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Risk allocation through securitization: Evidence from non-performing loans

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Abstract: 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. Overall, we provide evidence for a negative impact of securitization on NPL exposures suggesting that banks predominantly used securitization as an instrument of credit risk transfer and diversification. In addition, the analysis at hand reveals a time-sensitive relationship between securitization and NPL exposures. While we observe an even stronger NPL-reducing effect through securitization during the non-crisis periods, the effect reverses during and after the global financial crisis suggesting that banks were forced to provide credit enhancement and employ securitization as a funding management tool. Along with the results from a variety of sensitivity analyses our study provides important implications for the recent debate on reducing NPL exposures of European banks by revitalizing the European securitization market.

JEL Classification: G21, G28, G32
Keywords: European banking, non-performing loans, securitization

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1. Introduction and motivation

According to the European Central Bank (ECB) and in line with the Basel II/III regulatory framework, not yet written-off loans are defined as non-performing loans (NPLs) (i) when payments of interest and principal are past due by 90 days or more or (ii) when it is considered unlikely that debt payments will be made in full (ECB, 2017). Due to the fact that the Global Financial Crisis (GFC) from 2008 has sharply increased NPL exposures on banks' balance sheets, NPLs have become the subject of an intense debate among academics, regulators and practitioners alike, while this discussion has gained a renewed momentum due to the coronavirus pandemic.

Hence, while the gross amount of NPLs within the European banking sector reached a peak of more than one trillion Euro in the aftermath of the crisis in 2012/13, European banks' aggregated NPL exposures have decreased only marginally to 820 billion Euro until the outbreak of the coronavirus pandemic in 2020 (ECB, 2021). Suggesting that the pandemic is likely to trigger NPL stocks under a severe but plausible scenario up to 1.4 trillion Euro by the end of 2022, the ECB has urged euro area banks to prepare for a further rise in NPLs and more quickly reduce their NPL exposures.

The ECB's urgent appeal is rational since it is well understood that the negative effects of extensive NPL exposures at banks are twofold. On a *micro-level*, banks may suffer from lower capital and profitability ratios, higher funding costs and stronger capital requirements, which limit them to grant new loans. Depending on their business models, these banks may additionally be incentivized to a "gambling of resurrection"-strategy (Freixas et al., 2004; Boyd and Hakenes, 2014), i.e., they may take on more profitable but riskier loans in order to reestablish financial soundness, which may further increase their NPL exposures (Klein, 2013; ECB, 2017). 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 rising NPL stocks may also deteriorate the resilience and the sustainability of the entire banking market (Ozili, 2020).

To ward off these negative consequences, several 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 variety of solutions proposed, also *loan securitization* was stressed as an instrument of credit risk transfer that helps to sell securitized NPLs to sophisticated and institutional capital market investors, who search for "high-risk and high return" investments (ECB, 2017).

However, proposing securitization as a possible instrument to cope with the NPL-problem is surprising for two reasons. *First*, it is theoretically argued and empirically shown that securitization may not only serve as an instrument of credit risk transfer. Rather, banks likewise employ securitization as an instrument of their liquidity and funding management. *Second*, the European securitization market completely failed in the aftermath of the GFC in 2010 and has still not fully recovered (AFME, 2018). As a consequence, information asymmetries between banks and European investors in asset backed securities (ABS) are high and investors' trust towards securitization transactions is still shaken. Furthermore, several actions to restore confidence and revitalize the securitization market have not been very successful so far (Di Patti and Sette, 2016; AFME, 2018). Under such a framework, the conditions for securitizing information-sensitive and high-risk NPLs in Europe seem to be unfavorable.

Against this background, we empirically analyze if European banks indeed employed true sale loan securitization to transfer NPLs out of their balance sheets for a period of time when the securitization business started in Europe in 1997 until the European securitization market failed in 2010. We employ 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. Overall, we

[1] Hence, between 2016 and 2018 several European institutions presented proposals and guidelines including different measures, processes and instruments for European banks to tackle NPLs on their balance sheets (ECB, 2017; ESRB, 2017; European Commission, 2018). Recently, the ECB and the European Parliament have proposed further (modified) tools to address the re-increase in NPL due to the coronavirus pandemic in 2021 (ECB, 2020; European Parliament, 2021).

provide evidence for a negative impact of securitization on the issuing banks' NPL exposures suggesting that banks predominantly used securitization as an instrument of credit risk transfer and diversification.

However, our analysis at hand reveals a time-sensitive relationship between securitization and NPL exposures. While we observe an even stronger NPL-reducing effect through securitization during the non-crisis periods, the effect reverses during and after the GFC suggesting that banks were forced to provide credit enhancement as a quality signal by retaining high-risk NPLs on their balance sheets. In addition, as European banks exhibited severe financial needs due to the crisis, our results imply that banks first and foremost employed securitization to diversify their funding sources and raise fresh liquidity. Our findings are robust and economically relevant. Moreover, a variety of sensitivity analyses provides further interesting insights into the securitization-NPL nexus.

The study at hand provides important implications concerning the motives and conditions under which European banks may reduce their NPL exposures by means of securitization. In particular, our results contribute to the vitally important political and academic debate on reducing NPL exposures of European banks and the process of revitalizing the European securitization market.

The remainder of the paper is organized as follows. Section 2 initially presents the process of true sale loan securitization with a focus on NPLs as well as a bank's and an investor's motives to engage in securitization business (Section 2.1.). Subsequently, theoretical arguments and hypotheses as well as empirical findings concerning the impact of securitization on an issuing bank's NPL exposure are discussed in Section 2.2. In Section 3, the originality of the paper at hand is elaborated by distinguishing it from previous most related empirical studies. Section 4 describes the data and the empirical model as used for the analysis at hand. The regression results are reported and discussed in Section 5. While Section 5.1. and Section 5.2. include results from our baseline analyses and robustness checks, Section 5.3. presents and discusses results from a

variety of sensitivity analyses. Finally, Section 6 summarizes and provides important policy implications.

2. Theoretical background

2.1. Securitization of NPLs

Process. The securitization of NPLs can be described as an alternative to an outright sale of high-risk loans. Hence, during a traditional true sale securitization the bank transfers a pool of (non-performing) loans to a special purpose vehicle (SPV), which in turn refinances the purchase of these loans by selling loan-backed securities to capital market investors. Subsequently, the SPV passes funding from selling these securities through to the bank and forwards interest and principal payments from the underlying loan agreements to the investors.

Typically, a large portfolio of loans is pooled and then segmented into a three-tier security structure including different tranches (junior, mezzanine and senior tranche) with different information-sensitivities, risk-return characteristics and strict subordination. Tranching the loan-pool this way is necessary since (i) asymmetric information between the originating banks and investors concerning the quality of securitized loans and (ii) different levels of risk tolerance among the investors may describe major impediments to the credit risk transfer process (DeMarzo, 2005; Albertazzi et al., 2015). Usually, the least subordinated senior tranche and the less risky mezzanine tranche are attractive to less informed investors who exhibit a low risk tolerance and less experience and knowledge to screen the quality of the underlying loan pool. In contrast, sophisticated institutional investors with a higher risk tolerance, a preference for high-yield investments and sufficient capabilities to screen the underlying loan portfolio are attracted to the junior tranche. Considering that high-risk NPLs are typically allocated to the junior tranche, it is the most information-sensitive tranche, which is also known as the first-loss piece (FLP). The FLP is the smallest of all tranches from a securitization transaction, concentrates most of the loan default risk, but receives the highest investment return if loan defaults do not occur.

Bank motives. A broad strand of theoretical and empirical research papers suggests two well-accepted motives for banks to engage in the securitization of (non-performing) loans (e.g. Farruggio and Uhde, 2015; Buchanan, 2017). These motives include (i) the reduction of capital requirements under Basel regulations by credit risk transfer and (ii) employing securitization to serve a bank's liquidity and funding management.[2]

As regards the *first motive*, a targeted transfer of (non-performing) loans to external investors following the "originate-to-distribute" model (Gorton and Pennacchi, 1995) may decrease a bank's exposure to loan risk through portfolio risk diversification and thus, may reduce a bank's regulatory capital burden (Instefjord, 2005; Wagner, 2007). Given that NPLs represent the riskiest loan class, regulatory capital relieves should be at their highest when securitizing NPLs. However, as to be discussed in greater detail in Section 2.2., former Basel I regulations set an incentive for banks to retain the FLP including NPLs. Moreover, depending on the degree of information asymmetries between the issuing banks and capital market investors, banks may be forced to retain the FLP as a quality and reputation signal and have a weak incentive to securitize NPLs if they can expect a governmental bail-out.

Referring to the *second motive*, securitization may also provide an alternative funding source beyond traditional deposit-financing and thus, serve a bank's liquidity and funding management since the bank receives cash inflows when selling (non-performing) loans to the SPV by means of a true sale transaction. In this context, securitization may also entail lower funding costs since funding costs primarily depend on the quality of the underlying loan portfolio rather than the rating of the issuing bank itself (Loutskina, 2011; Krahnen and Wilde, 2006). In addition, funding through securitization is not subject to deposit insurance and reserve requirements (Affinito and Tagliaferri, 2010). Obviously, and demonstrated by previous empirical studies, if and to what

[2] Note that more recent studies additionally suggest earnings management by accounting gains (Loutskina and Strahan, 2009; Dechow and Shakespeare, 2009) as well as tax avoidance (Uhde, 2020; Gong et al., 2015; Han et al., 2015) as further incentives for banks to securitize assets.

extent a bank benefits from these effects clearly depends on the bank's actual need for liquidity and the costs from re-financing with retail deposits (Bannier and Hänsel, 2008; Cardone-Riportella et al., 2010; Affinito and Tagliaferri, 2010; Farruggio and Uhde, 2015). Indeed, employing securitization as an alternative funding source was especially observed during the GFC between 2007 and 2008. During this crisis period, in particular banks with severe financial needs utilized securitization almost exclusively to diversify their funding sources and raise fresh liquidity (Bedendo and Bruno, 2012). In addition, securitization activities may also increase if liquidity needs exist due to strong competition in the deposit market while the bank has market power in the loan market (Farruggio and Uhde, 2015).

