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The relationship between credit risk transfer and non-performing loans – Evidence from European banks

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The relationship between credit risk transfer and non-performing loans - Evidence from European banks*

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Abstract

Employing a unique sample of 930 true sale and synthetic credit (risk) securitization transactions issued by 63 stock-listed banks across the EU-13 plus Switzerland over the period from 1997 to 2010, this paper empirically analyzes the relationship between credit (risk) securitization and non-performing loans. Using fixed effects panel estimations we provide evidence that credit (risk) securitizations reduce the issuing banks' non-performing loan ratios. This result can be explained by a direct and indirect effect. As regards the direct effect, results indicate that banks in our sample may (partly) securitize non-performing loans as the most risky tranche and do not fully retain these loans as the first-loss piece. Concerning the indirect effect, we provide empirical evidence for a more risk-averse credit investment strategy by banks after securitization, which might be due to the fact that bank managers are disciplined by explicit or implicit recourse arrangements from securitization transactions. Our baseline results remain robust even when controlling for endogeneity concerns and a potential persistence in the time series of the non-performing loan data. Findings from sensitivity analyses provide further important implications for banking regulators, the intense discussion on how to reduce the large amounts of non-performing loans in European banks' balance sheets as well as the ongoing process of revitalizing the European securitization market.

Keywords: Non-performing Loans, Securitization, European Banking, Capital Markets Union

JEL Classification: G21,G28,G32

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1 Introduction

As a result of the Global Financial Crisis (GFC) from mid-2007 and the European Sovereign Debt Crisis (ESDC) starting in 2009, many European banks suffer from large amounts of non-performing loans (NPLs) on their balance sheets. The Statistical Data Warehouse of the European Central Bank (ECB) reports that the gross amount of NPLs in the European Union (EU) amounted to a peak of more than €1 trillion in 2012/13. Since then, the amount of NPLs has decreased only marginally to a value of approximately €820 billions at the end of 2017.

The consequences of high NPL exposures are diverse. Initially, European banks exhibiting larger NPL exposures have higher funding costs and stronger capital requirements. Both aspects limit them to grant new loans and long-term economic growth may decrease if banks reduce their credit supply. This lack of lending can lead to severe financing shocks, which may also affect the real economy. High amounts of NPLs may also raise concerns about European banks' future profitability and the survivability of the their business models. In this context, banks may be incentivized to a 'gambling of resurrection', i.e. banks take on more profitable but more risky loans in order to reestablish financial soundness, which results in a distorted reallocation of loans (European Central Bank, 2017; European Commission, 2018). Finally, high amounts of NPLs in European banks' balance sheets may deteriorate the resilience and the sustainability of the entire European banking market due to an increasing systemic risk.

Taking these consequences into account, national authorities (parliaments, central banks) and European institutions including the European Commission, the European Systemic Risk Board (ESRB), the European Banking Authority (EBA) and the ECB have jointly released several proposals and initiatives[1] to extend the scope of guidance for banks concerning NPLs. In particular, the European Parliament and the ECB stress the need for a transfer of NPLs and their including risk exposure by means of credit (risk) securitizations (European Central Bank, 2017).

The GFC from mid-2007, however, impressively revealed that securitization markets were characterized by failures in valuating complex securitization transactions, a poor transparency and a weak market discipline resulting in widespread disturbances throughout the financial

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

system and a drying up of the European securitization market (Basel Committee on Banking Supervision, 2008; International Monetary Fund, 2008, 2009; Michalak and Uhde, 2012; di Patti and Sette, 2016; Association for Financial Markets in Europe, 2018a). As a reaction, the EU published several proposals that aim at revitalizing the European securitization market.[2] In particular, these proposals stress the necessity for simple, transparent and standardized (STS) securitizations in order to increase the liquidity and the reliability of the European securitization market. Moreover, STS securitizations are an essential part of the initiative to create a Capital Markets Union and should establish a more prudential framework by increasing transparency and harmonization as well as by reducing information asymmetry of securitization transactions (European Union, 2017b).

The Association for Financial Markets in Europe (AFME) basically supports the political agreement on the proposals for a STS securitization framework. However, the AFME additionally emphasizes that the recovery of the European securitization market strongly depends on the recalibration of supporting regulations e.g., the Capital Requirements Directive (CRD IV), the Capital Requirements Regulation (CRR) and Solvency II as well as technical standards on securitization retention rules, due diligence and disclosure requirements (Association for Financial Markets in Europe, 2017, 2018b). Hence, addressing regulatory requirements, which negatively affect the recovery of the European securitization market, is crucial for the successful launch of the STS framework.

Against this background, the paper at hand empirically investigates the relationship between credit (risk) securitization and NPLs. While a huge strand of the academic literature examines

[2] At the supranational level, the Basel Committee on Banking Supervision (BCBS) published a Basel III report on the *revisions to the securitization framework* in December 2014. In July 2015, the BCBS and the International Organization of Securities Commissions (IOSCO) presented jointly a set of *criteria for identifying simple, transparent and comparable securitizations*. At the EU level, the European Commission passed two important legislative regulations on (i) securitization transactions and (ii) capital requirements in December 2017: (i) Regulation (EU) 2017/2402 of the European Parliament and of the Council of 12 December 2017 laying down a general framework for securitization and creating a specific framework for simple, transparent and standardized securitization, and amending Directives 2009/65/EC, 2009/138/EC and 2011/61/EU and Regulations (EC) No 1060/2009 and (EU) No 648/2012 and (ii) Regulation (EU) 2017/2401 of the European Parliament and of the Council of 12 December 2017 amending Regulation (EU) No 575/2013 on prudential requirements for credit institutions and investment firms (European Union, 2017a,b). The Association for Financial Markets in Europe (AFME) has also published numerous press releases, discussion letters (e.g., Association for Financial Markets in Europe, 2018b) and publications (e.g., Association for Financial Markets in Europe, 2017) promoting the revitalization of the European securitization market. At the U.S. level, the Securities Industry and Financial Markets Association (SIFMA) released two white papers on *rebalancing the financial regulatory landscape* and *modernizing and rationalizing regulation of the U.S. capital markets* in May and August 2017 in order to reduce regulatory burdens of securitization transactions. Moreover, SIFMA encourages the harmonization of U.S. and EU rules to establish a level playing field for securitizers (Securities Industry and Financial Markets Association, 2017a,b).

bank-specific and macroeconomic determinants of NPLs[3], researchers have paid little attention to the relationship between securitization transactions and NPLs so far (see Section 3).

We close this gap by analyzing a unique sample of 930 true sale and synthetic securitization transactions issued by 63 stock-listed banks across the EU-13 plus Switzerland over the period from 1997 to 2010. Our analysis extends previous empirical studies for several aspects. *First*, to the best of our knowledge, this is the first study that empirically investigates whether credit (risk) securitizations may have an impact on an issuing bank's NPL exposure. *Second*, in order to gain a deeper understanding of the nexus between securitization and NPLs, we control for differences in terms of (i) the type of securitization transactions, (ii) the degree of standardization and (iii) the respective underlyings of a securitization. *Third*, while previous empirical studies examine bank-specific and/or country-specific determinants of NPLs, we extend the analysis by additionally including regulatory control variables.

We provide evidence that credit (risk) securitization reduces the issuing bank's non-performing loan ratio. Our result can be explained by a direct and indirect effect. As regards the direct effect, our finding indicates that banks in our sample may (partly) securitize NPLs as the most risky tranche and do not fully retain NPLs as the first-loss piece (Cantor and Rouyer, 2000; Jiangli et al., 2007; Krainer and Laderman, 2014). Concerning the indirect effect, we provide empirical evidence for a more risk-averse credit investment strategy by banks after securitization (Demsetz, 2000; Cebenoyan and Strahan, 2004; Affinito and Tagliaferri, 2010), which might be due to the fact that bank managers are disciplined by explicit or implicit recourse arrangements from securitization transactions (Vermilyea et al., 2008; Casu et al., 2011). Moreover, our study reveals that the negative relationship between credit (risk) securitization and NPLs is primarily driven by true sale and non-opaque securitizations as well as by securitizations of residential mortgage backed securities and consumer loans. Our baseline results remain robust even when controlling for endogeneity concerns and a potential persistence in the time series of the NPL data. Results from sensitivity analyses reveal further important implications for banking regulators, the intense discussion on how to reduce the large amounts of NPLs in European banks' balance sheets as well as the ongoing process of revitalizing the European securitization market.

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

The remainder of the paper is organized as follows. Section 2 discusses the theoretical background and Section 3 summarizes related empirical research papers on the relationship between credit (risk) securitization and NPLs. Section 4 describes the entire set of regression variables and introduces the empirical methodology. The regression results are reported and discussed in Section 5. While Sections 5.1 and 5.2 present results from our baseline analyses, Section 5.3 discusses results from sensitivity analyses. Finally, Section 6 concludes and provides important policy implications.

2 Theoretical background

Credit (risk) securitization allows banks to convert illiquid loans and inherent risks into liquid and tradable securities with fixed cash flows. As regards the traditional structure of a securitization, the originating bank transfers an underlying portfolio of loans out of a bank's balance sheet to the asset side of a legally separated Special Purpose Vehicle (SPV). In turn, the SPV sells asset-backed securities (ABSs) to capital market investors and transfers the contractually governed interest and redemption payments from the underlying loan agreements to them. In this context, ABSs are usually tranched in different rating categories.

From an issuing bank's perspective, securitization causes regulatory capital relieves, an inflow of cash, a reduction of outstanding loans, and a restructuring of the bank's balance sheet. Usually, contractual (explicit recourse, e.g., standby letters of credit) or non-contractual arrangements (implicit recourse, e.g., funding credit enhancements beyond contractual obligations) build an integral part of a loan securitization transaction. Recourse arrangements are implemented to safeguard investors against defaults of the underlying loans and to mitigate adverse selection problems, which result from the fact that the issuing bank should be better informed about the loan portfolio quality than investors (Vermilyea et al., 2008; Casu et al., 2011).

Securitization transactions can be differentiated into true sale and synthetic transactions. By means of a *true sale* (cash) transaction the issuing bank transfers parts of their loan portfolio and inherent credit risks to the SPV. In contrast, in case of a *synthetic* transaction, credit risk from underlying loans is transferred entirely or partly through funded (e.g., credit-linked notes, CLN) or unfunded (e.g., credit default swaps, CDS) credit derivatives while the underlying loans remain on the issuing bank's balance sheet. Due to the implementation of credit derivatives,

synthetic securitization transactions are characterized by an additional counterparty risk and greater complexity as compared to *true sale* transactions.

Related literature provides contradictory predictions concerning the relationship between securitization and a bank's (credit) risk exposure, which is proxied by non-performing loan ratios in this study (Greenbaum and Thakor, 1987; Instefjord, 2005; Krahnen and Wilde, 2006). The conflicting arguments result from the fact that the relationship between securitization and NPLs hinges on both, a direct and indirect effect. The *direct* effect is determined by the amount of NPLs that is actually transferred out of the bank's balance sheet to external capital market investors. In this context, advocates of the *securitization-stability* view stress that a bank's overall credit risk is likely to be reduced if banks retain safer loans on their balance sheets and, instead, securitize loans with higher default rates, such as NPLs (Cantor and Rouyer, 2000; Jiangli et al., 2007; Krainer and Laderman, 2014). In contrast, advocates of the *securitization-fragility* view argue that the issuing bank will typically retain the more risky NPLs as the first-loss piece (FLP) on their balance sheet and rather securitize less risky loans in order to send out a quality signal towards potential investors (Greenbaum and Thakor, 1987; Gorton and Pennacchi, 1995; Riddiough, 1997; DeMarzo, 2004; Instefjord, 2005; Albertazzi et al., 2015).

