interaction variables are reported in regression specifications (3) - (5) in Table 6.

As initially shown, we do not find any statistical relationship between the interaction variable and the issuing banks' NPLRs during the *onset stage* of securitization activities in Europe. Turning to the *boom stage*, Table 6 reports that our overall baseline finding of a negative impact of securitization on the issuing banks' NPLRs is reiterated. However, it is also shown that the NPLR-decreasing impact of securitization has almost doubled during this stage as compared to the entire sample period. Accordingly, our finding indicates that European banks were less incentivized or forced to show '*skin in the game*' and employ risk-retention as a quality and reputation signal towards less informed ABS investors during the boom stage of securitizations. In contrast, the transfer of NPLs to capital market investors by means of true sale loan securitizations during the boom phase might be triggered by the fact that banks were able to sell even more risky securitization tranches since many (institutional) investors asked for high-risk and high-return securities to improve profitability, especially shortly before the GFC (Bank for International Settlements, 2011).

As regards the *crises stage*, we provide evidence for an NPLR-increasing impact of securitization. The significantly positive coefficient of the dummy variable underlines that NPLRs have increased per se during the crises period which is due to relaxed loan and borrowing standards, weaker monitoring incentives and an expanded loan quantity in the European banking market (Keys et al., 2010; Purnanandam, 2010; Hakenes and Schnabel, 2010; Dell'Ariccia et al., 2012; Nadauld and Weisbach, 2012). Furthermore, the significantly positive impact of the interaction variable points out that securitization has remarkably triggered the growth of the banks' NPLRs. An increase in the NPLRs is due to the fact that less NPLs but rather loans of higher quality were securitized during the crises period. Banks were forced to provide credit enhancement and sell tranches of higher quality since investors lost confidence towards issuing banks and rating agencies. Information asymmetries rose due to an increased complexity of securitization transactions, failures in valuating securitization tranches by rating agencies and an insufficient and ineffective supervision and regulation of credit (risk) securitization during the crises period in Europe (Basel Committee on Banking Supervision, 2008; Caprio et al., 2008; International Monetary Fund, 2008, 2009; Acharya et al., 2009; Acharya and Richardson, 2009;

Benmelech and Dlugosz, 2010; di Patti and Sette, 2016; European Union, 2017b; Association for Financial Markets in Europe, 2018a).

Overall, the time period analysis at hand demonstrates that the impact of securitization on the issuing banks' NPL exposures is sensitive to the choice of the sample period (crisis vs. non-crisis periods). Taking this into account, our analysis helps to explain why previous related studies provide ambiguous results. Hence, studies providing evidence that banks securitize more risky loans and retain loans with a lower default probability (ex ante), only employ pre-crises data on securitization transactions (Downing et al., 2009; Affinito and Tagliaferri, 2010; Piskorski et al., 2010; An et al., 2011; Casu et al., 2011; Benmelech et al., 2012; Jiang et al., 2014; Krainer and Laderman, 2014). In contrast, Jiang et al. (2014) and Kara et al. (2019) partly employ data which is based on the GFC period and find that securitized loans are less likely to default (ex post).

4.2 Sensitivity analyses

In this section, we analyze the relationship between true sale loan securitization and the issuing banks' NPLRs in greater detail by controlling for (i) the degree of standardization (opaque and non-opaque transactions), (ii) the respective underlyings of a securitization transaction, (iii) the issuing frequency of securitization transactions, (iv) different levels of NPLRs on the issuing banks' balance sheets, (v) the systemic importance of issuing banks (G-SIBs and non-G-SIBs), (vi) differences in the issuing banks' ratings as well as (vii) banks operating in crisis and non-crisis countries (PIIGS and non-PIIGS). Results from this large variety of sensitivity analyses are reported by Tables 7a - 7c.[16]

Opaque vs. non-opaque transactions

To begin with, we control for the degree of standardization in securitization by differentiating between opaque (*Opaque*) and non-opaque (*Non-Opaque*) transactions. Opaque transactions are issued on complex loan arrangements including securitizations of collateralized debt obligations (CDOs) and other less transparent unspecified underlyings (Others). In contrast, non-opaque transactions are characterized by higher levels of standardization, transparency, collateralization and granularity. This group of transactions comprises securitizations of residential mortgage-backed securities (RMBSs), commercial mortgage-backed securities (CMBSs), credit card

[16]Since results from control variables are qualitatively reiterated even when performing different sensitivity analyses, we do not comment them in the following.

receivables (CCs) and consumer loans (CLs). As reported by regression specifications (1) and (2) in Table 7a, we provide evidence that both, opaque and non-opaque securitization transactions may reduce the issuing banks' NPLRs. However, as also shown, the NPLR-reducing effect is nearly four times stronger in case of opaque transactions. We suggest that – among all other underlyings – especially CDO and other unspecified tranches may provide an opportunity for banks to transfer high-risk NPLs out of their balance sheets. This is due to the fact that opaque tranches are more complex and less transparent and thus, provoke stronger information asymmetries between issuers and investors (Vermilyea et al., 2008; Hartman-Glaser et al., 2012). Accordingly, lessons learned from the GFC show that investors, rating agencies and regulators underestimated risks from opaque tranches in many cases (European Union, 2015).

Underlyings

In a next step, we perform a more granular analysis by focusing on the single underlyings of securitization transactions in our sample. As reported by Table 7a, securitizations of CDOs, RMBSs, CLs and other unspecified loans enter respective regressions significantly negative. Our findings correspond to previous studies for the U.S. banking market. These studies provide evidence of a negative impact of securitized RMBSs and CLs on the issuing bank's (credit) risk exposure (Uzun and Webb, 2007; Jiangli and Pritsker, 2008; Casu et al., 2011). Referring to our sample of true sale securitization transactions, we suggest that different types of loans and their risk characteristics provide different opportunities to securitize NPLs. Against this background, especially asset-backed CDOs and other unspecified assets, RMBSs as well as CLs are characterized by (i) high levels of non-transparency and strong information asymmetry (Duffie, 2008; Maddaloni and Peydró, 2011; Piskorski et al., 2015), (ii) biased assessments of loan-collaterals and biased credit ratings (Griffin and Tang, 2012; Maddaloni and Peydró, 2011; Piskorski et al., 2015) as well as (iii) low-quality borrowers and high default rates (Newman et al., 2008; Keys et al., 2010; Purnanandam, 2010; Hakenes and Schnabel, 2010; Maddaloni and Peydró, 2011; Dell'Ariccia et al., 2012; Nadauld and Weisbach, 2012; Piskorski et al., 2015) during the crises sample period. Thus, these shortcomings may have incentivized issuing banks to exploit their information advantage towards ABS investors.