Investor motives. Typically, sophisticated institutional investors such as pension funds, insurance companies, investment funds and, to a lesser extent, banks represent the largest investors in securitized loans. Securitization benefits these investors by creating easy access to different loan-backed tranches with specific, even tailor-made, risk-return properties, which can be further differentiated according to loan classes, maturity, sectors and countries of origination (DeMarzo, 2005).

Considering that the different tranches provide a greater variety of diversification opportunities while the tranches are diversified themselves, investors may purchase loan-backed securities to pursue loan portfolio risk diversification and specification. Indeed, it is shown, that an investor's decision to purchase tranches with different risk-return properties may depend on the combination of assets (loans) held in the investor's portfolio and is thus a risk management issue (van Oordt, 2014). In this context, especially pension funds and insurance companies may seek for loan-backed securities with a direct legal claim on loan portfolios since these firms are often prohibited from engaging in loan-originating activities themselves.

Another motive for investors to purchase securitization tranches is set by the fact that loan-backed securities usually exhibit higher rates of return relative to other assets of comparable credit risk (Rajan, 2006). Having realized this, especially hedge funds entered the securities market in

order to search for high-yield junior tranches (including NPLs), which are generally unrated and riskiest, but offer the highest investment return.

2.2. The impact of securitization on NPL exposures

As to be discussed in detail in this section, the impact of loan risk securitization on an issuing bank's NPL exposure is not distinct.

To begin with, referring to the bank's *motive to employ securitization as an instrument of credit risk transfer*, the direct impact of securitization on a bank's NPL exposure depends on the amount of NPLs that is *actually* transferred to investors. In this context, it is shown, that slicing the loan portfolio into tranches with different seniority levels and selling them to investors provokes a superior nonlinear diversification strategy, which can reduce the bank's NPL exposure beyond the minimum level that would be achieved by linear loan portfolio diversification (van Oordt, 2014). However, unlike senior or mezzanine tranches, a major part of NPLs is included in the FLP, which may (partly) be retained by the bank for three reasons.

First, from an agency theory's perspective it is argued that the bank usually retains the riskiest and most information-sensitive FLP as a quality signal towards less informed investors when information asymmetries are high (Riddiough, 1997; Instefjord, 2005). Accordingly, the bank provides credit enhancement and signals "skin in the game" since potential credit losses are at first absorbed by the holder of the FLP (Vermilyea et al., 2008; Casu et al., 2011; Guo and Wu, 2014). However, incentives to borrower and loan monitoring remain with the bank and probably increase, if banks offer precisely determined (not excessive) credit-enhancement guarantees, such as implicit recourse or retaining the FLP (Chiesa, 2008).

Second, following the "regulatory capital arbitrage hypothesis" (Acharya et al., 2013), former Basel I regulations set an incentive for capital-constrained banks to retain the riskiest junior tranche since capital regulations under Basel I were not risk-sensitive. Thus, as loans were not risk-adjusted but globally backed up with equity capital, securitizing less risky loans and retaining

the high-risk NPLs within the FLP provoked regulatory capital arbitrage (Ambrose et al., 2005; Bannier and Hänsel, 2008). Trying to mitigate this negative external effect, Basel II/III-regulations now provide a "substance over form principle", which more precisely determines the required regulatory capital for all retained tranches of a securitization. As a consequence, Basel II/III in return now strongly stimulates the incentive to transfer subordinated tranches and the FLP to external investors.

Third, the bank may securitize high-quality loans and retain high-risk NPLs on their balance sheet if it expects a bail-out in case it fails due to an excessive accumulation of NPLs. As a consequence, and following the "asset deterioration"-hypothesis, bank-induced subsidies by governments may trigger a retention of NPLs during a securitization transaction and may lead to a deterioration in bank asset quality, which is especially true for larger and systemic relevant banks that securitize more frequently (Greenbaum and Thakor, 1987; Lockwood et al., 1996; Instefjord, 2005).

Turning to the bank's *motive to employ securitization as an alternative funding source*, the impact of securitization on NPL exposures is not obvious but rather hinges on the bank's reinvestment strategy ex post (Gorton and Pennacchi, 1995; Krahnen and Wilde, 2006; Leland, 2007). Hence, using cash inflows from selling securitization tranches and the release of regulatory capital to grant new and less risky loans will provoke a risk diversification of the bank's loan portfolio if total loans are less strongly correlated after securitization (Greenbaum and Thakor, 1987). In contrast, following a riskier lending strategy ex post may – ceteris paribus – result in an increase in the NPL exposure in the long run (Bedendo and Bruno, 2012). In this context, the bank's reinvestment strategy ex post itself is determined by (i) the current level of competition and quality of potential borrowers in loan markets (Instefjord, 2005), (ii) the strength of the bank's screening and monitoring efforts after securitization (Gorton and Pennacchi, 1995; Parlour and Plantin, 2008; Piskorski et al., 2015) and (iii) the bank's actual need to invest in risky but more

profitable loans (Stiglitz and Weiss, 1981; Bedendo and Bruno, 2012), e.g. due to a "gambling for resurrection strategy" (Freixas et al., 2004; Boyd and Hakenes, 2014).

3. Related literature and contribution

Since NPLs reflect the riskiness of the existing loan portfolio and past lending strategies, our analysis tackles previous academic research on the relationship between securitization and an issuing bank's financial risk exposure. This relationship has been intensively analyzed by theoretical and empirical studies while the focus has been on the banks' (i) credit and default risk, (ii) systematic risk and (iii) systemic risk (see Battaglia et al. (2021) for a most recent and comprehensive overview). Overall, these studies provide mixed results that can be classified either under the "securitization-stability" or the "securitization-fragility" view (Arif, 2020).

A few previous empirical studies more directly analyze the risk-level of securitized and retained loans, however, without a special focus on NPLs. Shivdasani and Wang (2011) find no difference in terms of the underlying quality between securitized and non-securitized loans. Downing et al. (2009), Piskorski et al. (2010) as well as Krainer and Laderman (2014) empirically demonstrate that banks may securitize riskier 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), Albertazzi et al. (2015) as well as Kara et al. (2019) provide empirical evidence that especially less risky loans are securitized, whereas loans with higher default risk are retained. In this context, it is further revealed that the exposure of retained high-risk loans grows with the extent of information asymmetries between issuing banks and ABS investors.

Next to these studies, three empirical research papers are most related to our analysis since they directly focus on an issuing bank's NPL exposure. To begin with, Affinito and Tagliaferri (2010) find a decrease in "bad loans" through securitization. The study employs annual data of an increasing number of Italian banks (up to 115 in 2006) during the period from 2000 to 2006.

Securitization data on households' and firms' loans with banks is retrieved from the Bank of Italy's Accounting Supervisory Reports and the Italian Central Credit Register. The latter also provides data on "bad loans" which is comparable to NPLs.

Next, Casu et al. (2011) use bank-level data for 230 U.S. bank holding companies (BHC) from Y-9C forms over the period from 2001 to 2007. Securitization data is retrieved from the Schedule HC-S of the Y-9C filings providing information on the securitization of family residential loans, home equity lines, credit card receivables, auto loans, commercial and industrial loans and other consumer loans. The empirical analysis reveals that the securitization of mortgage loans, home equity lines of credit and other consumer loans reduces the issuing BHCs' levels of asset risk, which is – among others – measured by the banks' non-performing assets to total assets ratio.

Finally, Bedendo und Bruno (2012) empirically investigate securitization deals especially during the GFC. The empirical analysis employs data on the securitization of home mortgages, credit card receivables, auto loans, as well as commercial and industrial (C&I) loans provided by Schedule RC-S of the Consolidated Reports of Condition and Income (Call Reports). This data is retrieved for an increasing number of U.S. commercial banks and trust companies (up to 517 in 2009) over the period from 2001:Q2 until 2009:Q2. The study provides evidence that banks, being more engaged in securitization activities, exhibit a higher proportion of NPL exposures on their balance sheets. This finding holds for both medium-sized and large banks and is significant during the pre-crisis and crisis period. In addition, the study reveals that the liquidity management motive was the main incentive to securitize loans for banks with severe funding constraints.

Overall, these most related studies solely focus on the U.S. and Italian banking and securitization market and provide mixed results. The analysis at hand contributes to these studies and extends them by several aspects. *First*, our study is the first to comprehensively investigate the relationship between securitization and NPL exposures for different European countries. While Affinito and Tagliaferri (2010) focus on Italian banks only, our analysis includes 648 true sale securitizations issued by 57 stock-listed banks from the EU-12 and Switzerland. *Second*, we

provide the longest and most complete sample of securitization data stretching from 1997, when the first securitization activities in Europe were observed, until 2010, when the European securitization market completely dried-up and securitization data was no longer available (except for STS-transactions). *Third*, with the sample at hand, we are able to investigate the time-sensitivity of the impact of securitization on NPL exposures by analyzing the onset-, boom- and crisis-period of securitization, which explains mixed results provided by previous related studies. *And fourth*, we employ a hand-collected and thus, unique dataset retrieved from circulars and presale reports provided by Moody's, Standard & Poor's and FitchRatings. Since our database includes detailed information on securitizing banks, issue dates, structures, types and volumes of securitization transactions and underlyings, it allows policy implications from numerous meaningful sensitivity analyses that have not been conducted by previous related studies yet.

4. Empirical methodology

4.1. Data and sources

In the appendix, Figure 1 illustrates the evolvement of the non-performing loan ratios (NPLs to total assets) from 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 including variables from the baseline regressions is presented in Table 5.