The *indirect* effect of a securitization transaction on a bank's NPL exposure depends on the bank's strategy to utilize the liquid capital, which has become available from true sale transactions and from regulatory capital relieves due to synthetic transactions. Accordingly, the indirect effect is not distinct but is rather determined by the risk-level of loan investments and credit risk-restructuring policies ex post (Krahnen and Wilde, 2006). In this context, advocates of the *securitization-stability* view point out that providing explicit and implicit recourse arrangements with regard to securitization transactions still exposes the issuing bank (off-balance) to credit risks from securitized loans. This in turn may discipline bank managers and encourage them to perform a less risky (credit) investment strategy after securitization (Benveniste and Berger, 1987; Vermilyea et al., 2008; Casu et al., 2011). As a consequence, using liquid capital from securitization transactions to invest into less risky loans may reduce the issuing bank's NPL exposure in the long run (Demsetz, 2000; Cebenoyan and Strahan, 2004; van Oordt, 2014). In contrast, advocates of the *securitization-fragility* view propose that the development of credit risk transfer mechanisms has fundamentally changed a bank's business model from a traditional lending model (e.g., relationship based lending) to a loan originating and distributing model during the last decades (Affinito and Tagliaferri, 2010).

In this context, it is argued that securitizing banks may even grant poor-quality loans and may pursue a more risky credit risk investment strategy ex post (e.g., due to competitive pressure in the loan market), if they have the opportunity to transfer credit risk by means of a securitization transaction (Cebenoyan and Strahan, 2004; Instefjord, 2005; Haensel and Krahnen, 2007; Wagner, 2007; Hakenes and Schnabel, 2010; Purnanandam, 2010). In addition, it is suggested that the opportunity to securitize may relax credit and borrowing standards, may lower a bank's monitoring incentives and hence, may lead to loan portfolios with higher default rates (Keys et al., 2010; Purnanandam, 2010).

3 Related empirical literature

Empirical evidence on the relationship between credit risk transfer through securitization and the issuing banks' NPL exposures is scarce. Most related to our study, Casu et al. (2011) examine the impact of securitization on the issuing banks' credit risk-taking *behavior*. The authors employ a 'risk-weighted assets to total assets' ratio and a 'non-performing assets to total assets' ratio as two dependent variables which proxy bank (credit) risk. Using a linear fixed effects panel model with quarterly data from 2001Q2 to 2007Q4 for 230 U.S. banks, the analysis reveals that the securitization of mortgages, home equity lines of credit and other consumer loans may decrease the issuing banks' (credit) risk exposure. The authors suggest that implicit and explicit recourse arrangements from securitization transactions may mitigate the risk-appetite of the issuing banks ex post.

As regards the European banking market, Affinito and Tagliaferri (2010) analyze main drivers of securitization activities for all Italian banks by using annual bank-level data between 2000 and 2006. The study identifies 'bad loans'[4] as a determinant of loan securitization. However, more important with regard to our study, employing a mean-difference comparison over time and splitting the sample into different time periods ((i) the years before the first securitization, (ii) the year of the first securitization, and (iii) the years after the first securitization), Affinito and Tagliaferri (2010) provide evidence for a decrease in 'bad loans' due to securitization.

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

4 Empirical methodology

4.1 Data and sources

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

4.1.1 Non-performing loan ratio

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

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

As shown by Figure 1, on average, the NPLR from our sample of European banks slightly decreased from 1997 until 2007. Since then, the NPLR has sharply increased as a result of the Global Financial Crisis (GFC) from mid 2007 and 2008 and the European Sovereign Debt Crisis (ESDC) starting in 2009.

4.1.2 Securitization transactions

We employ a unique sample of 930 cash and synthetic credit (risk) securitization transactions issued by 63[5] stock-listed[6] banks across the EU-13 plus Switzerland[7] over the period from 1997 to 2010. The securitization data is hand-collected from circulars and presale reports provided by *Moody's*, *Standard & Poor's* and *FitchRatings*. Our data contains detailed information on securitizing banks, issue dates, structures, types and volumes of securitization transactions as well as the underlying reference portfolios.[8]

The geographical distribution of securitizing banks in Europe is shown in Table 1. The descriptive statistics of true sale and synthetic securitization transactions are reported in Table 2.[9] As further shown by Figures 2 and 3, the sample period ranges from the beginning of European securitization activities in 1997 until the degeneration and drying up of the securitization market after 2010. Except for 2004, when the Basel II framework was announced, the growing importance of securitization in Europe is reflected by continuously increasing volumes and numbers of securitization transactions reaching their peaks in 2007. Since then, a sharp decline in values and number of securitization transactions has been observed, which is due to the GFC from 2007/08 and the beginning of the ESDC in 2009. Some of the banks

[5]Note that our initial sample of 64 securitizing banks is reduced by one bank (SNS Reaal NV / SRH NV) due to missing NPL data on a consolidated level.

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

[7]The EU-13 covers Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden and the United Kingdom. Issuing banks from Finland and Luxembourg are excluded since we are not able to assign securitization transactions to respective originating banks in these countries. In addition, we extend our sample by Switzerland for two reasons. *First*, although Switzerland is not part of the EU/EMU the interrelation between the Swiss and the European banking market is very distinctive. *Second*, two of the most important banks of Switzerland, namely UBS and Credit Suisse, issued a couple of large securitization transactions over the period from 1997 to 2010. To verify our results, we exclude Swiss bank holdings from our baseline regressions as a robustness check. However, since results do not remarkably differ from respective baseline regressions, we do not present them in this paper but provide them on request.

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

[9]As reported by the AFME, the cumulated transaction volume of credit risk being transferred through securitization between 1997 and 2010 amounts to a total of €3,522.74 billion for the EU-13 countries plus Switzerland. Compared to this, our sample covers approximately 59 percent of credit (risk) securitizations in Europe. Note, however, that the AFME aggregates the volumes of securitization transactions from stock-listed and non-stock-listed banks, other financial intermediaries, industrial companies as well as governmental authorities.

in our sample securitize more than once during the sample period.[10] Accordingly, Figures 4 and 5 present the ten frequently issuing banks in our sample with regard to the number of securitization transactions (TA) and the volume of securitization transactions (Vol).

In our study, we employ securitization as the one-year lagged ratio of a bank's cumulated securitization volume per year divided by total assets ($Securitization_{t-1}$). Implementing a one-year lag-structure for the securitization variable is rational for three reasons. *First*, we basically address probable endogeneity concerns between an issuing bank's NPLR and its securitization activities (Demsetz and Strahan, 1997; Stiroh, 2006; Casu et al., 2011). *Second*, as the indirect effect of a securitization transaction on NPLs depends on the banks' risk-taking incentives and credit reinvestment strategies ex post, the one-year lag-structure appropriately allows time for the indirect effect. *Third*, controlling for possible dependencies between our securitization measure and further bank-specific control variables (e.g. liquidity), the one-year lag-structure mitigates possible simultaneity and multicollinearity issues.

4.1.3 Control variables

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

Bank-specific data is obtained from the *BankScope* database compiled by *FitchRatings* and provided by *Bureau van Dijk*. Country-specific control variables are retrieved from the *World Development Indicator* (WDI) database, *Thomson Reuters Eikon*, the *ECB Statistical Data Warehouse* as well as the *Swiss National Bank* (SNB). Banking regulatory data is collected from the *World Bank's Banking Regulation Surveys* and from Barth et al. (2001, 2004, 2008, 2013a).

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

Bank-specific variables

Among the bank-specific control variables, we initially employ a bank's capital environment (*Capital*) as a measure of financial strength and the bank's ability to sustain future losses by means of capital buffers. *Capital* is included as the ratio of the accounting value of a bank's total equity divided by total assets per year. Related literature provides countervailing predictions concerning the relationship between a bank's capital environment and its NPLR. Following the *moral hazard* hypothesis provided by Keeton and Morris (1987) as well as Berger and DeYoung (1997), bank managers of undercapitalized banks may have an incentive to pursue excessive credit risk-taking along with an insufficient credit scoring and monitoring of borrowers (Wheelock and Wilson, 2000; Gambacorta and Mistrulli, 2004; Mehran and Thakor, 2011; Demirgüç-Kunt et al., 2013). In addition, the *gambling for resurrection* hypothesis suggests that undercapitalized banks may take on profitable but more risky loans in order to reestablish financial soundness, especially under the notion of governmental aid (Keeley, 1990; Konishi and Yasuda, 2004). Both hypotheses suppose an inverse relationship between a bank's capital environment and NPLs. In contrast, it is also argued that better capitalized banks may face weaker debt covenants. Hence, if bank managers are less forced to negotiate future investment projects with debt holders, risky (credit) investments with a negative net present value are more likely due to higher shareholder pressure and a weaker disciplining and monitoring (Jensen and Meckling, 1976; Calomiris and Kahn, 1991; Rajan and Zingales, 1995; Diamond and Rajan, 2001; Altunbas et al., 2011; Berger and Bouwman, 2013).

We employ management efficiency (*Management*) as a further bank-specific measure and include the cost-to-income ratio, which is built as the accounting value of a bank's total expenses divided by total income per year. This measure serves as a proxy for the quality of a bank's (risk) management (Louzis et al., 2012; Farruggio and Uhde, 2015). Results from previous empirical studies focusing on the relationship between management efficiency and a bank's NPL exposure are mixed. *On the one hand*, following the *bad management* hypothesis, Berger and DeYoung (1997) empirically show that the efficiency of the risk management and the quality of the loan portfolio may decrease if bank managers exhibit poor skills in credit scoring, estimating collateral-values as well as controlling and monitoring borrowers. As compared to better-skilled managers, it is further shown that poor-skilled managers may stronger allocate loans with low or even negative net present values (Berger and DeYoung, 1997; Williams, 2004). *On the other hand*, following the *skimping* hypothesis it is suggested that the extent of resources, which

is established to underwrite and monitor loans may have an impact on both, loan portfolio quality and cost efficiency (Berger and DeYoung, 1997). Hence, if banks reduce (credit) risk management efforts, it is shown that these banks operate more cost-efficiently (have fewer short-term operating expenses) and that their loan portfolio quality remains unaffected (same quantity of loans) in the *short run*, whereas future loan performance may decrease and credit risk may increase due to a declining quality of borrowers' creditworthiness in the *long run* (Berger and DeYoung, 1997).

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

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

Finally, we control for a bank's business model (*Business Model*). We construct this variable as the ratio of the accounting value of a bank's non-interest income to interest income per year. Building the measure this way, it indicates to which extent a bank engages in fee-based businesses (like investment banking or trading activities) as compared to interest rate based activities (traditional deposit taking and lending business). The relationship between a bank's business model and its NPL exposure is not distinct. *On the one hand*, engaging in fee-based activities - next to traditional banking - generates additional investment opportunities and income diversification (Louzis et al., 2012; Ghosh, 2015). Thus, as banks are less forced to generate profits from the interest-based business only, the incentive to pursue risky lending

strategies may be lower. *On the other hand*, following Lepetit et al. (2008), banks with an increased focus on fee-based income generating activities may employ loans as potential loss leaders to attract new customers (establishing a long-term relationship) by assuming a cross-selling potential between traditional and fee-based activities. Accordingly, banks with a higher reliance on fee-based businesses may charge lower lending rates and may underprice credit risk (borrower's default risk), which in turn should result in a larger NPL exposure (Lepetit et al., 2008).