Issuing frequency

We proceed and control for frequently issuing banks from our sample. Accordingly, we split the entire sample into *frequent-securitizers* (FS, the ten most frequently issuing banks) and *non-frequent securitizers* (Non-FS) with regard to the transaction volume (Vol) and the number of transactions (TA) respectively (Figures 4 and 5). As shown by Table 7b, regression specifications (1) - (4), we find a significant reduction of NPLRs through securitization for non-frequently issuing banks only. In contrast, we do not provide any evidence for the *asset deterioration* hypothesis proposing that in particular high-frequently issuing banks tend to retain larger parts of the more risky FLP (such as NPLs) (Greenbaum and Thakor, 1987; Instefjord, 2005).

Different levels of NPLRs

In a next sensitivity analysis, we control if our baseline finding depends on the amount of NPL exposures on the issuing banks' balance sheets. Accordingly, we split the entire dataset into a sample that includes banks with the highest average NPLRs (20 banks) and a sample which comprises banks that exhibit significantly lower NPLRs (37 banks).[17] As reported by regressions (5) and (6) in Table 7b, we provide evidence that the negative impact of securitization on NPLRs is nearly five times larger for those banks which exhibit the highest average NPLRs. As expected, our finding points to the fact that higher levels of NPLRs may stronger incentivize banks to transfer NPLs by means of securitizations in order to enhance financial soundness through loan risk diversification (Jiangli and Pritsker, 2008; Affinito and Tagliaferri, 2010; Casu et al., 2011).

G-SIBs vs. non-G-SIBs

We further investigate if classifying a bank as systemically important may change our baseline finding. Therefore, we split the entire sample into global systemically important banks (G-SIBs)[18] and non-G-SIBs. As shown by regression specifications (1) and (2) in Table 7c, we find a significant reduction of NPLRs through securitization for non-G-SIBs only. Taking into account that non-G-SIBs may less rely on governmental aid under the 'too-big-to-fail doctrine'

[17] Note that the NPLR-sample mean is at 0.0254 for those banks with the highest average of NPLRs, whereas it is at 0.0108 for the remaining banks.

[18] According to the classification of the Financial Stability Board (FSB) the following banks are identified as global systemically important banks: Dexia SA, BNP Paribas, Société Générale SA, Commerzbank AG, Deutsche Bank AG, UniCredit SpA, ING Groep NV, Banco Santander SA, Nordea Bank AB, Credit Suisse Group AG, UBS AG, Barclays Plc, HSBC Holdings Plc, Lloyds TSB Group Plc (Lloyds Banking Group Plc), Royal Bank of Scotland Group Plc. The G-SIB status does not only depend on the size of the bank but rather on the following five main criteria: cross-jurisdictional activity, complexity, interconnectedness, substitutability, and size.

(Stern and Feldman, 2004), have fewer channels to transfer and diversify loan risks and face a lower reputational risk, this group of banks may stronger be forced to reduce problem loans and prevent financial stability by means of true sale securitizations as compared to systemically important institutions.

Issuer ratings

In a next step, we control if an issuing bank's financial rating may influence the transfer of NPLs through true sale loan securitizations. We employ issuer ratings from the three major rating agencies *Standard & Poor's*, *Moody's* and *Fitch*.[19] Following Jorion et al. (2005), we transform the alphabetical codes of the different credit ratings into an ordinal scale, starting with 1 as AAA and ending up with 23 as the default category. Hence, a lower value indicates a better rating status. Subsequently, we split our entire sample into a subsample of banks with an average rating score below ($Rating_{below}$) and a subsample of banks with an average rating score above ($Rating_{above}$) the sample mean rating during the period from 1997 to 2010.[20] As shown by regression specifications (3) and (4) in Table 7c, we find a significantly negative impact of securitization on NPLRs for banks exhibiting a worse issuer rating. In contrast, we do not find a statistical effect for the group of better-rated banks. Our results suggest that banks with a worse rating may have a stronger incentive to employ securitization to reduce their loan risk exposure and hence, earn a rating upgrade in the long run (Jiangli and Pritsker, 2008; Casu et al., 2011).

PIIGS vs. non-PIIGS countries

Finally, we investigate if the NPLR-reducing effect through securitization differs between banks from PIGGS (Portugal, Italy, Ireland, Greece and Spain) and non-PIIGS countries. Regression results from respective subsamples (Table 7c, regressions (5) and (6)) reveal that our baseline findings are reiterated for both subsamples. Accordingly, we provide evidence that the NPLR-reducing effect from securitization is also observed for issuing banks operating in those European countries which suffered most from the ESDC.

[19]Note that our sample of 57 securitizing banks is reduced by one bank (Northern Rock) due to missing issuer-rating data. The rating data is retrieved from *Thomson Reuters Eikon*.

[20]Note that the subsample of banks with an average rating score below the sample mean rating during the period from 1997 to 2010 is rated with an 'A rating' (Min: AA, Max: BB+) on average, whereas the rating of the better-rated subsample is equivalent to an 'AA- rating' (Min: AAA, Max: A-) on average.

5 Summary and implications

Employing a unique and hand-collected sample of 648 true sale loan securitization transactions issued by 57 stock-listed banks across the EU-12 plus Switzerland over the period from 1997 to 2010, this paper empirically analyzes the relationship between true sale loan securitization and the issuing banks' non-performing loans to total assets ratios (NPLRs). We provide evidence for an NPLR-reducing effect during the boom phase of securitizations in Europe. Our result suggests that banks in our sample may (partly) securitized NPLs as the most risky junior tranche and did not (fully) retain NPLs as a quality signal towards less informed investors in imperfect capital markets. However, the analysis also reveals a positive impact of securitization on NPLRs during the GFC and ESDC period. This finding indicates that issuing banks provided credit enhancement during the crises period. They allocated loan tranches of higher quality to capital market investors, whereas a larger amount of NPLs was retained to send a reputation and quality signal towards investors and to demonstrate 'skin in the game'. Finally, results from a variety of sensitivity analysis reveal that the NPLR-reducing effect is stronger for opaque securitization transactions, for issuing banks exhibiting higher average levels of NPLRs and for banks operating from non-PIIGS countries. In addition, a reduction of NPLRs through securitization is observed for issued collateralized debt obligations, residential mortgage-backed securities, consumer and other unspecified loans as well as for non-frequently issuing, systemically less important and worse-rated banks.

The analysis at hand provides important policy implications as it contributes to the recent and vital debate on how to stipulate European banks to cut their large NPL-exposures. Accordingly, baseline results from our analysis generally support proposals from European authorities and institutions to employ true sale securitization as an instrument to reduce NPL-exposures and distribute loan risk more widely within the European financial system (European Banking Authority, 2014; European Central Bank, 2017; European Union, 2017b; European Commission, 2018). However, securitization has limitations. *First*, as our analysis reveals, the NPLR-reducing effect of securitization seems to be less effective during financial crisis periods when information asymmetries increase and trust in banks and rating agencies decreases. Under such circumstances, issuing banks may be incentivized (or forced) to retain NPLs on their balance sheets. *Second*, we do not find any empirical evidence for an NPLR-reducing effect through securitization at high-frequently issuing, systemically important and high-rated European banks.