4.1.1. Non-performing loans ratio

We retrieve annual consolidated balance sheet data of NPLs for the 57 securitizing banks in our sample from the *BankScope* database compiled by *FitchRatings* and provided by *Bureau van Dijk*. The data corresponds to the ECB definition and the Basel II/III framework suggesting that a not yet written-off loan is defined as non-performing if payments of interest and principal are past

due by 90 days or more or (ii) when it is considered unlikely that debt payments will be made in full (ECB, 2017).

We employ the ratio of the accounting value of a bank's non-performing loans to total assets (*NPLR*) as our dependent variable. Scaling NPL stocks by total assets controls for the fraction of NPLs on a bank's balance sheet as well as the bank's size. Constructing the NPL measure this way, a decrease in the NPLR due to true sale securitizations indicates that an issuing bank reduces its NPL exposure by selling NPLs to ABS investors. In contrast, the NPLR will increase, if an issuing bank retains NPLs within the FLP on its balance sheet and rather transfers performing loans out of its balance sheet.

Table 4 reports the descriptive statistics for the NPLR measure. As shown, the mean of this ratio is at 1.58 per cent with a standard deviation of 1.48, while we observe a maximum value of 10.63 per cent and a minimum value of 0.01 per cent. Furthermore, as displayed by Figure 1, NPLRs from securitizing banks in our sample slightly decrease between 1997 and 2007 on average. Since then, NPLRs have sharply increased due to the GFC starting in 2007/08. In this context, comparing the development of securitization activities in Europe (Figures 2 and 3) with the evolution of NPLRs at issuing banks (Figure 1) provides a rough indication that – on average – NPLRs from European banks decrease with increasing securitization activities and vice versa.

4.1.2. Securitization transactions

We retrieve securitization data from circulars and presale reports provided by *Moody's*, *Standard & Poor's* and *FitchRatings*. Our unique and hand-collected data contains detailed information on securitizing banks, issue dates, structures, types and volumes of securitization transactions as well as the underlying reference portfolios. Corresponding to the NPLR measure, we employ the ratio of the cumulated volume of true sale securitizations to an issuing bank's total assets (*Securitization*) since scaling securitization by total assets controls for the bank's size and its potential to securitize loans.

Our sample includes 648 true sale loan securitization transactions issued by 57 stock-listed banks across the EU-12 plus Switzerland. Even though Switzerland is not part of the EU, we additionally consider Switzerland since the Swiss banking sector is strongly connected with the European banking market and several large securitization transactions are observed, especially at UBS and Credit Suisse.[3]

The sample covers the period from 1997 to 2010. It starts in 1997 when a notable transfer of bank loans through true sale securitizations in Europe is observed. The sample ends in 2010 since the European securitization market has failed at the end of 2010 due to the GFC. Until now, the European securitization market has still not fully recovered. Except for a slowly growing number of so-called "simple, transparent and standardized" STS-securitizations (EBA, 2014; BCBS, 2015) starting in 2017, sufficient data on loan securitization is not available for the time period after the year 2010.

Table 1 indicates that the number of securitizing banks is not equally distributed across the European countries in or sample. We observe the highest number of issuing banks for Italy, Spain and UK. Table 2 provides the descriptive statistics concerning the different underlyings of the securitization transactions in our sample. As shown, while the entire cumulated volume of securitized loans amounts to 1,363.6445 billion Euro, our sample is mainly represented by Residential Mortgage Backed Securities (1,026.9072 billion Euro). We are aware of this fact and investigate the impact of the different underlyings on the issuing banks' NPL exposures in a later sensitivity analysis.

Figures 2 and 3 more precisely illustrate the distribution of true sale securitizations over the sample period. It is generally shown that the growing importance of securitization in Europe is reflected by both, increasing volumes and numbers of true sale transactions as well as a growing share of participating banks. Volumes, numbers and shares reach their respective peaks in 2007.

[3] We exclude Switzerland from our baseline regressions as a robustness check. However, as we do not obtain remarkably different results, we do not present them in this paper but provide them on request.

Since then, a sharp decline has been observed until 2009, which is due to the GFC. In the aftermath of the crisis, the European securitization market has recovered a little but has definitely dried up at the end of 2010. We control if the securitization-NPL relationship differs during these different time periods by separate time-sensitive regressions.

Finally, as displayed by Figures 4 and 5, some of the banks in our sample securitize more than once during the sample period ("*frequent issuers*"). We control for the different issuing frequencies in a later sensitivity analysis. As we use annual data, we aggregate the volumes of a frequently issuing bank's single transactions and calculate a cumulated volume per year if we observe multiple transactions. Furthermore, following Farruggio and Uhde (2015), those banks from our sample, that have not securitized in a respective year during the sample period, are included with a transaction volume of zero. Table 4 reports the descriptive statistics of the securitization to total assets ratio (*Securitization*) as used for the empirical analysis. As shown, the mean of this variable is at 9.2 per cent with a standard deviation of 2.31, while the maximum value is at 25.17 per cent and the minimum value is zero per cent.

4.1.3. Control variables

When examining the impact of true sale loan securitization on the issuing banks' NPL exposures it is imperative to control for further factors that are likely to affect NPL exposures and hence, help mitigating omitted variable biases. As regards the selection of control variables, we follow previous empirical studies that have analyzed different determinants of NPL exposures at banks (Louzis et al., 2012; Klein, 2013; Beck et al., 2015; Ghosh, 2015).

To begin with, we include bank-specific control variables following the so-called CAMEL rating, with the acronym standing for "Capital adequacy, Asset quality, Management, Earnings, and Liquidity".[4] These indicators are widely used in related studies since they provide accurate

[4] Note, that we do not include a proxy for a bank's asset quality as a control variable since our dependent variable of NPL exposures is a proxy for this indicator.

predictions of bank distress and hence, of financial risks from NPL exposures (e.g., Citterio, 2020). We initially control for a bank's capital adequacy, which is measured as the one-period lagged ratio of the accounting value of total equity divided by total assets per bank and year ($Capital_{t-1}$). We suggest a positive relationship between a securitizing bank's capital ratio and its NPL exposures since previous research demonstrates that especially better capitalized banks may exhibit larger amounts of risky loans in their balance sheets. This is due to the fact that stronger capitalized and hence, less leveraged banks, may face weaker debt covenants and higher shareholder pressure (Gambacorta and Mistrulli, 2004). Accordingly, and as discussed in Section 2.2., NPL exposures may increase when shareholders exert pressure to pursue a more profitable but riskier reinvestment strategy after securitization, which is less monitored by debt holders (Rajan and Zingales, 1995; Altunbas et al., 2009).

Referring to theoretical predictions and empirical findings that a bank's efforts to monitor borrowers and loans may decrease after loan risk securitization as outlined in Section 2.2., we additionally control for the efficiency of a bank's (risk) management by including the one-period lagged cost-to-income ratio ($Management_{t-1}$). This ratio is built as the accounting value of a bank's total expenses divided by total income per year.[5] Basically, one may argue that risk managers with greater skills may be more prone to employ securitization as an instrument of credit risk transfer. However, academic research shows that the relationship between a bank's risk management efficiency and its NPL exposure is ambiguous. Hence, according to the "skimping"-hypothesis, it is shown that reducing risk management efforts in order to operate more cost-efficiently, may not negatively affect a bank's loan portfolio quality in the short term. Rather, and given that the loan and borrower quality deteriorate slowly, a decrease in the (loan) portfolio

[5] We are aware of the fact that the cost-to-income ratio is only a rough measure of the efficiency of a bank's (risk) management. Unfortunately, more precise management data is not available for our sample of European banks. The lack of more precise management data is a well-known problem with regard to European banks. As a consequence, most European empirical studies are forced to rely on the cost-to-income ratio (e.g., Louzis et al., 2012; Farruggio and Uhde, 2015) arguing that the efficiency of a bank's (risk) management is reflected in the bank's cost structure.

quality is only found in the long run (Williams, 2004). In contrast and referring to the "bad management"-hypothesis, Berger and DeYoung (1997) empirically show that both, risk management efficiency and loan portfolio quality decrease, if bank managers exhibit poor skills in loan scoring, estimating collateral-values and monitoring borrowers. As a consequence, managers with poor skills may more strongly allocate loans with low or even negative net present values. Finally, Chen et al. (2019) find that banks with a higher management expertise securitize loans of a higher quality and retain riskier loans, while these findings are weaker for more liquid banks supporting the idea that securitization is also used as an instrument for a bank's liquidity and funding management.

Considering that securitization is also employed as an alternative funding source next of credit risk transfer, the impact on an issuing bank's NPL exposure may also depend on the riskiness of the bank's reinvestment strategy ex post, as discussed in Sections 2.1. and 2.2. As more risk-taking after securitization is especially found in less profitable and distressed banks, we control for a bank's earnings ($Earnings_t$) which are measured as the accounting value of a bank's return on average assets (ROAA) per year. Following the "gambling for resurrection"-hypothesis (Freixas et al., 2004; Boyd and Hakenes, 2014), we suggest that less profitable banks may be more prone to use cash inflows from securitization to invest in more profitable but riskier loans, which may increase an issuing bank's NPL exposure, also known as the "risk-return trade-off".

Finally, we control for the strength of a bank's liquidity position by employing the ratio of the accounting value of a bank's liquid assets to total assets per year ($Liquidity_t$). Referring to the liquidity-motive of securitization as outlined in Section 2.1., we argue that banks with higher liquidity resources and hence, less financial needs, may primarily employ securitization as an instrument of credit risk transfer in order to reduce NPL exposures. In contrast, however, it is also found that larger liquidity buffers may encourage banks to increase their (loan) risk exposure since liquidity buffers may absorb potential future loan losses (Wagner, 2007). Against this

background, the relationship between a bank's liquidity position and its NPL exposure is not distinct.

Next to bank-specific determinants, we additionally employ two measures of the *country-specific macroeconomic environment* as well as a measure of *banking market concentration* to control for differences in European economies and banking market structures.