Country-specific variables

Next to bank-specific determinants, we additionally employ measures of the country-specific macroeconomic environment. To begin with, the slope of the yield curve (*Yield Curve*) is included to control for the relationship between economic growth and NPLRs. As a leading indicator for future prospects of the economy (Estrella and Hardouvelis, 1991; Wheelock et al., 2009; Adrian et al., 2010), we calculate the slope of the yield curve as the annual change of the difference between the 10-year and 2-year government bond yields per country and year. Corresponding to previous studies we expect that NPLRs may decrease during a prospering economy (Louzis et al., 2012; Gropp et al., 2014; Ghosh, 2015; Dimitrios et al., 2016).

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

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

Finally, we control for the impact of the banking market structure on the NPLR of local banks. We include the Herfindahl-Hirschman index (HHI) per country and year as a

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

structural measured banking market concentration (*Concentration*). Previous studies provide countervailing results concerning the relationship between banking market concentration and a bank's NPLR. Advocates of the *concentration-stability* view stress the *franchise value* hypothesis provided by Keeley (1990) suggesting that monopolistic banks may engage in less risky (credit) investments in order to protect their monopoly rents and higher franchise values, which in turn should result in smaller NPL exposures (Park and Peristiani, 2007; Jiménez et al., 2013). Furthermore, monopolistic banks may have a better access to borrower-specific information (Marquez, 2002), may be able to identify high-quality (less risky) creditors on their own (Chan et al., 1986; Marquez, 2002), may have advantages in providing credit monitoring services (Uhde and Heimeshoff, 2009) and hence, a higher loan portfolio quality. In contrast, advocates of the *concentration-fragility* view propose that banks in concentrated banking markets typically may charge higher loan interest rates. As a consequence, borrowers have to take on more risky investments in order to compensate the higher loan interest rate payments, which in turn may increase the likelihood of loan defaults (Stiglitz and Weiss, 1981; Boyd and De Nicoló, 2005; Berger et al., 2009; Jiménez et al., 2013).

Regulatory environment

Finally, we control for the banking regulatory environment and initially include a capital regulation index (*Capital Regulation*) provided by Barth et al. (2013a). This index is calculated as the sum of initial capital stringency and overall capital requirements per country and year (Barth et al., 2001; Beck et al., 2006). Since capital requirements are designed to strengthen a bank's capital buffer, financial soundness and stability, stricter capital regulation may encourage bank managers to pursue a more prudential investment behavior, which should have an NPL-reducing effect (Furlong and Keeley, 1989; Barth et al., 2004; Kopecky and VanHoose, 2006; Uhde and Heimeshoff, 2009; Beltratti and Stulz, 2012). However, since stricter capital requirements increase a bank's regulatory costs of capital and negatively affect a bank's profits, freedom of action and investment opportunities, more stringent capital requirements may also encourage bank managers to engage in more risky (credit) investments in order to compensate future losses (Koehn and Santomero, 1980; Besanko and Kanatas, 1996; Blum, 1999; Pasiouras et al., 2006, 2009; Laeven and Levine, 2009; Barth et al., 2013b).

Next to the capital regulation index, we additionally include the mitigating moral hazard index (*MMHI*) proposed by Barth et al. (2013a). This index includes different design features

of a country's deposit insurance system that may help mitigating moral hazard in the banking industry. If banks are forced to financially participate in a deposit insurance, bank managers may be encouraged to a more prudent (credit) investment behavior (Gropp and Vesala, 2004; Uhde and Heimeshoff, 2009; Chernykh and Cole, 2011) and we expect a decrease in a bank's NPL exposure. In contrast, financially participating in a deposit insurance system may also incentivize bank managers to a more excessive risk-taking behavior in order to compensate the costs of the co-insurance (Hovakimian and Kane, 2000; Demirgüç-Kunt and Detragiache, 2002; Barth et al., 2004; Demirgüç-Kunt and Huizinga, 2004; Ioannidou and Penas, 2010; Barth et al., 2013a; Lambert et al., 2017).

4.2 Empirical model

We employ a linear model on panel data to empirically investigate the relationship between credit (risk) securitization and the issuing banks' NPLRs:

$$y_{it} = \alpha_i + \gamma Securitization_{it-1} + \sum_{k=1}^{M} \beta_k x_{it,k} + \epsilon_{it}, \tag{1}$$

where y_{it} denotes the non-performing loan ratio ($NPLR$) of a securitizing bank i in a respective year t. $Securitization_{it-1}$ is the one-year lagged ratio of a bank's cumulated securitization volume per year divided by total assets. The vector $x_{it,k}$ contains the M explanatory variables as described in Section 4.1.3. ϵ_{it} represents an independently and identically distributed error term. α_i, γ and β_k are the regression coefficients to be estimated.

We employ a bank-specific fixed effects model and include time dummies to capture time-specific effects, such as institutional and regulatory changes or common shocks to the European banking market. 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 credit risk over the entire sample period while others do not, we cluster standard errors at the bank-level to control for heterogeneous securitization frequencies in our sample. Following Greene (2000), we utilize a modified Wald statistic for groupwise heteroskedasticity in the residuals while allowing for unbalanced panels in order to verify whether the use of clustered-robust standard errors enhances our model fit. The Wald test statistic rejects the null-hypothesis of homoscedasticity

at $\rho < 0.000$ suggesting that clustering at the bank-level is appropriate to address a possible downward bias and misspecification in the estimated standard errors (Moulton, 1990).[12]

Furthermore, 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 employing a fixed effects model is adequate.

Finally, we control for multicollinearity concerns among our independent variables by computing two collinearity diagnostic measures. Both instruments, the mean variance inflation factor (VIF) of all right-hand side variables from our baseline regression (2.56) and the value of the conditional number (7.04) indicate that our results are not biased by multicollinearity issues.

5 Empirical Results

Tables 6a and 6b present the empirical results from our baseline analyses. Results from sensitivity analyses are reported in Tables 7a and 7b.

5.1 Baseline regressions

In a first step, we investigate the relationship between credit (risk) securitization and the issuing banks' NPLRs by employing the fixed effects model on panel data as described in Section 4.2. Subsequently, we additionally estimate a dynamic panel model in order to control for endogeneity issues and a likely persistence in the time series of our NPL data.

5.1.1 Linear fixed effects panel model

As reported by Table 6a, the one-year lagged securitization variable ($Securitization_{t-1}$) enters regression specification (1) significantly negative at the five-percent level indicating that credit (risk) securitization reduces the issuing European banks' NPLRs. Our baseline finding is in line with results from previous related empirical studies for the Italian and the U.S. banking sector,

[12] Petersen (2009) shows that too few clusters may bias the results even when having clustered in the right dimension. In this case, the author proposes to address the time-dependence parametrically and cluster at bank-level. Nevertheless, we implement double-clustered standard errors with 63 bank and only 13 time clusters in order to verify whether the clustered-robust standard errors are correctly specified. Since the results remain robust, we do not present the results in this paper but provide them on request.

revealing that credit (risk) securitization may provoke a decrease in non-performing assets and may lead to a less risky reinvestment strategy ex post (Affinito and Tagliaferri, 2010; Casu et al., 2011). Moreover, our result supports arguments from the *securitization-stability* hypothesis. Accordingly, following the direct effect of securitization, our finding indicates that European banks may (partly) securitize NPLs as the most risky tranche and do not fully retain NPLs as the first-loss piece (Cantor and Rouyer, 2000; Jiangli et al., 2007; Krainer and Laderman, 2014). In addition and referring to the indirect effect of securitization, our result suggests that issuing banks may pursue a more risk-averse credit investment strategy ex post (Demsetz, 2000; Cebenoyan and Strahan, 2004; Affinito and Tagliaferri, 2010), which might be due to the fact that managers are disciplined by explicit or implicit recourse arrangements from securitization transactions (Vermilyea et al., 2008; Casu et al., 2011).

Among the bank-specific control variables, the coefficient of *Capital* exhibits a significantly positive sign indicating that better capitalized banks exhibit higher NPLRs. Our result corresponds to previous findings for the U.S. and the Turkish banking sector (Ghosh, 2015, 2017; Macit, 2017). We suggest that better capitalized banks may exhibit weaker debt covenants and hence, may face a weaker monitoring through debt holders and a less disciplining effect through debt covenants. As a consequence and along with higher shareholder pressure, managers from better capitalized banks may be less forced to negotiate future investment projects with debt holders and thus, may pursue more profitable but more risky (credit) investment strategies (e.g., investing in low-quality loans) (Jensen and Meckling, 1976; Calomiris and Kahn, 1991; Rajan and Zingales, 1995; Diamond and Rajan, 2001; Altunbas et al., 2011; Berger and Bouwman, 2013).

Furthermore, *Profitability* enters the regression significantly negative at the one-percent level. Our result is in line with empirical findings provided by Louzis et al. (2012), Klein (2013), Messai and Jouini (2013), Ghosh (2015, 2017) as well as Dimitrios et al. (2016) and also supports the *gambling for resurrection* and the *bad management* hypotheses. Following these hypotheses, it is argued that more profitable and well-managed banks may be less prone to engage in risky (credit) investments. In addition, these banks may have more accurate credit monitoring and credit scoring processes and managers with greater skills to assess the value of collaterals more precisely resulting in a better loan portfolio quality (Berger and DeYoung, 1997; Williams, 2004).

As further shown, *Liquidity* enters the regression significantly negative at the one-percent level indicating that more liquid banks exhibit a smaller NPL exposure. Our finding confirms

theoretical predictions suggesting that a higher amount of liquid assets may allow for a more flexible and immediate rearrangement of the asset side of a bank's balance sheet, which extends the bank's credit investment opportunities. As a consequence, higher liquidity may provide a better loan portfolio composition if loans are less correlated after having reinvested liquid capital from selling securitization transactions (Wagner, 2007; Demirgüç-Kunt et al., 2013).

Turning to country-specific macroeconomic control variables, it is shown that the coefficient of the slope of the *Yield Curve* exhibits a significantly negative sign. As expected, our finding indicates that NPL exposures decrease during a prospering economy. Our result supports previous empirical findings from Salas and Saurina (2002), Nkusu (2011) Louzis et al. (2012), Klein (2013), Messai and Jouini (2013), Makri et al. (2014), Ghosh (2015, 2017), Beck et al. (2015) as well as Dimitrios et al. (2016) and confirms the cyclical properties of NPLs.

As expected and in line with related studies from Nkusu (2011), Louzis et al. (2012), Klein (2013), Messai and Jouini (2013), Makri et al. (2014), Ghosh (2015, 2017) as well as Dimitrios et al. (2016), *Unemployment* enters the regression significantly positive at the one-percent level suggesting that NPLRs are likely to rise under increasing unemployment rates, which may be due to the fact that the borrowers' ability to meet their financial debt obligations is mitigated under these circumstances.