Third, the European securitization market has still not fully recovered from its drying up due to the GFC and ESDC. Accordingly, if securitization is believed to stronger allocate NPLs to capital market investors, a revitalization of the European securitization market is urgently needed, however, under much sounder conditions. In this context, we suggest that policy and regulatory initiatives, which propose to open the market especially for simple, transparent and standardized (STS) securitizations, are a step in the right direction since they help to mitigate information asymmetries and restore trust (Basel Committee on Banking Supervision, 2014; European Banking Authority, 2014; Basel Committee on Banking Supervision and Board of the International Organization of Securities Commissions, 2015; European Parliament, 2016; European Union, 2017a,b).

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Appendix

Figure 1: Development of the aggregated non-performing loan ratios (NPLs to total assets) from sample banks

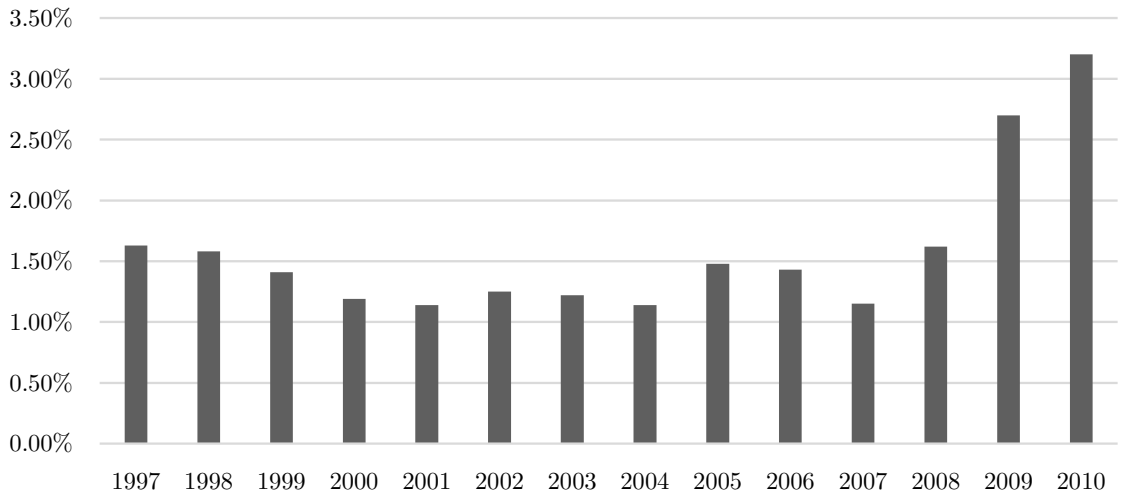

Figure 2: Development of the aggregated volumes (in billion €) and the aggregated numbers of true sale securitization transactions from sample banks

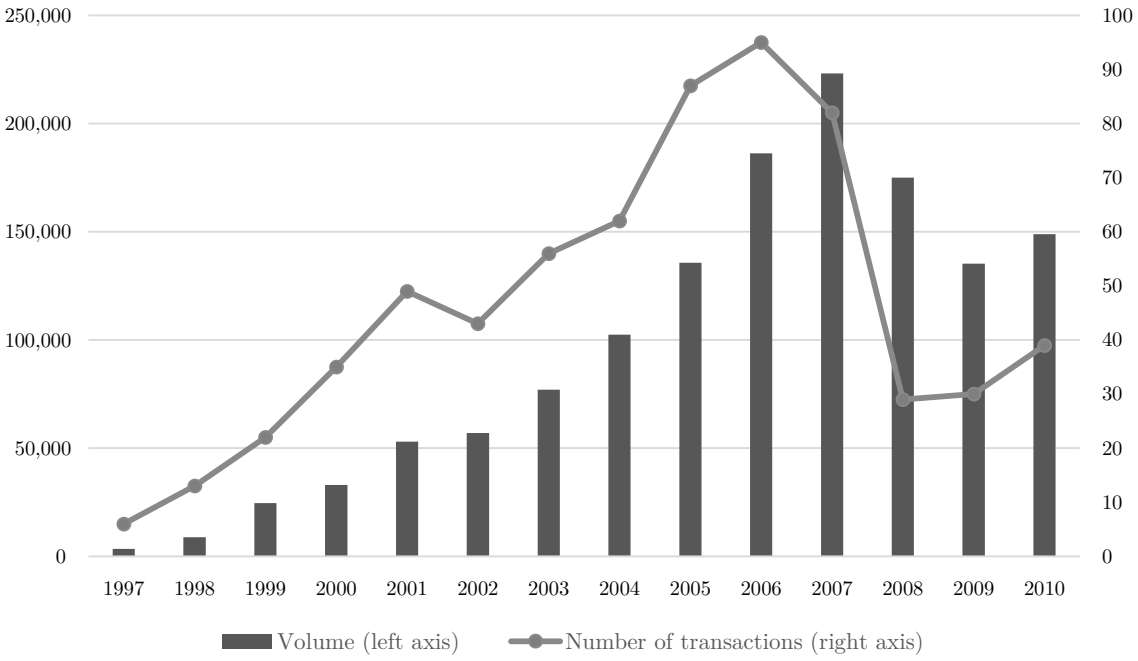

Figure 3: Percentage of sample banks that engaged in the true sale securitization business per year

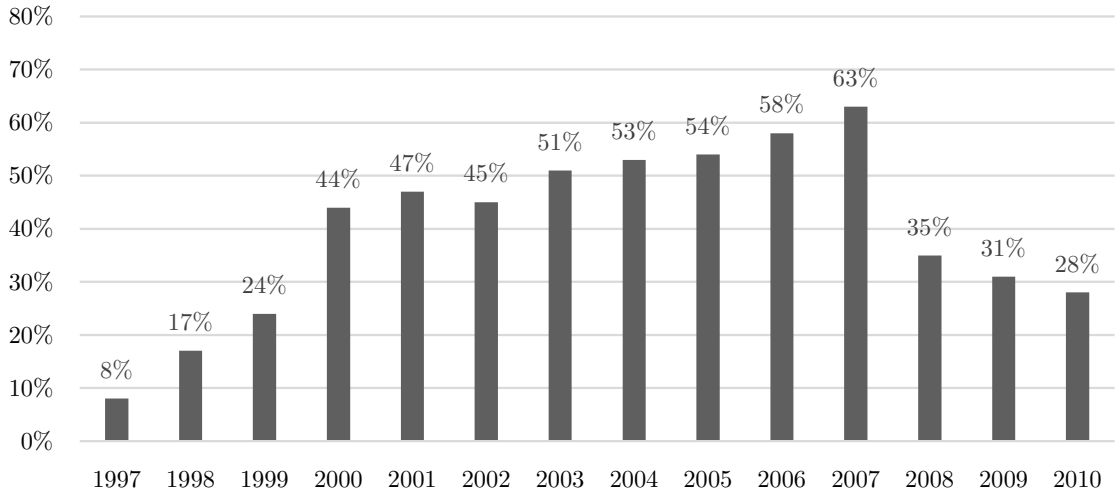

Figure 4: Frequent securitizers by the volume of true sale securitization transactions