To begin with, the change of the slope of the yield curve *(*Δ*Yield Curve*) is included to control for 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), 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. In line with previous related studies, we expect decreasing NPL exposures during a prospering economy since investment opportunities grow and the borrowers' solvency may be higher under increasing economic performance which in turn raises the banks' asset quality (Louzis et al., 2012; Ghosh, 2015).

We additionally include the annual change in unemployment rates *(*Δ*Unemployment*), which is calculated as the number of unemployed persons divided by the labor force per country and year. We argue 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 (Ghosh, 2015).

Finally, since Farruggio and Uhde (2015) empirically demonstrate that banks may securitize risky loans in competitive and hence, less concentrated markets, we control for the relationship between a securitizing bank's degree of market power and its NPL exposure by including 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 NPL exposures. Advocates of the "concentration-stability view" suggest that securitizing 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

stocks (Keeley, 1990). Furthermore, it is argued that monopolistic banks may have a better access to borrower-specific information as well as an advantage to identify high-quality (less risky) creditors (Marquez, 2002) and to provide monitoring services (Uhde and Heimeshoff, 2009) resulting in 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 riskier investments in order to compensate higher loan interest rate payments, which in turn may increase the likelihood of loan default (Boyd and De Nicoló, 2005).

4.2. 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:

$$y_{i,t} = \alpha_i + \gamma\, Securitization_{i,t} + \beta_1\, Capital_{i,t-1} + \beta_2\, Management_{i,t-1} + \beta_3\, Earnings_{i,t} + \beta_4\, Liquidity_{i,t} + \beta_5 \Delta YieldCurve_{i,t} + \beta_6 \Delta Unemployment_{i,t} + \beta_7\, Concentration_{i,t} + \varepsilon_{i,t}, \quad (1)$$

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 control variables as described in detail in Section 4.1.3. $\varepsilon_{i,t}$ 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 employ 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 $\rho < 0.000$ indicating that 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. 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 homoskedasticity 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.[6]

Finally, we control for multicollinearity concerns among our independent variables by computing two collinearity diagnostic measures. Both measures, the mean variance inflation factor (VIF = 2.34) of all right-hand side variables from our baseline regression as well as the value of the conditional number (6.9968) indicate that multicollinearity is not a concern.

5. Empirical results

5.1. Baseline results

In the appendix, results from our baseline regressions and robustness checks are shown in Table 6. Tables 7a – 7c display empirical findings from several sensitivity analyses.

[6] Petersen (2009) shows that an insufficient number of clusters may bias the results even when having clustered in the right dimension. In this case, it is suggested to address the time-dependence parametrically and cluster at the bank-level. Nevertheless, we implement double-clustered standard errors with 57 banks 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.

As reported by Table 6, the securitization measure (*Securitization*) enters regression specification (1) significantly negative at the one-percent level suggesting that true sale loan securitization may reduce NPLRs of European banks during the entire sample period. In addition, as we find that securitization provokes a decrease in NPLRs by 9.09 per cent, we provide evidence for an economically relevant impact.

Our finding indicates that European banks from our sample may primarily employ true sale securitization as an instrument of credit risk transfer, and less as an alternative funding source. In addition, our result does not support theoretical arguments from the agency theory suggesting that issuing banks provide credit enhancement by retaining high-risk NPLs within the FLP on their balance sheets as a quality and reputation signal or to demonstrate "skin in the game" (Franke et al., 2012; Hartman-Glaser et al., 2012; Albertazzi et al., 2015).

As regards empirical evidence provided by previous most related studies, our baseline result supports findings from Affinito and Tagliaferri (2010) as well as Casu et al. (2011), who empirically show that securitization reduces exposures of bad and non-performing loans in Italian banks and U.S. BHCs during the pre-GFC period. However, our baseline result does not support evidence provided by Bedendo und Bruno (2012) suggesting an NPL-increasing effect through loan securitization for U.S. commercial banks.

Turning to the bank-specific control variables, regression specification (1) initially reports that $Capital_{t-1}$ enters the regression significantly positive at the ten-percent level. Our finding of a positive impact on NPL exposures supports previous empirical evidence suggesting that better capitalized and hence, less leveraged banks have higher NPL exposures since they may face weaker debt covenants and higher shareholder pressure (Gambacorta and Mistrulli, 2004). Accordingly, and as discussed in Section 2.2., NPL exposures may increase when shareholders exert pressure to pursue a more profitable but riskier reinvestment strategy after securitization, which is less monitored by debt holders (Rajan and Zingales, 1995; Altunbas et al., 2009).

As further shown, the coefficient of *Earnings* turns out to be significantly negative at the one-percent level. Our finding corresponds to the "gambling for resurrection"-hypothesis (Freixas et al., 2004; Boyd and Hakenes, 2014), proposing that less profitable banks may be more prone to excessive risk-taking, i.e., they use cash inflows from securitization to invest in more profitable but riskier loans, which may increase an issuing bank's NPL exposure due to the "risk-return trade-off".

Finally, *Liquidity* enters the regression significantly negative at the one-percent level indicating that an increase in liquidity reduces the NPLRs. Taking into account the liquidity-motive of securitization (e.g., Loutskina, 2011) as outlined in Section 2.1., we argue that banks with higher liquidity resources and hence, less financial needs, may primarily employ securitization as an instrument of credit risk transfer in order to reduce NPL exposures.

Turning to the country-specific control variables, it is initially shown that the change of the slope of the yield curve (Δ*Yield Curve*) exhibits a significantly negative impact on the issuing banks' NPLRs. As expected, the negative coefficient reveals that NPL exposures may decrease during a prospering economy (Louzis et al., 2012; Klein, 2013; Ghosh, 2015; Beck et al., 2015).

Introducing the change in unemployment rates (Δ*Unemployment*), this variable enters the regression significantly positive at the one-percent level. The positive impact 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 (Louzis et al., 2012; Klein, 2013; Ghosh, 2015).

Finally, the measure of *Concentration* enters the regression significantly negative at the five-percent level. Our finding supports the "concentration-stability view" proposing that monopolistic securitizing banks, which operate in more concentrated markets, may engage in less risky (loan) investments (after securitization) in order to protect their monopoly rents and higher franchise values (Keeley, 1990). Furthermore, monopolistic securitizing banks may have better access to borrower-specific information, advantages in providing loan monitoring services and a more

efficient selection process of high-quality borrowers, which – in sum – may result in a better loan portfolio quality (Marquez, 2002; Uhde and Heimeshoff, 2009).

5.2. Robustness checks

In this section, we control for the robustness of our baseline findings. Results from the different robustness checks are displayed in Table 6, regression specifications (2) – (4) in the appendix.

To begin with, as outlined in Sections 2.1. and 2.2. the "regulatory capital arbitrage hypothesis" (Acharya et al., 2013) proposes that former Basel I regulations set an incentive for banks to retain the most-risky FLP since capital regulations under Basel I were not risk-sensitive. Hence, as loans were not risk-adjusted but globally backed up with equity capital, securitizing less risky loans and retaining high-risk NPLs within the FLP provoked regulatory capital arbitrage (Ambrose et al., 2005; Bannier and Hänsel, 2008).

We control for this aspect and generate a dummy variable that takes on the value of one for the sample years when Basel I was in effect (1997 – 2006), and zero otherwise. Subsequently, we interact the dummy variable with the securitization measure. As shown in specification (2), the interaction term enters the regression significantly negative at the ten-percent level, while the coefficient-value is slightly lower as compared to the coefficient from the baseline regression. Accordingly, the robustness check indicates that true sale loan securitization is also used as an instrument of credit risk transfer under Basel-regulations. In addition, as we find that the amount of securitized NPLs does only slightly decrease, results from the robustness check hardly support predictions provided by the "regulatory capital arbitrage hypothesis".

In a second check, we control for the robustness of our baseline finding implying that securitization is first and foremost used as an instrument of credit risk transfer. We argue that employing securitization to transfer high-risk NPLs should reduce the distance to default for European banks from our sample. Taking this into account, we include the modified version of the Altman Z-score (Altman, 2000) as an alternative dependent variable.

The Z-score has become a popular measure of bank soundness in previous empirical studies and is denoted as follows:

$$Z\_score_{i,t} \equiv \frac{\mu_{i,t}+k_{i,t}}{\sigma_{i,t}} \tag{2}$$

We construct the log of the Z-score per bank i and each single year t and define μ as the return on average assets before taxes (ROAA), k as the equity capital in percent of total assets and σ as the standard deviation (volatility) of the ROAA. Building the Z-score this way, the measure is designed to indicate the number of standard deviations a bank's asset return has to drop below its expected value before the bank's equity is depleted and the bank becomes insolvent. Hence, a higher (lower) Z-score implies a lower (higher) probability of insolvency risk.

As shown by specification (3), the securitization measure enters the regression significantly positive at the ten-percent level while the control variables exhibit expected signs and significances. Our result indicates that securitization may increase the distance to default of European banks and thus, promotes financial soundness. Accordingly, results from the robustness check support our baseline finding that securitization is primarily used as a risk-transfer instrument, which is not in line with previous evidence provided by Bedendo and Bruno (2012) who observe a decrease in the Z-score for U.S. commercial banks during non-crisis periods.

Finally, we control for the robustness of the baseline results from the linear fixed effects panel model. Although, two collinearity diagnostic measures (the mean variance inflation factor (VIF) and the value of the conditional number) indicate that multicollinearity is not a concern (Section 4.2.), we employ a dynamic panel model estimator in order to investigate if our baseline findings are biased due to endogeneity concerning the NPL measure, the securitization measure and the bank-specific control variables as well as a likely persistence in the time series of our NPL data.