As further shown and expected, the coefficient of *Stock Market* exhibits a significantly negative sign indicating that increased share prices decrease NPL exposures, which corresponds to with results from Nkusu (2011) and Beck et al. (2015). Our finding may be explained by the fact that prospering stock markets increase financial wealth, raise the value of shares used as collaterals and improve the ability of borrowers to service their loans (Nkusu, 2011; Beck et al., 2015).

Turning to banking *Concentration*, this variable enters the regression significantly negative at the five-percent level supporting arguments from the *concentration-stability* view. Accordingly, banks operating in more concentrated markets may engage in less risky (credit) investments in order to protect their monopoly rents and higher franchise values (Keeley, 1990; Park and Peristiani, 2007; Jiménez et al., 2013). Furthermore, monopolistic banks may have a better access to borrower-specific information (Marquez, 2002), advantages in providing credit monitoring services (Uhde and Heimeshoff, 2009) and a more accurate selection of high-quality borrowers resulting in a better loan portfolio quality (Chan et al., 1986; Marquez, 2002).

Next to bank- and country-specific variables, we additionally control for the regulatory environment. Introducing the capital regulatory index, we find a significantly negative relationship between *Capital Regulation* and a bank's NPLR. Our result supports related studies from Furlong and Keeley (1989), Barth et al. (2004), Kopecky and VanHoose (2006), Uhde and Heimeshoff (2009) as well as Beltratti and Stulz (2012), who provide evidence that stricter capital regulation may encourage bank managers to pursue a more prudential investment strategy, which in turn results in smaller NPL exposures.

Finally, the mitigating moral hazard index (*MMHI*) enters the regression significantly positive at the one-percent level. Our finding indicates that a legally forced financial participation in a national deposit insurance system increases the European banks' NPLRs. We suggest that participating in a deposit insurance system may incentivize bank managers to a more excessive risk-taking behavior in order to compensate the costs of the co-insurance (Hovakimian and Kane, 2000; Demirgüç-Kunt and Detragiache, 2002; Barth et al., 2004; Demirgüç-Kunt and Huizinga, 2004; Ioannidou and Penas, 2010; Barth et al., 2013a; Lambert et al., 2017).

5.1.2 Dynamic panel model

In a next step, we control if our baseline regression results are biased due to a likely persistence in the time series of our NPL data and due to a probable endogeneity between the NPL measure, the securitization measure and the bank-specific control variables. Doing so, we implement a one-step system Generalized Methods of Moments (system-GMM) estimator provided by Arellano and Bond (1991) and generalized by Arellano and Bover (1995) as well as Blundell and Bond (1998)[13] with robust standard errors clustered at the bank-level and time dummies:

$$y_{it} = \alpha + \delta y_{it-1} + \gamma Securitization_{it} + \sum_{k=1}^{M} \beta_k x_{it,k} + \epsilon_{it}, \tag{2}$$

where y_{it} is the non-performing loan ratio ($NPLR$) of bank i in a respective year t. y_{it-1} denotes the one-year lagged dependent variable. $Securitization_{it}$ represents the ratio of a bank's

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

cumulated securitization volume per year divided by total assets. The vector $x_{it,k}$ includes the M explanatory variables as described in Section 4.1.3. The independently and identically distributed error term is represented by ϵ_{it}. α, δ, γ and β_k denote the parameters to be estimated.

We instrument the country-specific and regulatory determinants in IV-style (instrumented by themselves) and consider them as *strictly exogenous* regressors (Louzis et al., 2012; Klein, 2013). In contrast, the assumption of *strict exogeneity* is too restrictive and probably violated (if NPLs reversely cause feedback effects) with regard to the securitization measure and the bank-specific control variables. Following Louzis et al. (2012), bank-specific balance sheet variables can be considered as forward-looking decision-making instruments of a bank's management. Thus, the management of balance sheet items could be affected by the expected future level of NPLs, whereas future random shocks to NPLs may not be taken into account due to their unpredictability. Against this background, the bank-specific variables are expected to be correlated with past and contemporaneous errors but not with future realizations of the error term suggesting partial endogeneity (weak exogeneity) of the bank-specific variables (Louzis et al., 2012). In addition, we allow for feedback effects from NPLs to banks' securitization activities and balance sheet variables by considering *Securitization* and the bank-specific determinants (including the lagged dependent variable) as *weakly exogenous* or *predetermined* explanatory variables. Accordingly, we instrument them with GMM-conditions by using their lagged values as instruments.[14] Moreover, in order to control for instrument proliferation, we employ the first and second lags of regressors as instruments and restrict the instrument count by collapsing the instrument set (Roodman, 2009).[15]

As shown by regression specification (2) in Table 6a, the high coefficient value of the one-year lagged NPLR ($NPLR_{t-1}$) measure reveals time persistence in our NPL data. More important, it is also shown that the significant coefficient of our securitization measure only marginally decreases in value while results from our control variables are generally reiterated even when performing a dynamic panel estimation. Against this background, we rule out that our results

[14] We introduce Arellano-Bond tests for first (AR(1)) and second (AR(2)) order autocorrelation of the residuals in order to control for the consistency of our dynamic panel estimation using GMM. The moment conditions in our framework are valid if there is no serial correlation in the idiosyncratic errors. The Arellano-Bond tests assume that rejecting the null hypothesis of no first order serial correlation implies no model misspecification, whereas a rejection of the null hypothesis at higher orders of serial correlations indicates an invalidity of the moment conditions (Beck et al., 2015; Ghosh, 2015, 2017). As shown in Table 6a, our dynamic panel framework satisfies the requirements concerning the AR(1) and AR(2) tests indicating the consistency of our dynamic panel regression results.

[15] As a result, the number of instruments (40) used in the dynamic panel estimation is kept far below the number of groups (63) 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) suggested by Roodman (2009) and thus, reveals that the used instruments are appropriate.

from the linear fixed effects model are severely biased by time persistence in our NPL data and by (partial) endogeneity.

5.2 Further baseline regressions

In the following, we analyze the relationship between securitization and an issuing bank's NPLR in greater detail by controlling for (i) the type of transaction, (ii) the degree of standardization and (iii) the respective underlyings of a securitization transaction (Tables 6a and 6b).[16]

5.2.1 True sale vs. synthetic securitization transactions

In a first step, we include true sale ($True\ sale_{t-1}$) and synthetic ($Synthetic_{t-1}$) transactions separately in order to control if the direct and indirect impact of securitizations on a bank's NPLR hinges on the type of transaction. As shown by regression specifications (3) and (4) in Table 6a, the significantly negative relationship between securitization and an issuing bank's NPLR is reiterated for *true sale* transactions, whereas we do not find any significant effect for *synthetic* transactions. This result supports our argumentation concerning a direct and indirect effect of securitization on NPLs. Hence, obviously only true sale transactions allow banks to (partly) securitize NPLs as the most risky tranche (direct effect). In addition, true sale securitizations should originate more fresh liquidity through selling loans as compared to capital relieves from synthetic transactions. Accordingly, banks issuing true sale transactions may exhibit a greater loan portfolio restructuring potential and more resources to pursue a more risk-averse credit investment strategy ex post (Franke and Krahnen, 2007). In sum, our finding supports regulatory initiatives from the EU, which propose to solely revitalize true sale securitizations under the framework of simple, transparent and standardized (STS) securitizations (European Union, 2017b).

5.2.2 Opaque vs. non-opaque securitization transactions

We also control for the degree of standardization by employing opaque ($Opaque_{t-1}$) and non-opaque ($Non\text{-}Opaque_{t-1}$) securitization transactions. Opaque transactions are issued on complex loan arrangements including securitizations of collateralized debt obligations (CDOs) and other less transparent unspecified underlyings (Others). In contrast, non-opaque transactions are

[16] Since results from control variables are qualitatively reiterated even when controlling for different securitization characteristics, we do not comment them in the following.

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 cards receivables (CCs) and consumer loans (CLs). As shown by regression specifications (5) and (6) in Table 6a, we provide evidence of a significantly negative relationship between *non-opaque* securitization transactions and NPLRs, whereas we do not find any statistical effect for *opaque* transactions. Thus, our results suggest that in particular less complex, but more standardized and transparent credit securitization transactions may reduce the issuing bank's NPL exposure (Jobst, 2005; Franke and Krahnen, 2008; Farruggio and Uhde, 2015).

5.2.3 Underlyings of securitization transactions

In a final step, we control for the impact of single underlyings on an issuing bank's NPLR. As reported by Table 6b, only *RMBS* and *CL* securitizations enter respective regressions significantly negative at the one-percent level respectively. Our findings correspond to previous studies for the U.S. banking market suggesting a negative relationship between mortgage backed securities (Uzun and Webb, 2007; Jiangli and Pritsker, 2008) as well as consumer loans (Casu et al., 2011) and an issuing bank's (credit) risk exposure.

5.3 Sensitivity analyses

We additionally perform several sensitivity analyses and provide further important findings. To begin with, we investigate the relationship between credit risk transfer through securitization and an issuing bank's NPLR during different stages of securitization activities in Europe. According to our explanations in Section 4.1.2 and with respect to Figures 2 and 3, we define (i) the beginning of European securitization activities from 1997 to 2001 as the *onset stage*, (ii) the boom phase of securitization transactions between 2002 and 2007 as the *boom stage* and (iii) the degeneration and drying up phase of the securitization market from 2008 to the sample end in 2010 as the *crises stage*. Accordingly, we build three time dummy variables *($Dummy_{onset}$, $Dummy_{boom}$* and *$Dummy_{crises}$)*, which take on the value of one for the years of the respective stage, and zero otherwise. Subsequently, we build interaction variables between our one-year lagged securitization measure and each time dummy variable in order to control if the impact of securitization on an issuing bank's NPL exposure differs during the different stages

of securitization activities.[17] As shown in regression specifications (1) to (3) in Table 7a, our dummy variables reveal decreasing NPLRs during the onset and boom stage of securitization activities, whereas we observe an increase in the NPLRs during the crises stage. Turning to the interaction variables, we provide evidence for an NPLR-decreasing effect through securitization during the boom stage and an NPLR-increasing effect through securitization during the crises period, whereas we do not find any significant impact during the onset stage. Accordingly, while our baseline finding is reiterated for the boom phase of securitization in Europe, the NPLR-increasing effect through securitization during the crises stage may be explained by an increased complexity of the securitization market (e.g., resecuritizations or structured finance CDOs), failures in valuating complex securitization transactions, a decreasing trust in securitization by capital market investors and widespread disturbances throughout the European financial system (Basel Committee on Banking Supervision, 2008; International Monetary Fund, 2008, 2009; Michalak and Uhde, 2012; di Patti and Sette, 2016; Association for Financial Markets in Europe, 2018a).

We proceed and control if the frequency of securitization activities has an impact on the issuing banks' NPLRs. Thus, we split[18] our entire sample into *frequent-securitizers* (FS, the ten most frequently issuing banks) and *non-frequent securitizers* (Non-FS) with regard to transaction volume (Vol) and the number of transactions (TA) respectively (Figures 4 and 5). As shown, regression specifications (4) and (5) in Table 7a reveal that $Securitization_{t-1}$ enters both regressions significantly negative at the ten-percent level. However, as also shown, the coefficient of the securitization measure is higher for non-frequent securitizing banks (as measured by the transaction volume) as compared to frequently issuing banks. Furthermore, focusing on the number of transactions in regression specifications (6) and (7), we provide evidence for a negative relationship between securitization and the NPLR of non-frequently issuing banks, whereas we do not find any significant impact in the case of frequent securitizers. In sum, our results support the *overcollateralization* hypothesis and *asset deterioration* hypothesis (Greenbaum and Thakor, 1987; Instefjord, 2005) suggesting that in particular high-frequently issuing banks tend to retain larger parts of the more risky FLP (such as NPLs) instead of securitizing too risky tranches.