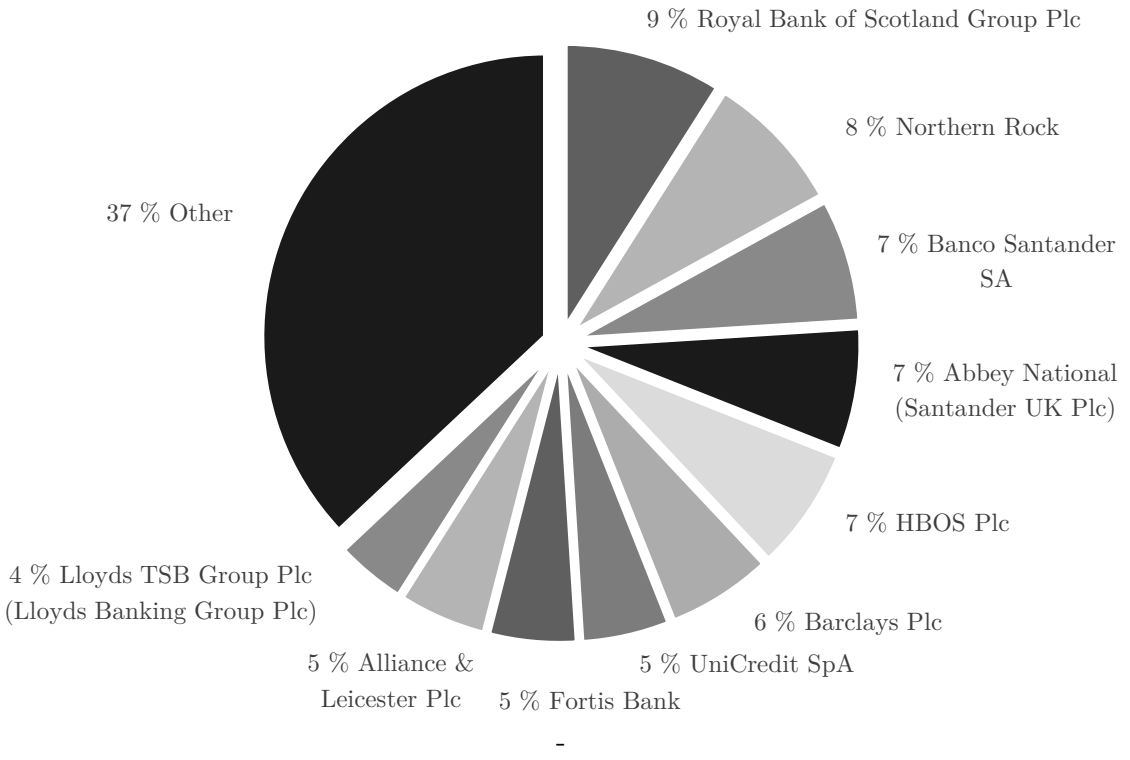

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Figure 5: Frequent securitizers by the number of true sale securitization transactions