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) to control for a probable bias.[7]

In line with our baseline model, we estimate this model with robust standard errors clustered at the bank-level and include time dummies:

$$\begin{aligned} y_{i,t} = {} & \alpha + \delta\, y_{i,t-1} + \gamma\, Securitization_{i,t} + \beta_1\, Capital_{i,t-1} + \beta_2\, Management_{i,t-1} \\ & + \beta_3\, Earnings_{i,t} + \beta_4\, Liquidity_{i,t} + \beta_5\, \Delta YieldCurve_{i,t} + \beta_6\, \Delta Unemployment_{i,t} \\ & + \beta_7\, Concentration_{i,t} + \varepsilon_{i,t}, \end{aligned} \tag{3}$$

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 NPLR. The additional input parameters include the securitization measure and control variables as employed in the linear fixed-effects OLS regression. The independently and identically distributed error term is represented by $\varepsilon_{i,t}$. α, δ, γ and the βs denote the parameters to be estimated.

We instrument the country-specific macroeconomic and banking market determinants in IV-style (instrumented by themselves) and consider them as *strictly exogenous* regressors (Louzis et al., 2012; Klein, 2013). As regards the securitization measure and the bank-specific control variables, the assumption of a *strict exogeneity* is too restrictive and probably 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

[7] 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).

variables might be correlated with the error term, which should 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 the securitization measure as a *strictly endogenous* explanatory variable. Accordingly, we instrument the securitization measure with GMM-conditions by using at least second lag orders 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 considered 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. 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.[8] Moreover, in order to control for instrument proliferation, we restrict the instrument count by collapsing the instrument set (Roodman, 2009).[9]

[8] 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). As shown in Table 6, regression specification (2), our dynamic panel framework satisfies the requirements concerning the AR(1) and AR(2) tests suggesting that our dynamic panel regression results are consistent.

[9] 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.

Employing the one-step system-GMM estimator generates empirical results as reported in regression specification (4). As shown, the one-year lagged NPLR measure ($NPLR_{t-1}$) exhibits a significantly high coefficient value of 0.9231 indicating a time persistence in our series of NPL data. However, as also revealed, the coefficient of the securitization measure is still significantly negative while its value has only marginally decreased as compared to our baseline findings from the linear fixed-effects regression in specification (1). Accordingly, and since results from the control variables are qualitatively reiterated even when employing a dynamic estimator, we rule out that our baseline results are severely biased by endogeneity problems and a time persistence in our NPL data.

5.3. Sensitivity analyses

In this section, we present and discuss a variety of sensitivity analyses. The aim is to investigate securitization-NPL nexus more deeply by focusing on (i) different time periods of securitization activities in Europe, (ii) the degree of standardization (opaque and non-opaque transactions), (iii) the respective underlyings of a securitization transaction, (iv) the issuing frequency of securitization transactions, (v) different levels of NPLRs on the issuing banks' balance sheets as well as the (vi) the systemic importance of an issuing bank (G-SIBs and non-G-SIBs). Results from these sensitivity analyses are reported by Tables 7a - 7c in the appendix.

Different time periods of securitization activities

To begin with, we control if our overall finding of an NPLR-decreasing effect varies during different time periods of securitization activities in Europe (regression specifications (1) – (3), Table 7a). Referring to Figure 2 and in line with Farruggio and Uhde (2015), 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 period during and afterwards the GFC as the crisis stage (2008 – 2010). Subsequently, we build three dummy

variables (*Onset*, *Boom*, *Crisis*), which take on the value of one for the years of the respective stage, and zero otherwise. Finally, interaction variables from multiplying the securitization measure with each dummy variable are built and included in the specifications, respectively.

Onset stage. As initially shown by regression specification (1), 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.

Boom stage. Turning to results from the boom stage as reported by specification (2), the empirical analysis reiterates the negative impact of securitization on the issuing banks' NPLRs from our baseline regression. However, as further shown, the NPLR-decreasing impact of securitization has almost doubled during this stage as compared to the entire sample period. Our result is not in line with findings provided by Bedendo and Bruno (2012) suggesting that securitizing banks exhibit a higher proportion of NPL exposures on their balance sheets during the pre-crisis period. In contrast, results from the boom stage imply that true sale securitization is more intensively used as an instrument of credit risk transfer (and less as an alternative funding source) during this time period. Taking this into account, we do not provide evidence that banks provided credit enhancement or gained from capital regulatory arbitrage under Basel I-regulations by retaining high-risk NPLs within the FLP during the boom period of securitizations in Europe.

Crisis stage. However, results reverse when considering the crisis stage (specification (3)). As expected, and in line with findings from previous studies, the significantly positive coefficient of the dummy variable (*Crisis*) underlines that NPLRs have increased per se during the crisis period (Keys et al., 2010). More interesting, however, the positive coefficient of the interaction variable implies that securitization was not (predominantly) employed as an instrument of credit risk transfer during and afterwards the GFC. In contrast, our results support the belief that – during and after the GFC – especially banks with severe financial needs primarily used securitization to diversify their funding sources and raise fresh liquidity. In addition, our finding underlines that banks were forced to provide credit enhancement and to show "skin in the game" by retaining

high-risk NPLs within the FLP due to increasing information asymmetries and a growing investors' mistrust in securitization activities during and after the crisis period (Acharya et al., 2009; Di Patti and Sette, 2016; AFME, 2018).

Our result is in line with empirical evidence provided by Bedendo und Bruno (2012) suggesting an NPL-increasing effect through loan securitization for U.S. commercial banks during the GFC-period. In addition, our result complements and extends findings from a previous empirical study provided by Battaglia et al. (2021), who analyze the relationship between securitization and crash risk, which is defined as bank-specific extreme return movements. Employing a sample of 37 stock-listed European banks from 11 European countries over the period between 2000 and 2017, Battaglia et al. (2021) find an overall crash risk-reducing effect in the year of securitization. However, and similar to our results, they also provide evidence that the reduction of crash risk is weaker during the crisis period as compared to normal times. Accordingly, while our result supports previous findings provided by Battaglia et al. (2021), the analysis at hand even reveals a (weak) risk-increasing effect during the crisis period.

Opaque vs. non-opaque transactions

Next, 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 (*Other*). 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 receivables (CCs) and consumer loans (CLs).

As reported by regression specifications (1) and (2) in Table 7b, we provide evidence that both, opaque and non-opaque securitization transactions provoke a reduction in the issuing banks'

NPLRs. Furthermore, the NPLR-reducing effect is almost four times stronger in case of opaque transactions. Taking this into account, our results indirectly support previous findings provided by Battaglia et al. (2021) who empirically demonstrate that an issuing bank's crash risk decreases due to less complex (non-opaque) rather than opaque securitization transactions.

Supporting Battaglia et al. (2021), who recommend enhancing disclosure requirements so that investors can capture whether banks securitize opaque loans, we find that especially opaque transactions, including CDOs 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, lead to stronger information asymmetries between issuers and investors (Hartman-Glaser et al., 2012). Indeed, lessons learned from the GFC show that investors, rating agencies and regulators underestimated risks from opaque securitization 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 shown by regression specifications (3) – (8) in Table 7b, securitization transactions including *CDOs*, *RMBS*s, *CLs* and other unspecified loans (*Other*) enter respective regressions significantly negative. Our findings correspond to previous studies for the U.S. banking market providing evidence of a negative impact of securitized RMBSs and CLs on the issuing bank's credit risk and NPL exposure (Uzun and Webb, 2007; Jiangli and Pritsker, 2008; Casu et al., 2011).

As observed during the GFC, especially asset backed CDOs and RMBSs were characterized by high default rates of low-quality borrowers combined with a lower degree of transparency, which repeatedly led to biased loan and collateral ratings (Duffie, 2008; Griffin and Tang, 2012; Piskorski et al., 2015). Thus, as information asymmetries increased, especially CDOs and RMBSs provided a stronger incentive for banks to exploit their information advantage and securitize NPLs.

Issuing frequency

As shown by Figures 4 and 5, some of the banks in our sample securitize more than once during the sample period ("frequent issuers"). Thus, we additionally investigate whether multiple securitizations have a different impact on the issuing banks' NPL exposures in a next sensitivity analysis. To do so, we split the entire sample into frequent-securitizers (*FS*) and non-frequent securitizers (*Non-FS*) with regard to the transaction volume (FS_{Vol}, $Non\text{-}FS_{Vol}$) and the number of transactions (FS_{TA}, $Non\text{-}FS_{TA}$) respectively.

As reported by Table 7c, regression specifications (1) - (4), we find a significant reduction of NPLRs through securitization for non-frequently issuing banks only. Hence, we do not provide evidence that repeatedly securitizing banks may have a better access to capital markets and may be more prone to build a reputation that enables them to transfer high-risk NPLs out of their balance sheets. In contrast, our findings support the "asset deterioration"-hypothesis suggesting that in particular high-frequently issuing banks tend to retain larger parts of the riskiest FLP including NPLs (Greenbaum and Thakor, 1987; Instefjord, 2005).

Different levels of NPLRs

We proceed and control if our baseline findings are triggered by different amounts of NPL exposures. Accordingly, we split the entire dataset into a subsample that includes banks with average NPLR-values above the sample mean NPLR-value ($NPLR_{above}$) and a respective subsample of banks with average NPLR-values below the sample mean NPLR-value ($NPLR_{below}$).[10]

The sensitivity analysis reveals that the NPLR-reducing effect through securitization is nearly five times larger for those 20 banks that exhibit higher NPLRs (Table 7c, specification (5) and (6)). As expected, our finding points to the fact that higher levels of NPLRs may more strongly

[10] The mean of the NPLR is at 0.0254 for those banks with an average NPLR-value above the sample mean, whereas it is at 0.0108 for those banks with an average NPLR-value under the sample mean.

incentivize banks to use securitization as an instrument of credit risk transfer (Jiangli and Pritsker, 2008; Affinito and Tagliaferri, 2010; Uhde and Michalak, 2010).