[17] We also rebuild the three interaction variables also without the one-year lag structure of our securitization measure in order to control for potential time-shifting dependencies. Since the regression results do not remarkably differ, we do not present the results in this paper but provide them on request.

[18] Note that empirical findings from sample splits have to be taken with caution, especially for regression specifications (4) and (6) in Table 7a as well as (1) in Table 7b, since the number of observations is relatively small in the context of a panel regression.

In a next sensitivity analysis, we control if classifying a bank as systemically important may change our baseline finding of a negative relationship between securitization and the issuing bank's NPLR. Hence, we split our entire sample into global systemically important banks (G-SIBs)[19] and non-G-SIB institutions. As shown by regression specification (1) in Table 7b, the coefficient of $Securitization_{t-1}$ turns out to be significantly positive at the one-percent level for the G-SIB sample, whereas it is negatively significant for the non-G-SIB sample in regression specification (2). Our findings suggest that global systemically important banks may stronger engage in excessive (credit) risk investment strategies after securitization since they may rely on governmental aid as proposed by the *too-big-to-fail* hypothesis (Stern and Feldman, 2004). If this is true, increased risk-taking incentives due to (implicit) governmental aid may offset the beneficial impact of securitization on the issuing banks' NPL exposures (Louzis et al., 2012).[20]

Finally, we control if an issuing bank's financial rating may influence negative the relationship between securitization and NPLs. We implement issuer ratings from the three major rating agencies *Standard & Poor's*, *Moody's* and *Fitch*. Following Jorion et al. (2005), we transform the alphabetical codes of the different credit ratings into an ordinal scale, starting with 1 as AAA and ending up with 23 as the default category. Hence, a lower value indicates a better rating status. Subsequently, we split our entire sample into subsamples of banks with an average rating score below ($Rating_{below}$) and banks with an average rating score above ($Rating_{above}$) the sample mean rating during the period from 1997 to 2010.[21] As shown by regression specifications (3) and (4) in Table 7b, $Securitization_{t-1}$ exhibits a significantly negative sign for banks exhibiting a poorer issuer rating, whereas we do not provide any empirical evidence for an impact of securitization on the NPLR of better-rated banks. Our results suggest that banks with a poorer rating may employ securitization to reduce their credit risk exposures and obtain a rating upgrade in the long run (Jiangli and Pritsker, 2008; Casu et al., 2011).

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

[20] Assuming that G-SIBs are typically larger in size (sample mean size: \$783.82 billions for G-SIBs and \$155.62 billions for non-G-SIBs as measured by total assets), our results become even more interesting with regard to studies provided by Bannier and Hänsel (2008) as well as Farruggio and Uhde (2015), which reveal that larger banks are more likely to securitize assets.

[21] Note that our sample of 63 securitizing banks is reduced by two banks (Sydbank and Northern Rock) due to missing issuer rating data. Rating data is retrieved from *Thomson Reuters Eikon*.

6 Conclusion

Employing a unique sample of 930 true sale and synthetic credit (risk) securitization transactions issued by 63 stock-listed banks across the EU-13 plus Switzerland over the period from 1997 to 2010 this paper empirically analyzes the relationship between securitization and the issuing banks' NPLRs. We provide evidence that credit (risk) securitization reduces the issuing bank's NPL exposure. These findings are primarily driven by true sale and non-opaque securitizations as well as securitizations of residential mortgage backed securities and consumer loans. Our results can be explained by a direct and indirect effect of a securitization transaction on the issuing banks' amount of NPLs. As a direct effect, our finding indicates that European banks in our sample may (partly) securitize NPLs as the most risky tranche and do not fully retain NPLs as the first-loss piece on their balance sheets (Cantor and Rouyer, 2000; Jiangli et al., 2007; Krainer and Laderman, 2014). Referring to the indirect effect, our analysis reveals a more risk-averse credit investment strategy after securitization (Demsetz, 2000; Cebenoyan and Strahan, 2004; Affinito and Tagliaferri, 2010), which might be due to the fact that managers are disciplined by explicit or implicit recourse arrangements from securitization transactions (Vermilyea et al., 2008; Casu et al., 2011).

Our baseline results remain robust even when controlling for endogeneity concerns and a likely persistence in the time series of the NPL data. Results from sensitivity analyses additionally reveal that (i) the relationship between securitization and the issuing banks' NPLRs is time-dependent, (ii) high-frequently issuing banks retain larger parts of NPLs on their balance sheets, (iii) global systemically important banks pursue a more risky credit investment strategy through securitization under the *too-big-to-fail* doctrine and (iv) banks exhibiting a poorer rating employ securitization to reduce their NPLR.

Against the background of our empirical results, we derive the following policy implications. As the analysis at hand reveals that credit (risk) securitization has been an effective instrument to reduce European banks' NPL exposures before the degeneration of the securitization market starting in 2008, our study supports the EU's view that securitization may be an important channel for banks to diversify funding sources, unlock credit markets and distribute credit risk more widely within the European financial system (European Union, 2017b). However, referring to findings from our sensitivity analyses, it is essential that regulatory initiatives have to keep track on misaligned incentives (e.g., excessive risk-taking under the *too-big-to-fail*

doctrine), which negatively affect the credit risk transfer through securitization. In addition, the revitalization of the European securitization market has to be prepared under much sounder conditions without repeating the failures made before (complex valuation, opaqueness, weak market discipline, drying up, lack of reliance), which led to a distorted credit risk transfer. Following the Capital Markets Union action plan provided by European institutions, we endorse recently passed regulations and proposals, which shall strengthen the legislative framework and increase the transparency and standardization level for the European securitization market (Basel Committee on Banking Supervision, 2014; European Banking Authority, 2014; Basel Committee on Banking Supervision and Board of the International Organization of Securities Commissions, 2015; European Parliament, 2016; European Union, 2017a,b). These regulatory initiatives aim to reestablishing a reliable securitization market by separating STS securitizations from more opaque, complex and risky transactions (European Union, 2017b).

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A Appendix

Table 1: Geographical distribution of securitizing banks in the sample

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

This table shows all reference entities and their corresponding countries as used in our analysis.

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

	Obs	Total Volume	Mean	Std.Dev.	Min	Max
Type of transaction						
True sale Transactions	648	1363.6445	2.1044	2.8465	0.0250	27.4886
Synthetic Transactions	282	713.2992	2.5294	2.8698	0.0580	22.0000
Underlying asset pool						
Collateralized Debt Obligations	295	655.4450	2.2218	2.5696	0.0580	16.8630
Residential Mortgage Backed Securities	394	1182.9657	3.0025	3.4807	0.0680	27.4886
Commercial Mortgage Backed Securities	93	95.1984	1.0236	1.1382	0.1990	7.0920
Credit Cards Receivables	24	28.8900	1.2037	1.9085	0.0560	9.9359
Consumer Loans	59	49.5661	0.8401	0.8392	0.0250	5.2751
Others	65	64.8785	0.9981	0.7645	0.0280	3.1000
Total Transactions	930	2076.9437	2.2333	2.8587	0.0250	27.4886

The total volumes are cumulated over the entire sample of 63 banks and the entire sample length of 14 years, whereas the mean, standard deviation, minimum and maximum refer to single securitization transactions.

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

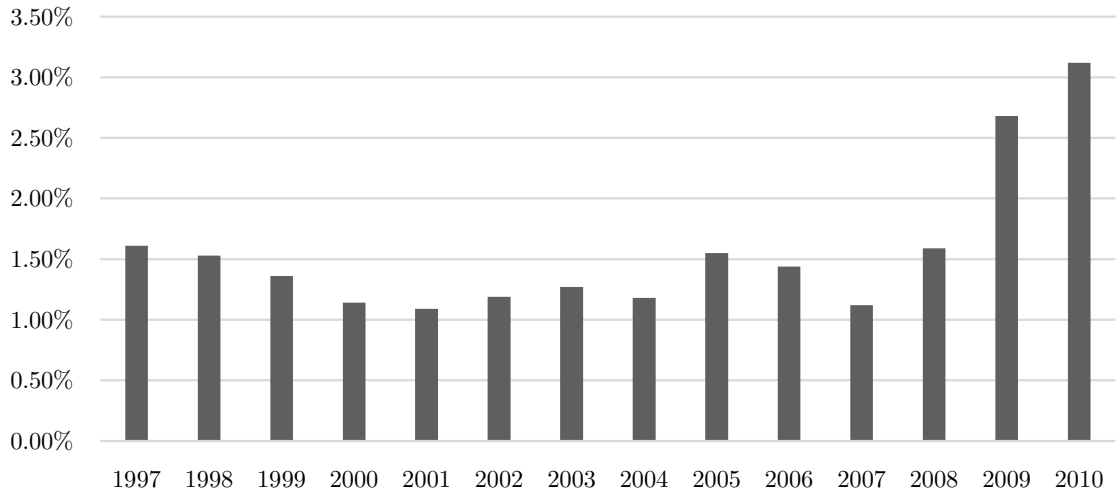

Figure 2: Development of the aggregated volumes of securitization transactions (in billion €) from sample banks

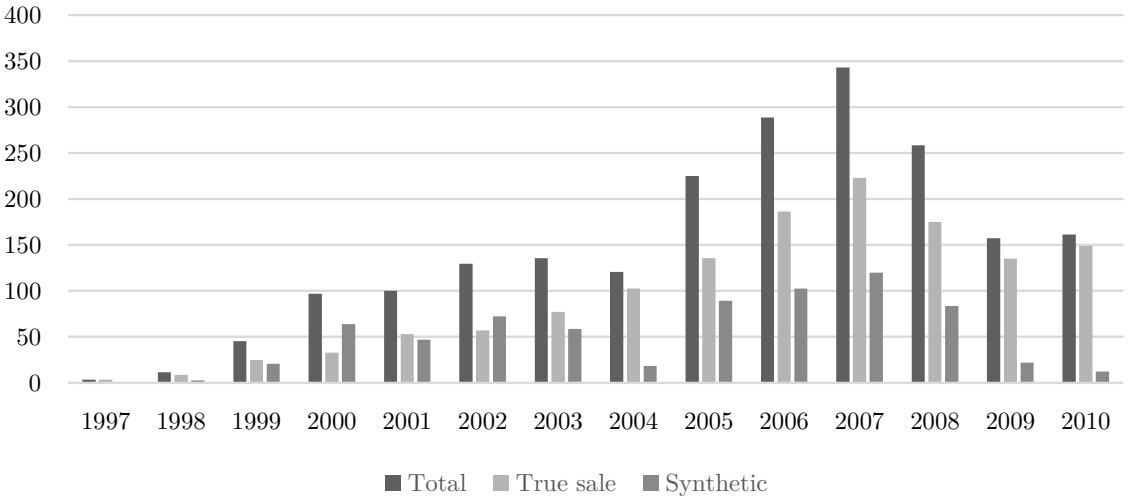

Figure 3: Development of the aggregated numbers of securitization transactions from sample banks