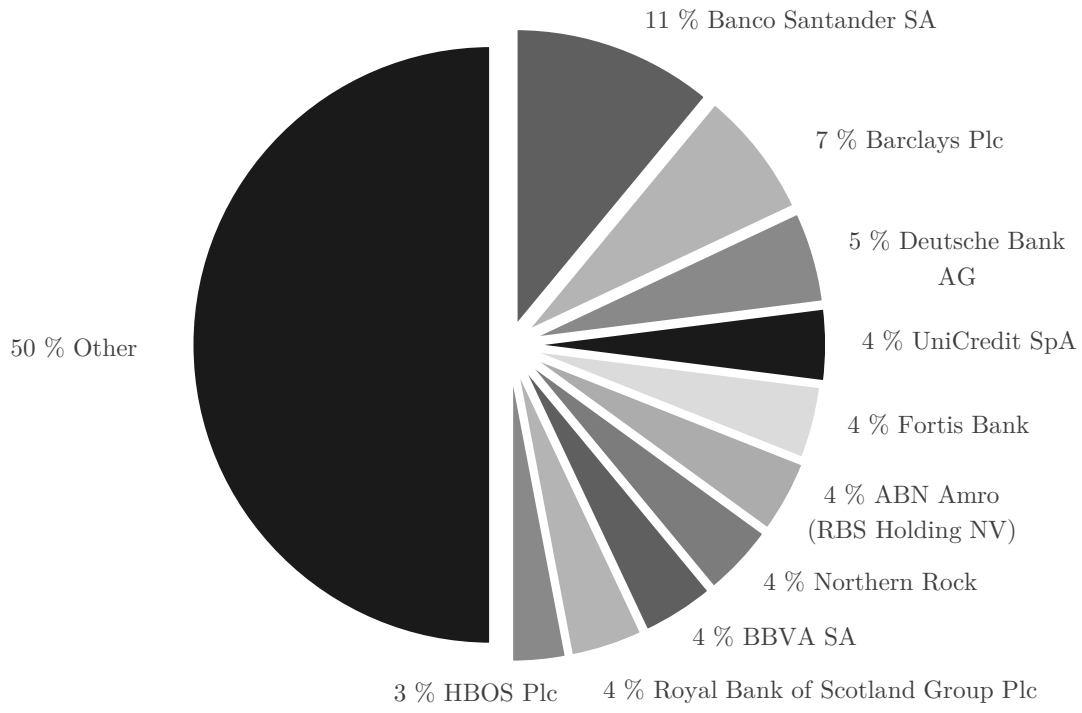

Table 1: Geographical distribution of true sale securitizing banks in the sample

Country	**Bank**	
Austria	Erste Group Bank AG	
Belgium	Dexia SA	KBC Groupe NV
France	BNP Paribas	Natixis SA
	Société Générale SA	
Germany	Bayerische Hypo- und Vereinsbank (UniCredit Bank AG)	Commerzbank AG
	Deutsche Bank AG	Deutsche Postbank AG
	Dresdner Bank AG	Hypo Real Estate Holding AG
Greece	EFG Eurobank Ergasias	Piraeus Bank SA
Ireland	Allied Irish Banks Plc	Bank of Ireland
Italy	Banca Antonvenata	Banca Carige SpA
	Banca Lombarda e Piemontese	Banca Monte Dei Paschi di Siena SpA
	Banca Nazionale del Lavoro SpA	Banca Popolare di Milano SCaRL
	Banca Popolare Italiana/di Lodi	Capitalia Group/Banca di Roma
	Intesa Sanpaolo	Mediobanca SpA
	Sanpaolo IMI	UniCredit SpA
Netherlands	ABN Amro (RBS Holding NV)	Fortis Bank
	ING Groep NV	
Portugal	Banco BPI SA	Banco Espirito Santo SA
	Banco Comercial Português, SA	
Spain	Banco Bilbao Vizcaya Argentaria (BBVA) SA	Banco de Sabadell SA
	Banco de Valencia SA	Banco Espanol de Crédito SA
	Banco Pastor SA	Banco Popular Espanol SA
	Banco Santander SA	Bankinter SA
	Caja de Ahorros del Mediterraneo	
Sweden	Nordea Bank AB	Skandinaviska Enskilda Banken AB
Switzerland	Credit Suisse Group AG	UBS AG
United Kingdom	Abbey National (Santander UK Plc)	Alliance & Leicester Plc
	Barclays Plc	Bradford & Bingley Plc
	HBOS Plc	HSBC Holdings Plc
	Lloyds TSB Group Plc (Lloyds Banking Group Plc)	Northern Rock
	Royal Bank of Scotland Group Plc	Standard Chartered Plc

Table 2: Descriptive statistics of true sale securitization transactions (in billion €)

	Obs	Total Volume	Mean	Std.Dev.	Min	Max
Underlying asset pool						
Collateralized Debt Obligations	86	132.1603	1.5367	1.9514	0.1960	13.9535
Residential Mortgage-Backed Securities	345	1,026.9072	2.9765	3.4548	0.0680	27.4886
Commercial Mortgage-Backed Securities	74	68.6694	0.9280	1.0022	0.1990	7.0920
Credit Card Receivables	24	28.8900	1.2037	1.9085	0.0560	9.9359
Consumer Loans	57	46.2161	0.8108	0.8006	0.0250	5.2751
Others	62	60.8015	0.9807	0.7488	0.0280	3.1000
Total true sale transactions	648	1,363.6445	2.1044	2.8465	0.0250	27.4886

Note that the total volumes are cumulated over the entire sample of 57 banks and the entire sample length of 14 years, whereas the mean, standard deviation, minimum and maximum refer to single securitization transactions.

Table 3: Notes on variables and data sources

Variable	Expected sign	Description	Data Sources
Dependent variable			
NPLR		Ratio of the accounting value of a bank's non-performing loans to total assets per year.	BankScope
$NPLR_{t-1}$		One-year lagged ratio of the accounting value of a bank's non-performing loans to total assets per year.	
Securitization variables			
Securitization	+/-	Ratio of a banks' cumulated volume of true sale securitizations to total assets per year.	Moody's, Standard & Poor's, FitchRatings, BankScope
Opaque	+/-	Ratio of a banks' cumulated volume of true sale securitizations to total assets per year while the underlying securitization portfolio is based on collateral debt obligations (CDOs) and other unspecified assets.	
Non-Opaque	+/-	Ratio of a banks' cumulated volume of true sale securitizations to total assets per year while the underlying securitization portfolio is based on residential (RMBSs) and commercial mortgage-backed securities (CMBSs), credit card receivables (CCs) and consumer loans (CLs).	
CDO	+/-	Ratio of a banks' cumulated volume of true sale securitizations to total assets per year while the underlying securitization portfolio is based on collateralized debt obligations (CDOs).	
RMBS	+/-	Ratio of a banks' cumulated volume of true sale securitizations to total assets per year while the underlying securitization portfolio is based on residential mortgage-backed securities (RMBSs).	
CMBS	+/-	Ratio of a banks' cumulated volume of true sale securitizations to total assets per year while the underlying securitization portfolio is based on commercial mortgage-backed securities (CMBSs).	
CC	+/-	Ratio of a banks' cumulated volume of true sale securitizations to total assets per year while the underlying securitization portfolio is based on credit card receivables (CCs).	
CL	+/-	Ratio of a banks' cumulated volume of true sale securitizations to total assets per year while the underlying securitization portfolio is based on consumer loans (CLs).	
Other	+/-	Ratio of a banks' cumulated volume of true sale securitizations to total assets per year while the underlying securitization portfolio is based on other underlyings.	

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Table 3: Notes on variables and data sources - continued

Variable	Expected sign	Description	Data Sources
Bank-specific variables			
Capital_{t-1}	+/-	One-year lagged ratio of the accounting value of a bank's total equity to total assets per year. A larger ratio indicates a higher capitalization.	BankScope
Management_{t-1}	+/-	One-year lagged ratio of the accounting value of a bank's total costs to total income per year. A greater management inefficiency is denoted by higher values.	
Profitability	-	Accounting value of a bank's return on average assets per year. A higher ratio suggests a more profitable bank.	
Liquidity	+/-	Ratio of the accounting value of a bank's liquid assets to total assets per year. A larger ratio indicates a higher liquidity position.	
Business Model	+/-	Ratio of the accounting value of a bank's non-interest income to interest income per year. A higher value suggests a more fee-based business model.	
Macroeconomic variables			
ΔYield Curve	-	Annual change of the slope of the yield curve. The slope is calculated as ten-year minus two-year government bond yields per country and year. A prospering economy is denoted by higher values.	Thomson Reuters Eikon
ΔUnemployment	+	Annual change of the unemployment rate. The unemployment rate is defined as the number of unemployed persons divided by the labor force per country and year. A larger ratio indicates a worsening of labor market conditions.	World Bank's WDI
Stock market	-	Annual return of the main stock market index per country and year. A higher value indicates greater stock market performance and a higher value of collaterals.	Thomson Reuters Datastream
Concentration	+/-	Herfindahl-Hirschman index (HHI) for credit institutions based on total assets per country and year. A higher value implies a greater bank concentration.	ECB Statistical Data Warehouse, SNB
Regulatory environment			
Capital Regulation	+/-	The capital regulatory index as proposed by Barth et al. (2013a) is computed using principal component analysis (PCA). This yearly index captures information on (i) whether the capital requirements appropriately reflect risk elements, (ii) whether market value losses are deducted prior to the calculation of the capital adequacy ratio, and (iii) which types of funds are employed to establish a bank. The capital regulatory index is the sum of the first three principal components for which the eigenvalues exceed one. Higher index values indicate greater regulatory requirements and capital stringency.	World Bank, Barth et al. (2001, 2004, 2008, 2013a)

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Table 3: Notes on variables and data sources - continued

Variable	Expected sign	Description	Data Sources
MHI	+	The moral hazard index (MHI) as proposed by Demirgüç-Kunt and Detragiache (2002) and extended by Demirgüç-Kunt et al. (2015) is based on different design features of a country's deposit insurance system and measures the generosity of the deposit insurance regime. The MHI is computed using principal component analysis (PCA) of the following standardized deposit insurance design features: no coinsurance, coverage of foreign currency and interbank deposits, type of funding, source of funding, management, membership, the ratio of explicit coverage to GDP per capita, government guarantees on deposits, non-deposit liabilities and bank assets, no payment, no risk-adjusted premiums, no legal power of the deposit insurance authority, compensation of depositors. The MHI is the sum of the first six principal components for which the eigenvalues exceed one. Higher index values indicate a greater generosity of a country's deposit insurance regime which incentivizes moral hazard at banks.	Demirgüç-Kunt and Detragiache (2002), Demirgüç-Kunt et al. (2015), national central banks and Barth et al. (2001, 2004, 2008, 2013a)
Time variables			
Dummy_{onset}	-	Dummy variable that takes on the value of one for the years from 1997 to 2001 (onset stage), and zero otherwise.	Authors calc.
Dummy_{boom}	-	Dummy variable that takes on the value of one for the years from 2002 to 2007 (boom stage), and zero otherwise.	
Dummy_{crises}	+	Dummy variable that takes on the value of one if for the years from 2008 to 2010 (crises stage), and zero otherwise.	