G-SIBs vs. non-G-SIBs

Finally, we investigate if classifying a bank as systemically important may change our baseline finding. The Financial Stability Board (FSB) classifies financial institutions as global systemically important banks (G-SIBs) and non-G-SIBs using the criteria of size, cross-jurisdictional activity, complexity, interconnectedness and substitutability. We follow the FSB's classification and define two subsamples of *G-SIBs* and *Non-G-SIBs* with regard to the banks from our sample.[11]

As shown by regression specifications (7) and (8) in Table 7c, we find a significant reduction of NPLRs through securitization for non-G-SIBs only. Considering that non-G-SIBs may less rely on governmental aid under the "too-big-to-fail doctrine" (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.

6. 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 securitization and the issuing banks' non-performing loans to total assets ratios.

[11] The following banks from our sample are identified as G-SIBs: 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) and Royal Bank of Scotland Group Plc.

Overall, we provide evidence for a negative impact of securitization on the issuing banks' NPL exposures suggesting that banks predominantly utilize securitization as an instrument of credit risk transfer and diversification. This finding is robust, economically relevant, and even holds when former Basel I-regulations set an incentive for banks to realize regulatory capital arbitrage by retaining the riskiest loans within the FLP.

However, we also provide evidence for a time-sensitive relationship between securitization and NPL exposures. Analyzing the boom phase of securitization activities in Europe, the analysis reveals an even stronger NPL-reducing effect through securitization supporting the credit risk transfer-motive of securitization. In contrast, the impact of securitization reverses during and after the GFC suggesting that banks were forced to provide credit enhancement as a quality and reputational signal by retaining high-risk NPLs within the FLP on their balance sheets. In addition, as European banks exhibited severe financial needs due to the crisis, our results imply that banks first and foremost employed securitization to diversify their funding sources and raise fresh liquidity during and after the crisis-period.

Finally, a variety of sensitivity analyses provides further important insights into the securitization-NPL nexus. Thus, we observe that the NPL-reducing effect is stronger for more complex and less transparent opaque securitization transactions, for transactions with underlying CDOs and RMBSs, for issuing banks exhibiting higher average levels of NPLRs as well as for non-frequently issuing and systemically less important banks.

The analysis at hand provides important policy implications as it contributes to the recent and vitally important debate on how to stipulate European banks to cut their large NPL-exposures. *On the one hand*, baseline results from our analysis generally support calls from European authorities and institutions to employ true sale securitization as an instrument to reduce non-performing loans at banks and thus, distribute loan risk more widely within the European financial system.

On the other hand, however, the analysis at hand also reveals that securitizing high-risk loans has limitations. *First*, the NPLR-reducing effect through securitization seems to be less effective

during financial crisis periods when information asymmetries increase and ABS investors' trust in issuing banks and rating agencies decreases. Under such conditions, issuing banks are forced to retain NPLs on their balance sheets in order to demonstrate "skin in the game". *Second*, as we do not find any empirical evidence for an NPLR-reducing effect through securitization especially at systemically important Europeanbanks, these banks may have a weaker incentive to securitize NPLs but rather expect a governmental bail-out in case they fail. *Third*, the European securitization market has still not fully recovered from its drying-up as a consequence of the GFC. Accordingly, if securitization is believed to be an effective instrument to allocate NPLs to institutional, sophisticated capital market investors who search for high-risk and high-return investments, the revitalization process of the European securitization market needs to move forward. In this context, recent 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. Especially STS-transactions should contribute to restore trust in ABS and mitigate information asymmetries, which is imperative when securitizing high-risk loans.

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Empirical appendix

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

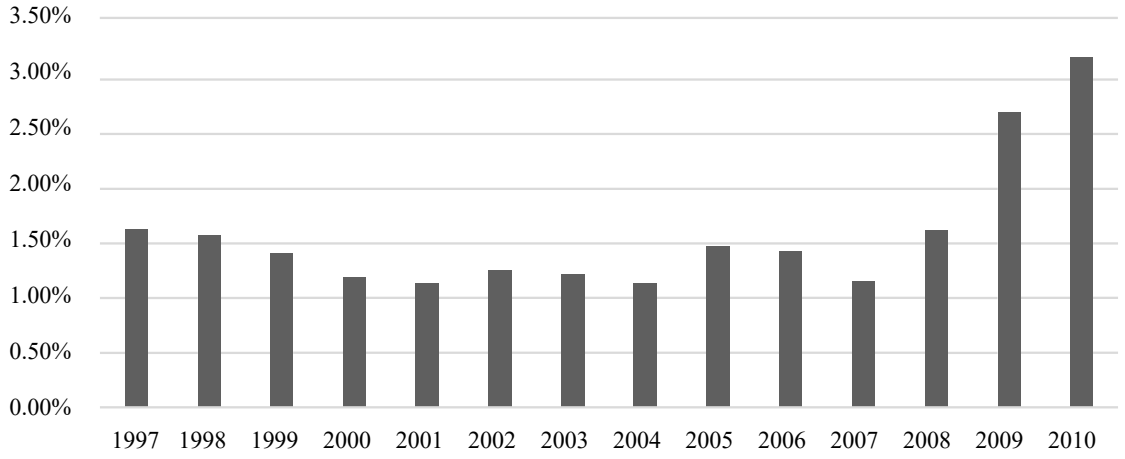

Figure 2: Development of the aggregated volumes (in billion Euro) and the aggregated numbers of true sale securitization transactions from sample banks

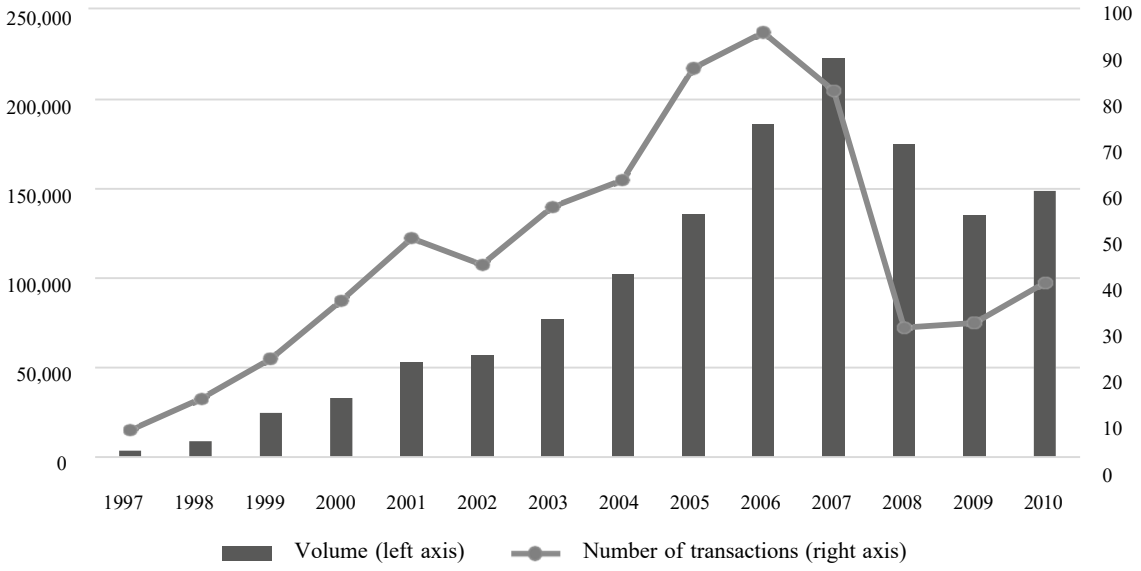

Figure 3: Percentage of sample banks that engaged in the true sale securitization business per year

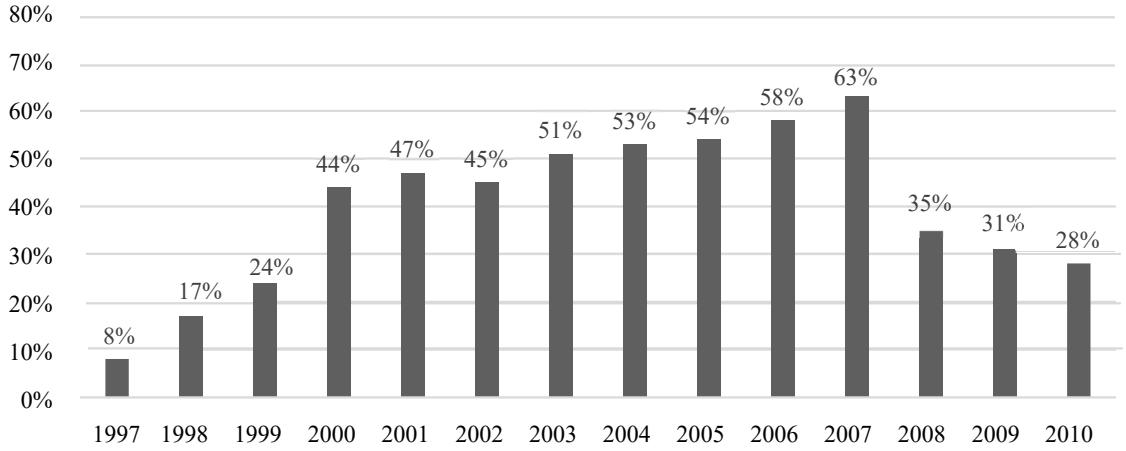

Figure 4: Frequent securitizers by the volume of true sale securitization transactions