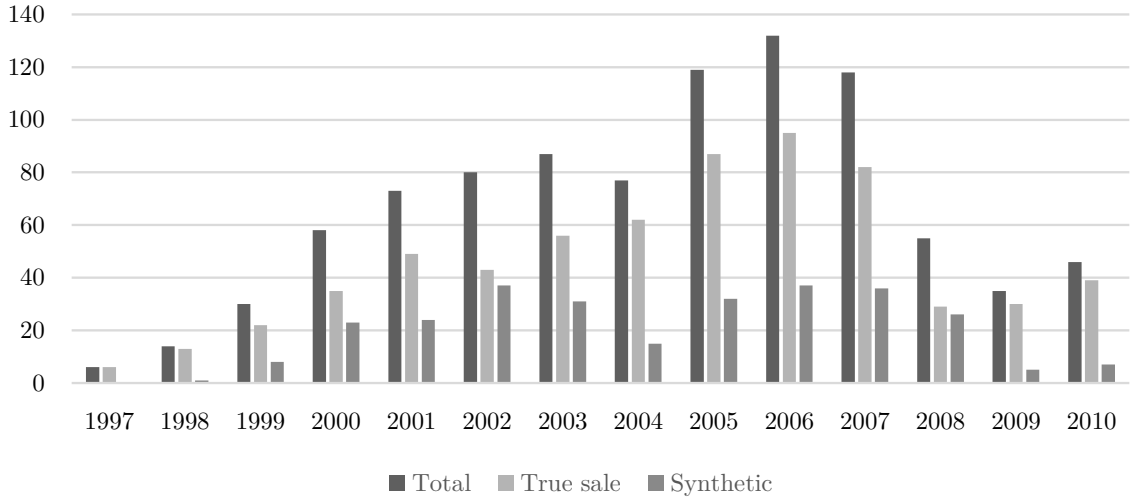

Figure 4: Frequent securitizers by the volume of securitization transactions

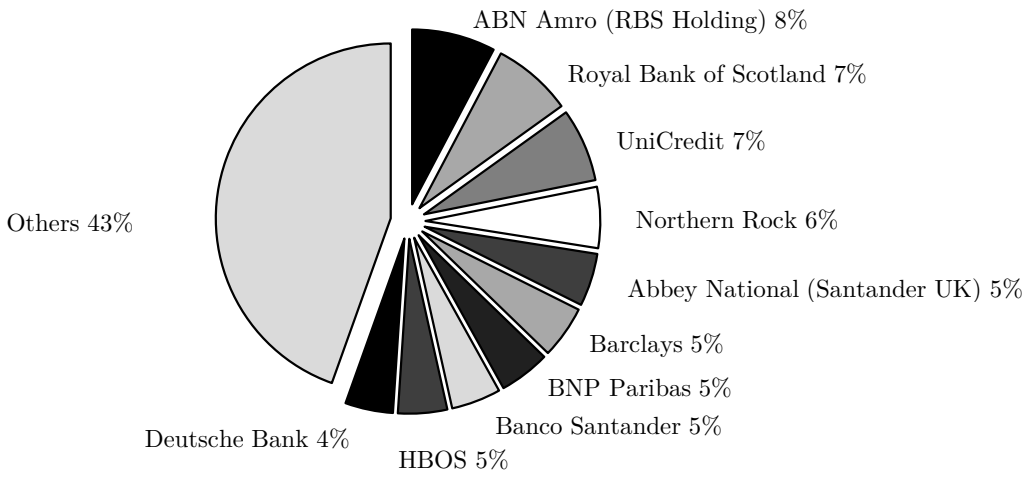

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Figure 5: Frequent securitizers by the number of securitization transactions

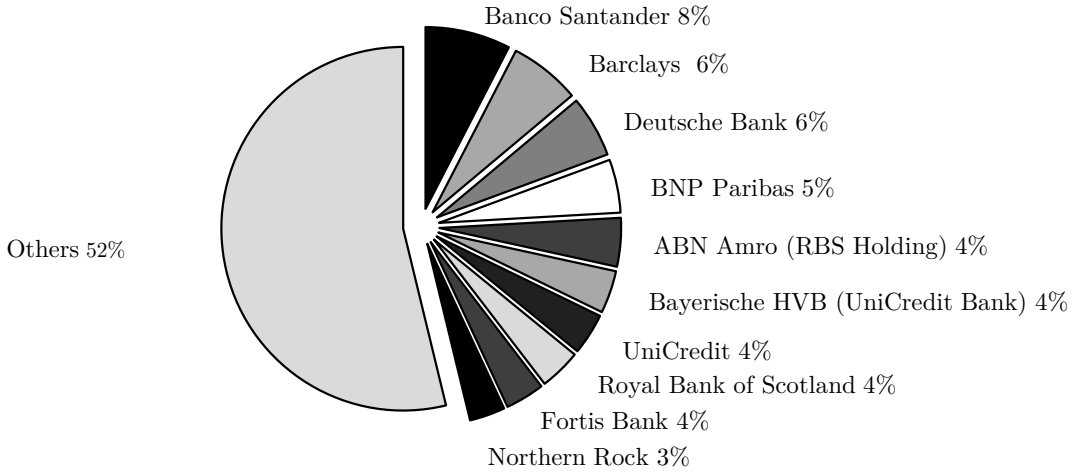

Table 3: Notes on variables and data sources

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

Continued on next page

Table 3: Notes on variables and data sources - continued

Variable	Expected sign	Description	Data Sources
Bank-specific variables			
Capital	+/-	Ratio of the accounting value of a bank's total equity to total assets per year. A larger ratio indicates a higher capitalized bank.	BankScope
Management	+/-	Ratio of the accounting value of a bank's total costs to total income per year. A greater management inefficiency is denoted by higher values.	
Profitability	-	Accounting value of a bank's return on average assets per year. A higher ratio suggests a more profitable bank.	
Liquidity	+/-	Ratio of the accounting value of a bank's liquid assets to total assets per year. A larger ratio indicates a higher liquidity position.	
Business Model	+/-	Ratio of the accounting value of a bank's non-interest income to interest income per year. A lower value suggests a lack of diversification in income sources.	
Country-specific variables			
Yield Curve	-	Annual change of the slope of the yield curve. The slope is calculated as 10-year minus 2-year government bond yields per country and year. A prospering economy is denoted by higher values.	Thomson Reuters Eikon
Unemployment	+	Annual change of the unemployment rate. The unemployment rate is defined as the number of unemployed persons divided by the labor force per country and year. A larger ratio indicates a worsening of labor market conditions.	World Bank's WDI
Stock market	-	Annual return of the main stock market index per country and year. A higher value indicates greater stock market performance.	Thomson Reuters Datastream
Concentration	+/-	Herfindahl-Hirschman index (HHI) for credit institutions based on total assets per country and year. A higher value implies a greater bank concentration.	ECB Statistical Data Warehouse, SNB
Regulatory environment			
Capital Regulation	+/-	Capital regulatory index proposed by Barth et al. (2013a). This yearly index captures information on (i) whether the capital requirements appropriately reflect risk elements, (ii) whether market value losses are deducted prior to the calculation of the capital adequacy ratio, and (iii) which types of funds are employed to establish a bank. Index values range from zero to ten. A higher level of the capital regulatory index indicates greater regulatory requirements and capital stringency.	World Bank, Barth et al. (2001, 2004, 2008, 2013a)

Continued on next page

Table 3: Notes on variables and data sources - continued

Variable	Expected sign	Description	Data Sources
MMHI	+/-	The mitigating moral hazard index (MMHI) proposed by Barth et al. (2013a) is based on different design features of a country's deposit insurance system that may help to mitigate moral hazard in the banking market. The index includes the following three questions from the Barth surveys: (i) Is the deposit insurance system funded by the government, banks or both?, (ii) Do deposit insurance fees charged to banks vary based on some assessment of risk? and (iii) Is there formal co-insurance, that is, are depositors only insured for some percentage of their deposits, either absolutely or above some floor and/or up to some limit? Index values range from zero to three. A higher value indicates that banks are stronger forced to financially participate in a deposit insurance system and hence implies a stronger potential to mitigate moral hazard.	World Bank, Barth et al. (2001, 2004, 2008, 2013a)
Time variables			
Dummy_{onset}	-	Dummy variable that takes on the value of 1 for the years from 1997 to 2001 (onset stage), and 0 otherwise.	Authors calc.
Dummy_{boom}	-	Dummy variable that takes on the value of 1 for the years from 2002 to 2007 (boom stage), and 0 otherwise.	
Dummy_{crises}	+	Dummy variable that takes on the value of 1 if for the years from 2008 to 2010 (crises stage), and 0 otherwise.	

Table 4: Descriptive statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Dependent variable					
NPLR	768	.0156	.0150	.0001	.1063
Securitization variables					
Securitization$_{t-1}$	781	.0113	.0250	0	.2517
True sale$_{t-1}$	781	.0087	.0227	0	.2517
Synthetic$_{t-1}$	781	.0026	.0101	0	.1051
Opaque$_{t-1}$	781	.0034	.0096	0	.1051
Non-Opaque$_{t-1}$	781	.0079	.0227	0	.2517
CDO$_{t-1}$	781	.0030	.0094	0	.1051
RMBS$_{t-1}$	781	.0073	.0224	0	.2517
CMBS$_{t-1}$	781	.0003	.0021	0	.0464
CC$_{t-1}$	781	.0001	.0009	0	.0169
CL$_{t-1}$	781	.0003	.0017	0	.0255
Other$_{t-1}$	781	.0005	.0025	0	.0292
Bank-specific variables					
Capital	836	.0517	.0230	.0001	.1606
Management	827	.8184	.2288	-3.6019	4.1562
Profitability	837	.0056	.0060	-.0636	.0330
Liquidity	829	.2034	.1293	.0136	.6495
Business Model	811	.2850	.2816	-1.2890	3.9316
Country-specific variables					
Yield Curve	860	.0004	.0067	-.0203	.0208
Unemployment	882	-.0009	.0130	-.0350	.0660
Stock Market	870	.0670	.2624	-.6621	1.0131
Concentration	882	.0587	.0454	.0114	.2167
Regulatory environment					
Capital Regulation	882	6.2540	1.9492	2	9
MMHI	882	1.8457	.7163	1	3
Time variables					
Dummy$_{onset}$	882	.3571	.4794	0	1
Dummy$_{boom}$	882	.4286	.4952	0	1
Dummy$_{crises}$	882	.2143	.4106	0	1