Table 4: Descriptive statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Dependent variable					
NPLR	709	.0158	.0148	.0001	.1063
NPLR_{t-1}	690	.0147	.0131	.0001	.1063
Securitization variables					
Securitization	757	.0092	.0231	0	.2517
Opaque	757	.0017	.0058	0	.0585
Non-Opaque	757	.0075	.0218	0	.2517
CDO	757	.0012	.0053	0	.0585
RMBS	757	.0070	.0215	0	.2517
CMBS	757	.0002	.0011	0	.0149
CC	757	.0001	.0009	0	.0169
CL	757	.0003	.0017	0	.0255
Other	757	.0005	.0025	0	.0292
Bank-specific variables					
Capital_{t-1}	706	.0534	.0235	.0061	.1606
Management_{t-1}	697	.8229	.1728	.2854	4.1562
Profitability	757	.0058	.0061	-.0636	.0330
Liquidity	749	.2023	.1241	.0136	.6495
Business Model	733	.3016	.2833	-.6685	3.9316
Macroeconomic variables					
ΔYield Curve	778	.0004	.0067	-.0203	.0208
ΔUnemployment	798	-.0009	.0131	-.0350	.0660
Stock Market	786	.0634	.2607	-.6621	1.0131
Concentration	798	.0569	.0459	.0114	.2167
Regulatory environment					
Capital Regulation	798	.0835	2.8207	-4.7946	4.6135
MHI	798	-.2791	2.8297	-12.0705	6.5704
Time variables					
Dummy_{onset}	798	.3571	.4795	0	1
Dummy_{boom}	798	.4286	.4952	0	1
Dummy_{crises}	798	.2143	.4106	0	1

Table 5: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) NPLR	1.00													
(2) $NPLR_{t-1}$	0.85***	1.00												
(3) Securitization	-0.16***	-0.18***	1.00											
(4) $Capital_{t-1}$	0.06	0.08**	-0.03	1.00										
(5) $Management_{t-1}$	-0.06	-0.06	-0.08**	-0.34***	1.00									
(6) Profitability	-0.30***	-0.17***	0.02	0.40***	-0.29***	1.00								
(7) Liquidity	-0.14***	-0.06	-0.23***	-0.23***	0.23***	-0.15***	1.00							
(8) Business Model	-0.10**	-0.07*	-0.12***	-0.01	0.08**	0.19***	0.17***	1.00						
(9) ΔYield Curve	0.02	-0.08**	0.01	-0.08**	0.12***	-0.24***	-0.11***	-0.15***	1.00					
(10) ΔUnemployment	0.28***	0.09**	-0.03	-0.11***	0.05	-0.23***	-0.02	-0.03	0.18***	1.00				
(11) Stock Market	-0.01	0.03	-0.03	-0.04	0.09**	0.16***	0.13***	0.09**	-0.33***	-0.00	1.00			
(12) Concentration	-0.17***	-0.20***	-0.03	-0.13***	0.22***	0.01	-0.16***	0.17***	0.02	0.10**	-0.05	1.00		
(13) Capital Regulation	-0.22***	-0.25***	0.18***	-0.10**	-0.12***	0.21***	-0.20***	-0.03	0.04	0.04	0.03	0.02	1.00	
(14) MHI	0.31***	0.23***	-0.10**	0.15***	-0.01	-0.14***	-0.28***	-0.08**	0.24***	0.19***	-0.13***	0.20***	-0.21***	1.00

***,**,* indicate statistical significance at the one-, five- and ten-percent level.

Table 6: Baseline regressions

	(1) Fixed effects NPLR	(2) System-GMM NPLR	(3) Onset NPLR	(4) Boom NPLR	(5) Crises NPLR
$NPLR_{t-1}$		0.9174***			
		(0.000)			
Securitization	-0.0856***	-0.0714*	-0.0858***	0.0252	-0.1189***
	(0.007)	(0.076)	(0.005)	(0.602)	(0.001)
$Dummy_{onset}$			-0.0113***		
			(0.002)		
Securitization * $Dummy_{onset}$			0.0028		
			(0.972)		
$Dummy_{boom}$				-0.0070**	
				(0.023)	
Securitization * $Dummy_{boom}$				-0.1440***	
				(0.005)	
$Dummy_{crises}$					0.0067**
					(0.027)
Securitization * $Dummy_{crises}$					0.2108**
					(0.020)
$Capital_{t-1}$	0.1120*	-0.0345	0.1121*	0.1209**	0.1191**
	(0.060)	(0.501)	(0.057)	(0.037)	(0.040)
$Management_{t-1}$	-0.0015	0.0004	-0.0015	-0.0018	-0.0022
	(0.518)	(0.789)	(0.520)	(0.439)	(0.358)
Profitability	-0.5745***	-0.3861**	-0.5746***	-0.5934***	-0.5931***
	(0.000)	(0.023)	(0.000)	(0.000)	(0.000)
Liquidity	-0.0270***	-0.0265***	-0.0270***	-0.0282***	-0.0281***
	(0.008)	(0.005)	(0.008)	(0.006)	(0.005)
Business Model	-0.0023	-0.0002	-0.0023	-0.0023	-0.0023
	(0.446)	(0.945)	(0.447)	(0.469)	(0.460)
ΔYield Curve	-0.2600*	-0.1212	-0.2601*	-0.3013**	-0.3091**
	(0.097)	(0.309)	(0.097)	(0.044)	(0.033)
ΔUnemployment	0.2684***	0.1028***	0.2685***	0.2727***	0.2649***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Stock Market	-0.0102**	-0.0089***	-0.0102**	-0.0102**	-0.0111**
	(0.023)	(0.000)	(0.026)	(0.019)	(0.013)
Concentration	-0.1287**	-0.0345***	-0.1288**	-0.1369**	-0.1332**
	(0.042)	(0.001)	(0.041)	(0.031)	(0.039)
Capital Regulation	-0.0006**	-0.0001	-0.0006**	-0.0005*	-0.0005*
	(0.042)	(0.506)	(0.043)	(0.080)	(0.073)
MHI	0.0006*	0.0000	0.0006*	0.0006*	0.0006*
	(0.091)	(0.973)	(0.092)	(0.091)	(0.089)
Cluster bank-level	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES
No. of observations	643	634	643	643	643
No. of groups	57	57	57	57	57
Adj. R^2	0.3651		0.3650	0.3605	0.3652
F-statistic		100.3528***			
Number of instruments		40			
Hansen J		16.3535			
Arellano/Bond AR(1)		-3.3338***			
Arellano/Bond AR(2)		0.3619			