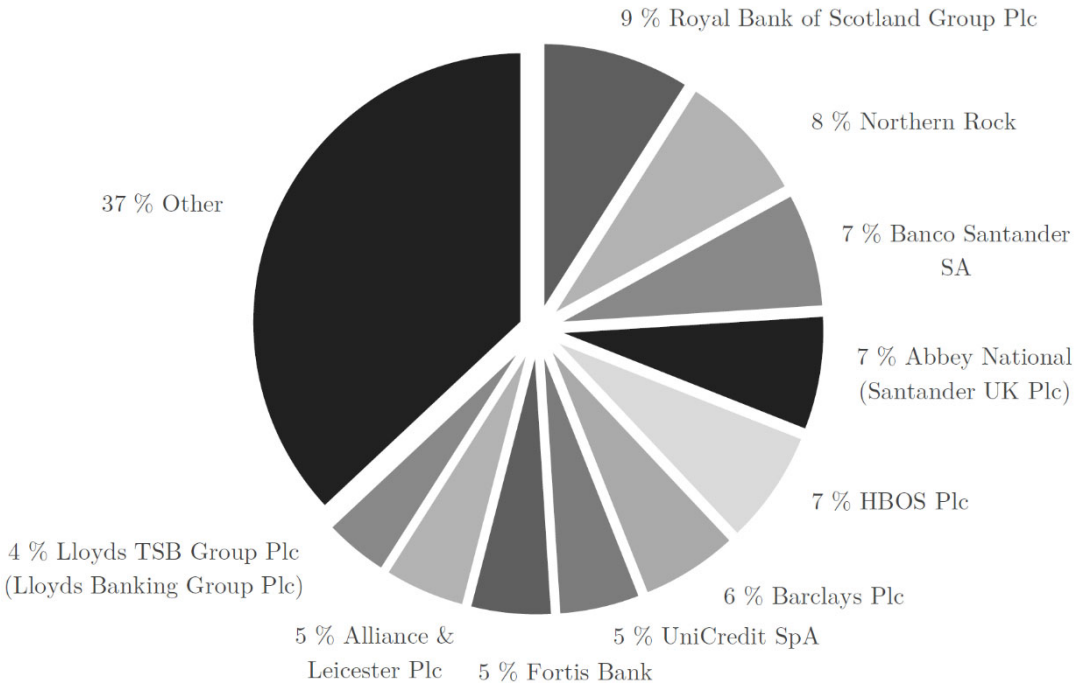

Figure 5: Frequent securitizers by the number of true sale securitization transactions

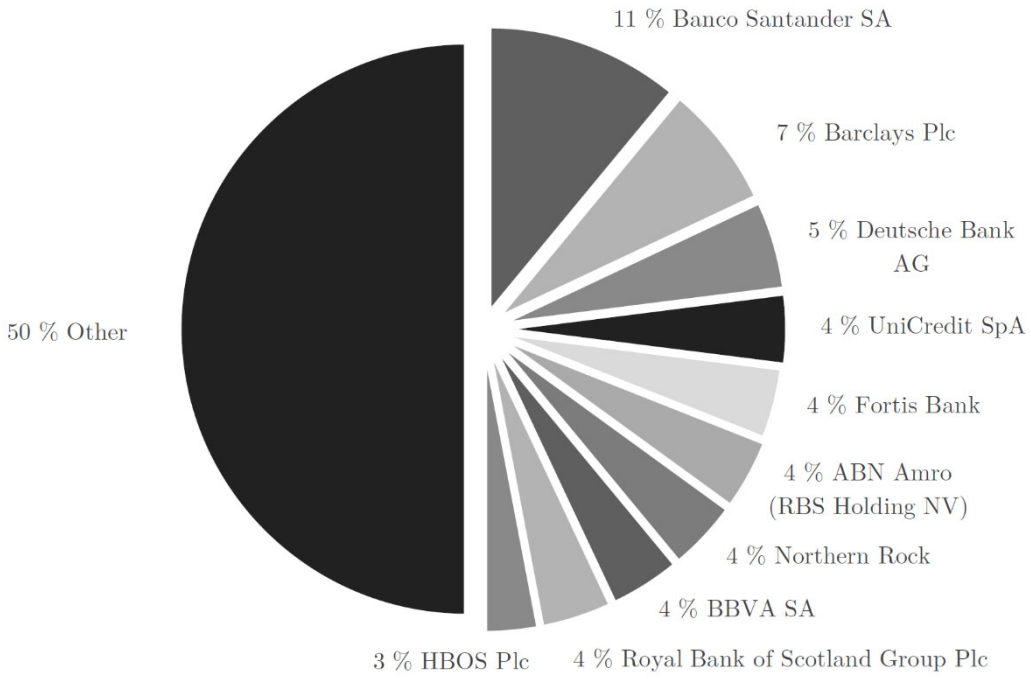

Table 1: Geographical distribution of true sale securitizing banks in the sample

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

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

	Obs	Total Volume	Mean	Std.Dev.	Min	Max
Underlying loan portfolio						
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	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.	
Z-score	Natural logarithm of the sum of equity capital to total assets and the return on average assets before taxes (ROAA) divided by the standard deviation of ROAA per bank and year.	BankScope, authors' calc.
Securitization variables		
Securitization	Ratio of a banks' cumulated volume of true sale securitizations to total assets per year.	Moody's, Standard & Poor's, FitchRatings
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.	

Continued on next page

Table 3: Notes on variables and data sources – continued

Variable	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.	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 cost-to-income ratio indicates higher management inefficiency.	
Earnings	Accounting value of a bank's return on average assets (ROAA) per year.	
Liquidity	Ratio of the accounting value of a bank's liquid assets to total assets per year.	
Macroeconomic and institutional 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.	Refinitiv's Eikon, own calc.
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.	World Bank's WDI
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 DataWarehouse, SNB
Basel I	Dummy variable that takes on the value of one for the sample years when Basel I was in effect (1997- 2006), and zero otherwise.	Own calc.
Time variables		
Onset	Dummy variable that takes on the value of one for the years from 1997 to 2001 (onset stage), and zero otherwise.	Own calc.
Boom	Dummy variable that takes on the value of one for the years from 2002 to 2007 (boom stage), and zero otherwise.	
Crisis	Dummy variable that takes on the value of one if for the years from 2008 to 2010 (crisis stage), and zero otherwise.	

Table 4: Descriptive statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Dependent variable					
NPLR	709	0.0158	0.0148	0.0001	0.1063
$NPLR_{t-1}$	690	0.0147	0.0131	0.0001	0.1063
Z-score	753	3.3529	1.2783	–1.3005	9.1764
Securitization variables					
Securitization	757	0.0092	0.0231	0	0.2517
Opaque	757	0.0017	0.0058	0	0.0585
Non-Opaque	757	0.0075	0.0218	0	0.2517
CDO	757	0.0012	0.0053	0	0.0585
RMBS	757	0.0070	0.0215	0	0.2517
CMBS	757	0.0002	0.0011	0	0.0149
CC	757	0.0001	0.0009	0	0.0169
CL	757	0.0003	0.0017	0	0.0255
Other	757	0.0005	0.0025	0	0.0292
Bank-specific variables					
$Capital_{t-1}$	706	0.0534	0.0235	0.0061	0.1606
$Management_{t-1}$	697	0.8229	0.1728	0.2854	4.1562
Earnings	757	0.0058	0.0061	–0.0636	0.0330
Liquidity	749	0.2023	0.1241	0.0136	0.6495
Macroeconomic variables					
ΔYield Curve	778	0.0004	0.0067	–0.0203	0.0208
ΔUnemployment	799	–0.0009	0.0131	–0.0350	0.0660
Concentration	799	0.0569	0.0459	0.0114	0.2167
Basel I	799	0.7134	0.4525	0	1
Time variables					
Onset	799	0.3571	0.4795	0	1
Boom	799	0.4286	0.4952	0	1
Crisis	799	0.2143	0.4106	0	1

Table 5: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) NPLR	1.00										
(2) $NPLR_{t-1}$	0.85***	1.00									
(3) Z-score	–0.02	0.04	1.00								
(4) Securitization	–0.16***	–0.18***	0.02**	1.00							
(5) $Capital_{t-1}$	0.06	0.08**	0.20***	–0.03	1.00						
(6) $Management_{t-1}$	–0.06	–0.06	–0.09	–0.08**	–0.31***	1.00					
(7) Earnings	–0.30***	–0.17***	0.16***	0.02	0.40***	–0.29***	1.00				
(8) Liquidity	–0.15***	–0.06	–0.02	–0.23***	–0.23***	0.23***	–0.15***	1.00			
(9) ΔYield Curve	0.02	–0.08**	0.07*	0.01	–0.08**	0.12***	–0.24***	–0.11***	1.00		
(10) ΔUnemployment	0.28***	0.09**	–0.02	–0.03	–0.11***	0.05	–0.23***	–0.02	0.18***	1.00	
(11) Concentration	–0.17***	–0.20***	0.09***	–0.03	–0.13***	0.22***	0.01	–0.16***	0.02	0.10**	1.00

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

Table 6: Baseline regressions and robustness checks

	(1) NPLR Fixed Effects	(2) NPLR Fixed Effects	(3) Z-score Fixed Effects	(4) NPLR System-GMM
$NPLR_{t-1}$				0.9231***
				(0.000)
Securitization	–0.0909***	–0.0401	8.2795*	–0.0750*
	(0.005)	(0.283)	(0.089)	(0.069)
Basel I		–0.0101***		
		(0.000)		
Securitization * Basel I		–0.0792*		
		(0.073)		
$Capital_{t-1}$	0.1079*	0.1107*	2.3437	–0.0287
	(0.073)	(0.066)	(0.633)	(0.613)
$Management_{t-1}$	–0.0028	–0.0032	0.1961	0.0003
	(0.248)	(0.208)	(0.647)	(0.877)
Earnings	–0.6337***	–0.6373***	49.6671**	–0.4182***
	(0.000)	(0.000)	(0.010)	(0.006)
Liquidity	–0.0282***	–0.0282***	–0.3167	–0.0267***
	(0.006)	(0.006)	(0.649)	(0.003)
ΔYield Curve	–0.2907*	–0.3086**	2.2008	–0.1831
	(0.068)	(0.048)	(0.872)	(0.109)
ΔUnemployment	0.2672***	0.2415***	–10.5974***	0.1008***
	(0.000)	(0.000)	(0.005)	(0.000)
Concentration	–0.1232**	–0.1214**	5.1631	–0.0328***
	(0.044)	(0.047)	(0.369)	(0.002)
Cluster bank-level	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES
No. of observations	646	646	667	637
No. of groups	57	57	57	57
Adj. R^2	0.3294	0.3307	0.0597	
F-statistic				63.29***
Number of instruments				34
Hansen J				16.66*
Arellano/Bond AR(1)				–3.38***
Arellano/Bond AR(2)				0.40