Table 5: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
(1) NPLR	1.00																									
(2) Securitization$_{t-1}$	-0.07	1.00																								
	(0.06)																									
(3) True sale$_{t-1}$	-0.10	0.92	1.00																							
	(0.01)	(0.00)																								
(4) Synthetic$_{t-1}$	0.06	0.42	0.02	1.00																						
	(0.09)	(0.00)	(0.66)																							
(5) Opaque$_{t-1}$	0.08	0.42	0.17	0.66	1.00																					
	(0.03)	(0.00)	(0.00)	(0.00)																						
(6) Non-Opaque$_{t-1}$	-0.11	0.92	0.94	0.18	0.04	1.00																				
	(0.00)	(0.00)	(0.00)	(0.00)	(0.28)																					
(7) CDO$_{t-1}$	0.06	0.41	0.15	0.68	0.97	0.04	1.00																			
	(0.12)	(0.00)	(0.00)	(0.00)	(0.00)	(0.24)																				
(8) RMBS$_{t-1}$	-0.10	0.92	0.93	0.17	0.04	0.99	0.05	1.00																		
	(0.01)	(0.00)	(0.00)	(0.00)	(0.26)	(0.00)	(0.20)																			
(9) CMBS$_{t-1}$	-0.04	0.14	0.09	0.13	-0.02	0.16	-0.01	0.07	1.00																	
	(0.30)	(0.00)	(0.01)	(0.00)	(0.57)	(0.00)	(0.68)	(0.05)																		
(10) CC$_{t-1}$	-0.02	0.04	0.05	-0.02	0.03	0.03	-0.02	-0.00	-0.00	1.00																
	(0.55)	(0.26)	(0.15)	(0.65)	(0.48)	(0.35)	(0.57)	(0.90)	(0.91)																	
(11) CL$_{t-1}$	-0.05	0.08	0.10	-0.03	-0.00	0.09	-0.01	0.02	-0.02	-0.01	1.00															
	(0.15)	(0.03)	(0.01)	(0.36)	(0.93)	(0.02)	(0.76)	(0.66)	(0.61)	(0.71)																
(12) Other$_{t-1}$	0.08	0.08	0.10	-0.02	0.24	-0.01	-0.02	-0.02	-0.02	0.17	0.03	1.00														
	(0.03)	(0.02)	(0.01)	(0.59)	(0.00)	(0.76)	(0.56)	(0.61)	(0.51)	(0.00)	(0.43)															
(13) Capital	0.07	-0.06	-0.03	-0.10	0.01	-0.07	-0.03	-0.08	-0.09	0.11	0.12	0.15	1.00													
	(0.04)	(0.08)	(0.48)	(0.01)	(0.81)	(0.04)	(0.38)	(0.03)	(0.01)	(0.00)	(0.00)	(0.00)														
(14) Management	-0.08	-0.01	-0.03	0.02	0.01	-0.02	0.02	-0.00	-0.14	-0.03	-0.04	-0.04	-0.23	1.00												
	(0.02)	(0.75)	(0.48)	(0.49)	(0.70)	(0.58)	(0.51)	(0.96)	(0.00)	(0.46)	(0.33)	(0.32)	(0.00)													
(15) Profitability	-0.32	-0.04	-0.02	-0.07	0.01	-0.05	0.02	-0.05	-0.04	0.02	0.01	-0.02	0.46	-0.24	1.00											
	(0.00)	(0.22)	(0.60)	(0.06)	(0.77)	(0.14)	(0.63)	(0.15)	(0.24)	(0.59)	(0.71)	(0.51)	(0.00)	(0.00)												
(16) Liquidity	-0.14	-0.20	-0.20	-0.04	-0.07	-0.19	-0.07	-0.19	0.02	0.04	-0.09	-0.02	-0.20	0.15	-0.14	1.00										
	(0.00)	(0.00)	(0.00)	(0.29)	(0.04)	(0.00)	(0.05)	(0.00)	(0.51)	(0.33)	(0.02)	(0.60)	(0.00)	(0.00)	(0.00)											
(17) Business Model	-0.10	-0.13	-0.11	-0.08	-0.06	-0.12	-0.06	-0.12	-0.08	-0.02	-0.00	0.01	0.05	0.05	0.21	0.15	1.00									
	(0.01)	(0.00)	(0.00)	(0.03)	(0.10)	(0.00)	(0.08)	(0.00)	(0.03)	(0.68)	(0.91)	(0.86)	(0.17)	(0.13)	(0.00)	(0.00)										
(18) Yield Curve	0.01	0.04	0.03	0.03	0.05	0.02	0.06	0.03	-0.01	-0.01	-0.02	-0.06	-0.05	0.06	-0.24	-0.09	-0.15	1.00								
	(0.68)	(0.28)	(0.40)	(0.42)	(0.18)	(0.52)	(0.07)	(0.47)	(0.86)	(0.73)	(0.61)	(0.11)	(0.14)	(0.08)	(0.00)	(0.01)	(0.00)									
(19) Unemployment	0.26	0.05	0.04	0.02	0.01	0.05	0.03	0.05	-0.02	-0.02	-0.02	-0.06	-0.10	-0.01	-0.24	-0.02	-0.03	0.20	1.00							
	(0.00)	(0.18)	(0.21)	(0.58)	(0.72)	(0.18)	(0.41)	(0.14)	(0.56)	(0.51)	(0.67)	(0.08)	(0.00)	(0.76)	(0.00)	(0.49)	(0.37)	(0.00)								
(20) Stock Market	0.01	-0.03	-0.03	-0.01	-0.03	-0.03	-0.03	-0.02	-0.01	0.02	-0.02	-0.02	0.06	-0.05	0.15	0.11	0.10	-0.33	0.01	1.00						
	(0.71)	(0.34)	(0.36)	(0.76)	(0.40)	(0.49)	(0.48)	(0.50)	(0.84)	(0.59)	(0.56)	(0.57)	(0.10)	(0.13)	(0.00)	(0.00)	(0.01)	(0.00)	(0.84)							
(21) Concentration	-0.21	-0.04	-0.06	0.03	0.01	-0.05	0.04	-0.04	-0.04	-0.01	-0.05	-0.13	-0.13	0.17	0.02	-0.15	0.16	0.02	0.10	-0.04	1.00					
	(0.00)	(0.25)	(0.10)	(0.36)	(0.78)	(0.17)	(0.22)	(0.24)	(0.22)	(0.80)	(0.20)	(0.00)	(0.00)	(0.00)	(0.51)	(0.00)	(0.00)	(0.62)	(0.00)	(0.27)						
(22) Capital Regulation	-0.18	0.17	0.18	-0.00	0.04	0.17	0.08	0.17	-0.01	0.01	0.06	-0.13	-0.02	-0.09	0.19	-0.19	0.01	-0.01	-0.05	0.04	-0.00	1.00				
	(0.00)	(0.00)	(0.00)	(0.99)	(0.26)	(0.00)	(0.03)	(0.00)	(0.82)	(0.80)	(0.08)	(0.00)	(0.48)	(0.01)	(0.00)	(0.00)	(0.75)	(0.86)	(0.13)	(0.23)	(0.99)					
(23) MMHI	0.11	-0.05	-0.08	0.07	0.01	-0.06	0.01	-0.06	0.05	-0.02	-0.05	0.02	-0.18	0.08	-0.20	0.23	-0.07	-0.06	0.01	0.01	-0.26	-0.14	1.00			
	(0.00)	(0.19)	(0.02)	(0.07)	(0.70)	(0.11)	(0.82)	(0.10)	(0.16)	(0.63)	(0.17)	(0.52)	(0.00)	(0.02)	(0.00)	(0.00)	(0.05)	(0.09)	(0.68)	(0.85)	(0.00)	(0.00)				
(24) Dummy$_{onset}$	-0.10	-0.19	-0.17	-0.09	-0.12	-0.16	-0.10	-0.15	-0.08	-0.03	-0.04	-0.08	0.09	0.05	0.20	0.07	0.06	-0.11	-0.43	0.18	-0.12	0.01	0.07	1.00		
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.45)	(0.21)	(0.02)	(0.01)	(0.19)	(0.00)	(0.06)	(0.11)	(0.00)	(0.00)	(0.00)	(0.00)	(0.72)	(0.05)			
(25) Dummy$_{boom}$	-0.16	0.17	0.15	0.09	0.14	0.13	0.10	0.12	0.08	0.06	0.07	0.14	-0.02	-0.05	0.11	0.00	0.05	-0.26	0.01	0.05	0.05	0.01	0.03	-0.65	1.00	
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.11)	(0.04)	(0.00)	(0.63)	(0.18)	(0.00)	(0.90)	(0.16)	(0.00)	(0.79)	(0.17)	(0.16)	(0.86)	(0.34)	(0.00)		
(26) Dummy$_{crises}$	0.32	0.00	0.01	-0.01	-0.03	0.02	-0.01	0.02	-0.01	-0.04	-0.04	-0.08	-0.09	0.00	-0.37	-0.08	-0.13	0.43	0.50	-0.26	0.09	-0.02	-0.12	-0.39	-0.45	1.00
	(0.00)	(0.94)	(0.81)	(0.73)	(0.37)	(0.64)	(0.76)	(0.54)	(0.76)	(0.26)	(0.30)	(0.02)	(0.01)	(0.89)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.53)	(0.00)	(0.00)	(0.00)	

P-values are in parentheses.

Table 6a: Baseline regressions

	(1) NPLR	(2) NPLR	(3) NPLR	(4) NPLR	(5) NPLR	(6) NPLR
$NPLR_{t-1}$		0.9299***				
		(0.000)				
Securitization		-0.0554***				
		(0.008)				
$Securitization_{t-1}$	-0.0634**					
	(0.013)					
$True\ sale_{t-1}$			-0.0862***			
			(0.001)			
$Synthetic_{t-1}$				0.0092		
				(0.870)		
$Opaque_{t-1}$					-0.0057	
					(0.913)	
$Non\text{-}Opaque_{t-1}$						-0.0837***
						(0.000)
Capital	0.1738***	0.0736	0.1748***	0.1630***	0.1633***	0.1771***
	(0.004)	(0.217)	(0.004)	(0.007)	(0.007)	(0.003)
Management	0.0009	0.0001	0.0008	0.0006	0.0007	0.0007
	(0.381)	(0.900)	(0.422)	(0.574)	(0.550)	(0.480)
Profitability	-0.6055***	-0.4614***	-0.6148***	-0.5898***	-0.5887***	-0.6208***
	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
Liquidity	-0.0245***	-0.0164*	-0.0251***	-0.0236***	-0.0236***	-0.0248***
	(0.006)	(0.052)	(0.005)	(0.008)	(0.008)	(0.006)
Business Model	-0.0007	-0.0010	-0.0007	-0.0007	-0.0007	-0.0007
	(0.812)	(0.589)	(0.810)	(0.797)	(0.799)	(0.796)
Yield Curve	-0.2306*	-0.1797*	-0.2208	-0.2354*	-0.2359*	-0.2330*
	(0.092)	(0.097)	(0.105)	(0.094)	(0.093)	(0.082)
Unemployment	0.2109***	0.0987***	0.2128***	0.2070***	0.2068***	0.2135***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Stock Market	-0.0108***	-0.0078***	-0.0107***	-0.0116***	-0.0116***	-0.0111***
	(0.008)	(0.001)	(0.009)	(0.006)	(0.005)	(0.007)
Concentration	-0.1372**	-0.0185*	-0.1392**	-0.1340**	-0.1340**	-0.1369**
	(0.018)	(0.063)	(0.015)	(0.022)	(0.023)	(0.016)
Capital Regulation	-0.0008*	0.0001	-0.0007*	-0.0007*	-0.0007*	-0.0007*
	(0.062)	(0.665)	(0.084)	(0.075)	(0.072)	(0.073)
MMHI	0.0082***	-0.0002	0.0080***	0.0079***	0.0079***	0.0079***
	(0.002)	(0.749)	(0.002)	(0.003)	(0.003)	(0.003)
Cluster bank-level	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES
N	702	689	702	702	702	702
No. of Groups	63	63	63	63	63	63
R^2 Overall	0.3035		0.3121	0.3066	0.3048	0.3151
F-statistic		63.1249***				
		(0.0000)				
Number of instruments		40				
Hansen J statistic		18.3624				
		(0.1908)				
Arellano/Bond AR(1)		-3.6331***				
		(0.0003)				
Arellano/Bond AR(2)		0.0183				
		(0.9854)				