As regards regression specifications (1) and (3) to (5), the linear fixed effects panel model estimated is $NPLR_{(i=bank,t=time)} = \alpha_i + \gamma Securitization_{i,t} + \beta_1 Capital_{i,t-1} + \beta_2 Management_{i,t-1} + \beta_3 Profitability_{i,t} + \beta_4 Liquidity_{i,t} + \beta_5 Business\ Model_{i,t} + \beta_6 \Delta Yield\ Curve_{i,t} + \beta_7 \Delta Unemployment_{i,t} + \beta_8 Stock\ Market_{i,t} + \beta_9 Concentration_{i,t} + \beta_{10} Capital\ Regulation_{i,t} + \beta_{11} MHI_{i,t} + \epsilon_{i,t}$. Regression specification (2) reports results from a one-step system-GMM dynamic panel model. This model is estimated as $NPLR_{(i=bank,t=time)} = \alpha + \delta NPLR_{i,t-1} + \gamma Securitization_{i,t} + \beta_1 Capital_{i,t-1} + \beta_2 Management_{i,t-1} + \beta_3 Profitability_{i,t} + \beta_4 Liquidity_{i,t} + \beta_5 Business\ Model_{i,t} + \beta_6 \Delta Yield\ Curve_{i,t} + \beta_7 \Delta Unemployment_{i,t} + \beta_8 Stock\ Market_{i,t} + \beta_9 Concentration_{i,t} + \beta_{10} Capital\ Regulation_{i,t} + \beta_{11} MHI_{i,t} + \epsilon_{i,t}$. Regression specifications (3) - (5) analyze the relationship between securitization and an issuing bank's NPLR during different stages (onset (1997-2001), boom (2002-2007), crises (2008-2010) stage) of securitization activities in Europe by employing interaction variables. The constant term is included but not reported. Heteroscedasticity consistent p-values are in parentheses. ***,**,* indicate statistical significance at the one-, five- and ten-percent level.

Table 7a: Sensitivity analyses I

	(1) NPLR	(2) NPLR	(3) NPLR	(4) NPLR	(5) NPLR	(6) NPLR	(7) NPLR	(8) NPLR
Opaque	-0.2361***							
	(0.000)							
Non-Opaque		-0.0647*						
		(0.062)						
CDO			-0.1944***					
			(0.000)					
RMBS				-0.0624*				
				(0.081)				
CMBS					0.4413			
					(0.116)			
CC						-0.0114		
						(0.963)		
CL							-0.3809*	
							(0.098)	
Other								-0.4554**
								(0.038)
Capital_{t-1}	0.1236**	0.1105*	0.1198**	0.1113*	0.1185**	0.1152*	0.1132*	0.1204**
	(0.037)	(0.064)	(0.041)	(0.062)	(0.044)	(0.051)	(0.053)	(0.045)
Management_{t-1}	-0.0020	-0.0016	-0.0019	-0.0016	-0.0018	-0.0019	-0.0019	-0.0019
	(0.425)	(0.494)	(0.429)	(0.494)	(0.446)	(0.422)	(0.427)	(0.411)
Profitability	-0.5690***	-0.5681***	-0.5673***	-0.5692***	-0.5626***	-0.5594***	-0.5533***	-0.5593***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Liquidity	-0.0263***	-0.0264***	-0.0264***	-0.0263***	-0.0250**	-0.0255**	-0.0257**	-0.0250**
	(0.009)	(0.009)	(0.010)	(0.010)	(0.014)	(0.012)	(0.011)	(0.012)
Business Model	-0.0025	-0.0022	-0.0024	-0.0022	-0.0023	-0.0022	-0.0023	-0.0022
	(0.408)	(0.468)	(0.421)	(0.467)	(0.451)	(0.468)	(0.457)	(0.460)
ΔYield Curve	-0.3005*	-0.2591*	-0.2965*	-0.2606*	-0.2772*	-0.2797*	-0.2776*	-0.2808*
	(0.054)	(0.095)	(0.057)	(0.093)	(0.073)	(0.072)	(0.073)	(0.073)
ΔUnemployment	0.2788***	0.2702***	0.2808***	0.2709***	0.2784***	0.2774***	0.2764***	0.2721***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Stock Market	-0.0097**	-0.0108**	-0.0096**	-0.0108**	-0.0112**	-0.0110**	-0.0111**	-0.0116**
	(0.031)	(0.019)	(0.033)	(0.019)	(0.017)	(0.020)	(0.019)	(0.015)
Concentration	-0.1374**	-0.1242**	-0.1334**	-0.1238*	-0.1252*	-0.1247*	-0.1278*	-0.1287**
	(0.036)	(0.050)	(0.041)	(0.050)	(0.054)	(0.055)	(0.052)	(0.049)
Capital Regulation	-0.0005**	-0.0006**	-0.0006**	-0.0006**	-0.0006**	-0.0006**	-0.0006**	-0.0006**
	(0.046)	(0.036)	(0.040)	(0.036)	(0.028)	(0.034)	(0.029)	(0.040)
MHI	0.0007*	0.0006*	0.0007*	0.0006*	0.0007*	0.0007*	0.0007*	0.0007*
	(0.058)	(0.100)	(0.062)	(0.096)	(0.063)	(0.088)	(0.080)	(0.088)
Cluster bank-level	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
No. of observations	643	643	643	643	643	643	643	643
No. of groups	57	57	57	57	57	57	57	57
Adj. R^2	0.3450	0.3641	0.3500	0.3630	0.3502	0.3519	0.3548	0.3419

The linear fixed effects panel model and estimation parameters are defined in Table 6. Regression specifications report results for opaque (1) and non-opaque (2) transactions and different securitization underlyings including (3) collateralized debt obligations (CDOs), (4) residential mortgage-backed securities (RMBSs), (5) commercial mortgage-backed securities (CMBSs), (6) credit card receivables (CCs), (7) consumer loans (CLs) and (8) other unspecified assets (Other). The constant term is included but not reported. Heteroscedasticity consistent p-values are in parentheses. ***,**,* indicate statistical significance at the one-, five- and ten-percent level.