The linear fixed effects panel model estimated by regression specifications (1) and (2) is $NPLR_{(i=bank,\ t=\ time)} = \alpha_i + \gamma\ Securitization_{i,t} + \beta_1\ Capital_{i,t-1} + \beta_2\ Management_{i,t-1} + \beta_3\ Earnings_{i,t} + \beta_4\ Liquidity_{i,t} + \beta_5\ \Delta Yield\ Curve_{i,t} + \beta_6\ \Delta Unemployment_{i,t} + \beta_7\ Concentration_{i,t} + \varepsilon_{i,t}$. Regression specification (1) shows results from the baseline regression while specification (2) adds the Basel I-dummy and a respective interaction variable. In specification (3), the NPLR is substituted by the log of the Z-score as an alternative risk measure. Regression specification (4) reports results from a one-step system-GMM dynamic panel model. This model is estimated as $NPLR_{(i=bank,t=time)} = \alpha + \delta\ NPLR_{i,t-1} + \gamma\ Securitization_{i,t} + \beta_1\ Capital_{i,t-1} + \beta_2\ Management_{i,t-1} + \beta_3\ Earnings_{i,t} + \beta_4\ Liquidity_{i,t} + \beta_5\ \Delta Yield\ Curve_{i,t} + \beta_6\ \Delta Unemployment_{i,t} + \beta_7\ Concentration_{i,t} + \varepsilon_{i,t}$. 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 Onset stage (1997-2001)	(2) NPLR Boom stage (2002-2007)	(3) NPLR Crisis stage (2008-2010)
Securitization	–0.0929*** (0.003)	0.0265 (0.586)	–0.1233*** (0.001)
Onset	–0.0115*** (0.003)		
Securitization * Onset	0.0284 (0.691)		
Boom		–0.0090*** (0.001)	
Securitization * Boom		–0.1521*** (0.003)	
Crisis			0.0089*** (0.001)
Securitization * Crisis			0.2048** (0.028)
$Capital_{t-1}$	0.1089* (0.069)	0.1170** (0.045)	0.1194* (0.051)
$Management_{t-1}$	–0.0028 (0.256)	–0.0031 (0.197)	–0.0035 (0.160)
Earnings	–0.6344*** (0.000)	–0.6501*** (0.000)	–0.6504*** (0.000)
Liquidity	–0.0283*** (0.006)	–0.0300*** (0.005)	–0.0295*** (0.004)
ΔYield Curve	–0.2913* (0.068)	–0.3340** (0.026)	–0.3448** (0.017)
ΔUnemployment	0.2485*** (0.000)	0.2521*** (0.000)	0.2446*** (0.000)
Concentration	–0.1241** (0.043)	–0.1311** (0.026)	–0.1272** (0.040)
Cluster bank-level	YES	YES	YES
Time dummies	YES	YES	YES
No. of observations	646	646	646
No. of groups	57	57	57
Adj. R^2	0.3298	0.3292	0.3329

The linear fixed effects panel model and estimation parameters are defined in Table 6. Regression specifications (1) to (3) analyze the relationship between securitization and the issuing banks' non-performing loan rations (NPLRs) during different time periods (onset stage (1997-2001), boom stage (2002-2007), crisis stage (2008-2010)) 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 7b: Sensitivity analyses II

	(1) NPLR Opaque	(2) NPLR Non-opaque	(3) NPLR CDO	(4) NPLR RMBS	(5) NPLR CMBS	(6) NPLR CC	(7) NPLR CL	(8) NPLR Other
Opaque	–0.2476***							
	(0.000)							
Non–Opaque		–0.0688*						
		(0.053)						
CDO			–0.2107***					
			(0.000)					
RMBS				–0.0661*				
				(0.069)				
CMBS					0.3049			
					(0.208)			
CC						–0.1308		
						(0.629)		
CL							–0.3404	
							(0.111)	
Other								–0.4399**
								(0.047)
$Capital_{t-1}$	0.1181**	0.1071*	0.1148*	0.1079*	0.1136*	0.1121*	0.1099*	0.1168*
	(0.047)	(0.076)	(0.052)	(0.074)	(0.056)	(0.061)	(0.064)	(0.054)
$Management_{t-1}$	–0.0034	–0.0029	–0.0033	–0.0029	–0.0032	–0.0033	–0.0033	–0.0033
	(0.186)	(0.231)	(0.188)	(0.229)	(0.185)	(0.183)	(0.182)	(0.177)
Earnings	–0.6292***	–0.6278***	–0.6283***	–0.6291***	–0.6233***	–0.6199***	–0.6159***	–0.6192***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Liquidity	–0.0276***	–0.0276***	–0.0277***	–0.0275***	–0.0265**	–0.0268**	–0.0270***	–0.0264***
	(0.007)	(0.008)	(0.008)	(0.008)	(0.010)	(0.010)	(0.009)	(0.009)
ΔYield Curve	–0.3243**	–0.2954*	–0.3209**	–0.2970*	–0.3149**	–0.3157**	–0.3157**	–0.3227**
	(0.044)	(0.061)	(0.046)	(0.060)	(0.049)	(0.048)	(0.049)	(0.046)
ΔUnemployment	0.2546***	0.2500***	0.2570***	0.2504***	0.2558***	0.2561***	0.2547***	0.2517***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Concentration	–0.1300**	–0.1193*	–0.1266**	–0.1187*	–0.1191*	–0.1195*	–0.1220*	–0.1232*
	(0.042)	(0.054)	(0.047)	(0.055)	(0.063)	(0.062)	(0.061)	(0.056)
Cluster bank–level	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
No. of observations	646	646	646	646	646	646	646	646
No. of groups	57	57	57	57	57	57	57	57
Adj. R^2	0.3081	0.3256	0.3139	0.3243	0.3090	0.3100	0.3123	0.2976

The linear fixed effects panel model and estimation parameters are defined in Table 6. Regression specifications report results for (1) opaque and (2) non-opaque transactions as well as 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 7c: Sensitivity analyses III

	(1) NPLR FS_{Vol}	(2) NPLR Non-FS_{Vol}	(3) NPLR FS_{TA}	(4) NPLR Non-FS_{TA}	(5) NPLR $NPLR_{above}$	(6) NPLR $NPLR_{below}$	(7) NPLR G-SIB	(8) NPLR Non-G-SIB
Securitization	–0.0483	–0.0974**	–0.0846	–0.0795*	–0.1980**	–0.0523**	0.0356	–0.0878***
	(0.284)	(0.029)	(0.201)	(0.051)	(0.035)	(0.037)	(0.739)	(0.010)
$Capital_{t-1}$	–0.1431	0.1469**	0.0939	0.1086*	0.0349	0.0081	0.0837	0.0722
	(0.623)	(0.013)	(0.775)	(0.070)	(0.796)	(0.896)	(0.524)	(0.272)
$Management_{t-1}$	0.0023	–0.0021	–0.0025	–0.0080	0.0139	–0.0016	0.0034	–0.0031
	(0.908)	(0.390)	(0.463)	(0.282)	(0.367)	(0.503)	(0.703)	(0.255)
Earnings	–1.0594**	–0.5852***	–0.6646	–0.6315***	–0.7398***	–0.3372**	–0.7959*	–0.6045***
	(0.040)	(0.000)	(0.156)	(0.000)	(0.001)	(0.024)	(0.076)	(0.000)
Liquidity	–0.0473*	–0.0303***	0.0062	–0.0339***	–0.0224	–0.0218**	–0.0176	–0.0298***
	(0.057)	(0.006)	(0.805)	(0.002)	(0.429)	(0.034)	(0.387)	(0.008)
ΔYield Curve	–0.7715***	–0.1520	–0.7650**	–0.2107	–0.6504**	–0.0014	–0.3375*	–0.3067
	(0.002)	(0.459)	(0.034)	(0.198)	(0.018)	(0.994)	(0.071)	(0.191)
ΔUnemployment	0.0698	0.2943***	0.0406	0.2815***	0.1443	0.2654***	0.1690**	0.2307***
	(0.469)	(0.000)	(0.592)	(0.000)	(0.146)	(0.000)	(0.031)	(0.000)
Concentration	–0.8301	–0.1197**	–0.3110	–0.1192*	–0.3432	–0.0547	0.0738	–0.2020***
	(0.153)	(0.030)	(0.283)	(0.060)	(0.404)	(0.225)	(0.464)	(0.010)
Cluster bank–level	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
No. of observations	105	541	113	533	226	420	185	461
No. of groups	10	47	10	47	20	37	15	42
Adj. R^2	0.1856	0.3058	0.1739	0.3188	0.3607	0.4499	0.0445	0.2891

The linear fixed effects panel model and estimation parameters are defined in Table 6. Regression specifications (1) and (3) include frequently issuing banks with regard to the transaction volume (FS_{Vol}) and the number of transactions (FS_{TA}), whereas specifications (2) and (4) comprise of non-frequently issuing banks with regard to the transaction volume (Non-FS_{Vol}) and the number of transactions (Non-FS_{TA}). Regression specification (5) includes a subsample of banks with average non-performing loan ratios above the sample mean ratio ($NPLR_{above}$), whereas specification (6) is employed for a subsample of banks exhibiting average non-performing loan ratios under the sample mean ratio ($NPLR_{below}$). Regression specifications (7) and (8) present results from a split of the entire sample into G-SIB and non-G-SIB financial institutions. 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.