As regards regression specifications (1) and (3) to (6), the linear fixed effects panel model estimated is $NPLR_{(i=bank,t=time)} = \alpha_i + \gamma Securitization_{i,t-1} + \beta_1 Capital_{i,t} + \beta_2 Management_{i,t} + \beta_3 Profitability_{i,t} + \beta_4 Liquidity_{i,t} + \beta_5 Business\ Model_{i,t} + \beta_6 Yield\ Curve_{i,t} + \beta_7 Unemployment_{i,t} + \beta_8 Stock\ Market_{i,t} + \beta_9 Concentration_{i,t} + \beta_{10} Capital\ Regulation_{i,t} + \beta_{11} MMHI_{i,t} + \epsilon_{i,t}$. Regression specification (2) reports results from a one-step system GMM dynamic panel model. This model is estimated as $NPLR_{(i=bank,t=time)} = \alpha + \delta NPLR_{i,t-1} + \gamma Securitization_{i,t} + \beta_1 Capital_{i,t} + \beta_2 Management_{i,t} + \beta_3 Profitability_{i,t} + \beta_4 Liquidity_{i,t} + \beta_5 Business\ Model_{i,t} + \beta_6 Yield\ Curve_{i,t} + \beta_7 Unemployment_{i,t} + \beta_8 Stock\ Market_{i,t} + \beta_9 Concentration_{i,t} + \beta_{10} Capital\ Regulation_{i,t} + \beta_{11} MMHI_{i,t} + \epsilon_{i,t}$. Further regression specifications report results for true sale (3), synthetic (4), opaque (5) and non-opaque (6) transactions respectively. All variables are included on a yearly basis, and they are described in detail in Table 3. The regression period spans from 1997 to 2010. 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 6b: Baseline regressions

	(1) NPLR	(2) NPLR	(3) NPLR	(4) NPLR	(5) NPLR	(6) NPLR
CDO_{t-1}	0.0125					
	(0.805)					
$RMBS_{t-1}$		-0.0789***				
		(0.001)				
$CMBS_{t-1}$			-0.0654			
			(0.393)			
CC_{t-1}				-0.1489		
				(0.204)		
CL_{t-1}					-0.5444***	
					(0.003)	
$Other_{t-1}$						-0.2403
						(0.101)
Capital	0.1635***	0.1754***	0.1630***	0.1640***	0.1695***	0.1670***
	(0.007)	(0.003)	(0.007)	(0.007)	(0.006)	(0.006)
Management	0.0006	0.0008	0.0005	0.0006	0.0006	0.0006
	(0.592)	(0.405)	(0.626)	(0.565)	(0.614)	(0.583)
Profitability	-0.5913***	-0.6165***	-0.5895***	-0.5916***	-0.5977***	-0.5969***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Liquidity	-0.0236***	-0.0246***	-0.0236***	-0.0234***	-0.0244***	-0.0235***
	(0.008)	(0.006)	(0.008)	(0.009)	(0.006)	(0.008)
Business Model	-0.0008	-0.0007	-0.0008	-0.0008	-0.0007	-0.0008
	(0.794)	(0.809)	(0.790)	(0.793)	(0.803)	(0.790)
Yield Curve	-0.2369*	-0.2338*	-0.2360*	-0.2347*	-0.2399*	-0.2365*
	(0.091)	(0.082)	(0.093)	(0.095)	(0.090)	(0.094)
Unemployment	0.2069***	0.2137***	0.2066***	0.2069***	0.2056***	0.2028***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Stock Market	-0.0117***	-0.0111***	-0.0116***	-0.0117***	-0.0114***	-0.0117***
	(0.005)	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)
Concentration	-0.1339**	-0.1360**	-0.1341**	-0.1343**	-0.1365**	-0.1371**
	(0.022)	(0.017)	(0.022)	(0.022)	(0.019)	(0.020)
Capital Regulation	-0.0007*	-0.0007*	-0.0007*	-0.0007*	-0.0008*	-0.0007*
	(0.075)	(0.073)	(0.076)	(0.083)	(0.063)	(0.086)
MMHI	0.0078***	0.0079***	0.0079***	0.0079***	0.0078***	0.0080***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Cluster bank-level	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES
No. of observations	702	702	702	702	702	702
No. of groups	63	63	63	63	63	63
Adj. R^2	0.3073	0.3137	0.3060	0.3056	0.3094	0.3011

The linear fixed effects panel model and estimation parameters are defined in Table 6a. Regression specifications report results for different securitization underlyings including (1) collateralized debt obligations (CDOs), (2) residential mortgage backed securities (RMBSs), (3) commercial mortgage backed securities (CMBSs), (4) credit cards receivables (CCs), (5) consumer loans (CLs) and (6) 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 7a: Sensitivity analyses

	(1) Onset NPLR	(2) Boom NPLR	(3) Crises NPLR	(4) FS_{Vol} NPLR	(5) Non-FS_{Vol} NPLR	(6) FS_{TA} NPLR	(7) Non-FS_{TA} NPLR
$Securitization_{t-1}$	-0.0643**	-0.0079	-0.0828***	-0.0483*	-0.0661*	-0.0446	-0.0719**
	(0.011)	(0.837)	(0.003)	(0.073)	(0.056)	(0.255)	(0.027)
$Dummy_{onset}$	-0.0169***						
	(0.000)						
$Securitization_{t-1}$ * $Dummy_{onset}$	0.0262						
	(0.697)						
$Dummy_{boom}$		-0.0098***					
		(0.000)					
$Securitization_{t-1}$ * $Dummy_{boom}$		-0.0766*					
		(0.069)					
$Dummy_{crises}$			0.0098***				
			(0.000)				
$Securitization_{t-1}$ * $Dummy_{crises}$			0.0801*				
			(0.092)				
Capital	0.1735***	0.1739***	0.1748***	0.3824**	0.1392**	0.2614	0.1654***
	(0.004)	(0.004)	(0.004)	(0.049)	(0.023)	(0.122)	(0.008)
Management	0.0009	0.0010	0.0009	0.0017	0.0014	0.0026	0.0008
	(0.363)	(0.337)	(0.385)	(0.682)	(0.272)	(0.454)	(0.591)
Profitability	-0.6059***	-0.6183***	-0.6176***	-1.0837**	-0.5223***	-0.5606*	-0.6407***
	(0.000)	(0.000)	(0.000)	(0.044)	(0.003)	(0.088)	(0.000)
Liquidity	-0.0245***	-0.0259***	-0.0261***	-0.0091	-0.0277***	-0.0103	-0.0286***
	(0.007)	(0.004)	(0.004)	(0.470)	(0.006)	(0.428)	(0.005)
Business Model	-0.0007	-0.0008	-0.0007	0.0048	-0.0009	-0.0080	0.0001
	(0.811)	(0.790)	(0.793)	(0.712)	(0.785)	(0.226)	(0.970)
Yield Curve	-0.2317*	-0.2401*	-0.2372*	-0.4824*	-0.1712	-0.5610**	-0.2001
	(0.091)	(0.087)	(0.091)	(0.094)	(0.281)	(0.023)	(0.194)
Unemployment	0.2118***	0.2081***	0.2054***	-0.0605	0.2387***	-0.0198	0.2160***
	(0.000)	(0.000)	(0.000)	(0.498)	(0.000)	(0.678)	(0.000)
Stock Market	-0.0108***	-0.0106***	-0.0108***	-0.0251	-0.0098**	-0.0128	-0.0087*
	(0.009)	(0.008)	(0.007)	(0.137)	(0.024)	(0.352)	(0.053)
Concentration	-0.1375**	-0.1396**	-0.1387**	-0.3418	-0.1218**	-0.5600	-0.0919*
	(0.018)	(0.017)	(0.017)	(0.202)	(0.037)	(0.110)	(0.095)
Capital Regulation	-0.0008*	-0.0007*	-0.0007*	0.0010	-0.0009*	0.0016	-0.0010**
	(0.063)	(0.071)	(0.071)	(0.385)	(0.052)	(0.172)	(0.040)
MMHI	0.0082***	0.0078***	0.0079***	0.0164**	0.0069**	0.0184**	0.0082***
	(0.002)	(0.003)	(0.003)	(0.041)	(0.019)	(0.016)	(0.008)
Cluster bank-level	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES
No. of observations	702	702	702	120	582	117	585
No. of groups	63	63	63	10	53	10	53
Adj. R^2	0.3038	0.3108	0.3101	0.1236	0.3268	0.1379	0.3241

The linear fixed effects panel model and estimation parameters are defined in Table 6a. Regression specifications (1) - (3) analyze the relationship between securitization and an issuing bank's NPLR during different stages (onset (1997-2001), boom (2002-2007), crises (2008-2010) stage) of securitization activities in Europe by employing interaction variables. Further regression specifications report results from splitting the entire sample into subsamples of frequent (FS, (4) and (6)) and non-frequent securitizers (Non-FS, (5) and (7)) with regard to the transaction volume (Vol) and the number of transactions (TA) respectively. 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

	(1) G-SIB NPLR	(2) Non-G-SIB NPLR	(3) Rating_{below} NPLR	(4) Rating_{above} NPLR
$\text{Securitization}_{t-1}$	0.2864***	-0.0812***	0.0359	-0.1094**
	(0.006)	(0.001)	(0.525)	(0.012)
Capital	0.1868	0.1387**	0.1715**	0.1356
	(0.133)	(0.036)	(0.013)	(0.186)
Management	0.0058	0.0010	0.0003	0.0037*
	(0.304)	(0.528)	(0.876)	(0.095)
Profitability	-0.8404	-0.5695***	-0.8633**	-0.4869**
	(0.133)	(0.001)	(0.018)	(0.022)
Liquidity	-0.0192	-0.0248**	-0.0150	-0.0303**
	(0.292)	(0.019)	(0.148)	(0.039)
Business Model	0.0017	-0.0050	0.0019	-0.0107
	(0.499)	(0.383)	(0.453)	(0.170)
Yield Curve	-0.3327*	-0.3087	-0.2192	-0.2198
	(0.073)	(0.106)	(0.104)	(0.345)
Unemployment	0.1653**	0.2037***	0.1377**	0.2765***
	(0.022)	(0.000)	(0.017)	(0.000)
Stock Market	-0.0145	-0.0089*	-0.0135**	-0.0087
	(0.118)	(0.068)	(0.014)	(0.183)
Concentration	0.0621	-0.1897**	-0.0625	-0.2260**
	(0.453)	(0.018)	(0.429)	(0.032)
Capital Regulation	-0.0008*	-0.0005	-0.0009*	-0.0002
	(0.076)	(0.402)	(0.091)	(0.826)
MMHI	-0.0010	0.0107***	0.0084**	0.0058
	(0.769)	(0.002)	(0.013)	(0.213)
Cluster bank-level	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES
No. of observations	190	512	331	352
No. of groups	16	47	28	33
Adj. R^2	0.1581	0.2764	0.3005	0.3098

The linear fixed effects panel model and estimation parameters are defined in Table 6a. Regression specifications present results from a split of the entire sample into G-SIB (1) and non-G-SIB (2) institutions as well as banks with an average rating score *below* (3) or *above* (4) the sample mean rating. A lower rating score indicates a better rating status. 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.