Table 7b: Sensitivity analyses II

	(1) FS_{Vol} NPLR	(2) Non-FS_{Vol} NPLR	(3) FS_{TA} NPLR	(4) Non-FS_{TA} NPLR	(5) Top20 NPLR	(6) Non-Top20 NPLR
Securitization	-0.0407	-0.0909**	-0.0827	-0.0726*	-0.2115**	-0.0492*
	(0.326)	(0.035)	(0.231)	(0.068)	(0.031)	(0.051)
$Capital_{t-1}$	-0.0831	0.1464**	0.1522	0.1091*	0.0226	0.0334
	(0.761)	(0.012)	(0.595)	(0.068)	(0.850)	(0.564)
$Management_{t-1}$	0.0063	-0.0012	-0.0007	-0.0060	0.0104	-0.0009
	(0.774)	(0.600)	(0.850)	(0.396)	(0.427)	(0.685)
Profitability	-1.0527**	-0.5057***	-0.5904	-0.5670***	-0.7016***	-0.2724*
	(0.030)	(0.002)	(0.232)	(0.000)	(0.002)	(0.072)
Liquidity	-0.0482**	-0.0301***	0.0174	-0.0338***	-0.0177	-0.0219**
	(0.023)	(0.005)	(0.423)	(0.002)	(0.575)	(0.023)
Business Model	0.0129	-0.0030	-0.0081	-0.0021	-0.0220	-0.0021
	(0.561)	(0.337)	(0.460)	(0.503)	(0.396)	(0.282)
ΔYield Curve	-0.4097*	-0.0955	-0.5672*	-0.1793	-0.6730**	0.0240
	(0.051)	(0.629)	(0.062)	(0.270)	(0.021)	(0.898)
ΔUnemployment	0.0788	0.3041***	0.1003	0.2981***	0.1024	0.2738***
	(0.548)	(0.000)	(0.175)	(0.000)	(0.312)	(0.000)
Stock Market	-0.0378*	-0.0108**	-0.0194	-0.0093*	-0.0013	-0.0106***
	(0.079)	(0.020)	(0.322)	(0.052)	(0.871)	(0.003)
Concentration	-0.8825	-0.1235**	-0.3138	-0.1218*	-0.2830	-0.0562
	(0.160)	(0.035)	(0.275)	(0.069)	(0.480)	(0.206)
Capital Regulation	-0.0038	-0.0006**	-0.0016	-0.0006*	0.0005	-0.0005**
	(0.253)	(0.035)	(0.508)	(0.055)	(0.667)	(0.043)
MHI	0.0032	0.0002	0.0015	0.0005	-0.0001	0.0003
	(0.115)	(0.534)	(0.447)	(0.184)	(0.899)	(0.355)
Cluster bank-level	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES
No. of observations	105	538	113	530	225	418
No. of groups	10	47	10	47	20	37
Adj. R^2	0.2357	0.3328	0.2193	0.3480	0.3512	0.4198

The linear fixed effects panel model and estimation parameters are defined in Table 6. Regression specifications report results from splitting the entire sample into subsamples of frequent (FS, (1) and (3)) and non-frequent securitizers (Non-FS, (2) and (4)) with regard to the transaction volume (Vol) and the number of transactions (TA) respectively. Further regression specifications present results from a split of the entire sample into the top 20 banks with the highest average non-performing loan ratio (NPLR) during the sample period (5) and the remaining banks (6). The constant term is included but not reported. Heteroscedasticity consistent p-values are in parentheses. ***,**,* indicate statistical significance at the one-, five- and ten-percent level.

Table 7c: Sensitivity analyses III

	(1) G-SIB NPLR	(2) Non-G-SIB NPLR	(3) Rating_{below} NPLR	(4) Rating_{above} NPLR	(5) PIIGS NPLR	(6) Non-PIIGS NPLR
Securitization	0.0499	-0.0856***	-0.0060	-0.1131**	-0.0704*	-0.0856*
	(0.622)	(0.010)	(0.917)	(0.028)	(0.068)	(0.059)
Capital_{t-1}	0.1249	0.0674	0.1439**	0.0260	0.0944*	-0.0145
	(0.395)	(0.273)	(0.020)	(0.790)	(0.098)	(0.872)
Management_{t-1}	0.0023	-0.0026	-0.0015	-0.0128	-0.0081	-0.0010
	(0.777)	(0.330)	(0.456)	(0.338)	(0.323)	(0.630)
Profitability	-0.8624	-0.5473***	-0.8810**	-0.4908***	-0.3224	-0.6677*
	(0.115)	(0.001)	(0.013)	(0.009)	(0.108)	(0.054)
Liquidity	-0.0191	-0.0280**	-0.0152	-0.0290*	-0.0396**	-0.0060
	(0.358)	(0.015)	(0.206)	(0.061)	(0.014)	(0.627)
Business Model	-0.0006	-0.0068	0.0006	-0.0128	-0.0206	-0.0012
	(0.855)	(0.359)	(0.781)	(0.211)	(0.103)	(0.634)
ΔYield Curve	-0.3310**	-0.2709	-0.3763**	-0.2410	0.1426	-0.4290***
	(0.035)	(0.266)	(0.026)	(0.318)	(0.611)	(0.005)
ΔUnemployment	0.2156***	0.2415***	0.2399***	0.2614***	0.0708	0.0784
	(0.008)	(0.000)	(0.000)	(0.000)	(0.148)	(0.511)
Stock Market	-0.0162	-0.0077	-0.0152**	-0.0100	0.0087	0.0033
	(0.170)	(0.182)	(0.027)	(0.110)	(0.312)	(0.336)
Concentration	0.0507	-0.2106**	0.0324	-0.2706**	0.0556	-0.0660
	(0.606)	(0.022)	(0.629)	(0.016)	(0.470)	(0.495)
Capital Regulation	-0.0008**	-0.0003	-0.0007**	-0.0000	-0.0040***	-0.0008**
	(0.037)	(0.530)	(0.027)	(0.996)	(0.001)	(0.035)
MHI	0.0011*	0.0003	0.0009	0.0004	-0.0023***	0.0006
	(0.067)	(0.482)	(0.153)	(0.428)	(0.000)	(0.131)
Cluster bank-level	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES
No. of observations	184	459	299	339	324	319
No. of groups	15	42	25	31	28	29
Adj. R^2	0.1220	0.3048	0.2107	0.2902	0.4422	0.2053

The linear fixed effects panel model and estimation parameters are defined in Table 6. Regression specifications present results from a split of the entire sample into G-SIB (1) and non-G-SIB (2) institutions and banks with an average rating score *below* (3) or *above* (4) the sample mean rating. A lower rating score indicates a better rating status. Further regression specifications present results from splitting the entire sample into banks operating from PIIGS (5) and non-PIIGS countries (6). The constant term is included but not reported. Heteroscedasticity consistent p-values are in parentheses. ***,**,* indicate statistical significance at the one-, five- and ten-percent level.