Chapter 15
How Does NPLs Securitization Affect EU Banks' Systemic Risk?

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Abstract This chapter contributes to the growing debate on the NPLs issue by addressing the challenges leading to financial stability and promoting the NPLs resolution plans for EU banks. Our main hypothesis is a U-shaped relationship between the NPLs securitizations and the systemic risk. We find that the maximum amount of NPLs securitization performed by EU banks to minimize the contribution to systemic risk shifts about Global systemic important banks (G-SIB) designation and country risk. The bank's contribution to systemic risk lies in the involvement of the bank in this instrument and not in its features. Our results contribute to the ongoing debate on the important issue of designing suitable systemic risk indicators that act as Early Warning Systems (EWS) for predicting incoming financial crises. Evaluating the bank's contribution to systemic risk is important to take into account the bank's exposure to NPL securitization.

Keywords Systemic risk · Securitization · Non-performing loans · Global Systemically Important Institutions (G-SIBs)

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Introduction

Preserving financial stability, and thereby supporting sustainable growth, requires the continued monitoring of developments in the global financial system. The recent financial turmoil has exacerbated the issue of the financial stability of the banking system. The collapse of important financial institutions has raised questions about the involvement of the banking sector in the propagation of the financial crisis. The large stock of non-performing loans (NPLs) has been and still is a pressing financial stability issue for the euro area (Fell et al. 2017). A high NPLs volume may cause micro-prudential and macro-prudential problems. From the micro-prudential point of view, the high volume of NPLs reduces the profitability and efficiency of the banks whereas, from the macro-prudential point of view, the amount of NPLs impacts economic growth by reducing the capability of banks to provide new lending. Furthermore, the banking sector's resilience to shock is harmed, which leads to an increase in systemic risk (EBA 2018). A wide range of possible resolution options to address the NPLs' problems have involved on- and off-balance sheet approaches, with the former involving the internal workout of NPLs, whereas the latter involves outright sales to investors (Grodzicki et al. 2015). Specifically, bank NPLs securitization is the process whereby distressed loans are pooled together into tradable securities, named Asset-Backed Securities (ABS), and sold to the investors. The possibility of transforming a distressed loan into tradable security allows for transferring the risks of the distressed loans to the market. For this reason, the effect of an NPLs securitization on the systemic risk could be twofold. On the one hand, NPLs securitization could enhance banks' risk appetite as they could find this tool as a good deal to sell distressed loans to the market. From this perspective, the securitization of bad loans could incentivize banks to reduce lending standards and thus, threaten financial stability and systemic risk. All this together is the basis of an unbalanced and fragile financial system. On the other hand, NPLs securitization allows banks to hold less risk and manage credit risk more effectively. Therefore, it provides a mechanism where the risks of distressed loans, concentrated in a bank, could be transferred and dispersed to the investors. NPLs securitization could operate as a means through which the risk is distributed on the market and thus it could make the financial system more stable and resilient.

This chapter aims to study the relationship between NPLs securitization and systemic risk to understand the logic behind the resolution plans of EU banks and the incentives of the supervisory authorities to develop and promote the use of this tool. The issuance of NPLs securitization might initially help the banks reduce their systemic risk by providing benefits related to liquidity, capital requirements, and NPLs resolutions. However, the nature of this relationship may change when a bank increases the use of this particular instrument. An increase in the NPLs securitization may be translated by the financial market as huge exposures of banks in distressed loans, ex-ante wrong assessment of the credit risk, and excessive risk-taking. All

this together would be translated into a change in the relationship between the NPL securitization and the systemic risk. An increase in the use of NPLs securitizations beyond a certain level would imply an increase in systemic risk related to the problems explained above.

This study makes several contributions to the literature. First, we extend the very scarce literature on the impact of NPLs securitizations on systemic risk (Vuković and Domazet 2013; Pedisic 2019). The paper examines the effect of NPLs resolution plan on systemic risk and evaluates the effectiveness of the NPLs management on financial stability. NPLs securitization is widely used in the EU context because of the need to manage the stocks of NPLs in the banking system. It appears important to understand how they impact the systemic risk for financial stability issues. Second, the study tests the hypothesis of a quadratic relationship between the systemic risk and the NPLs securitizations that allows calculating of a threshold beyond or below which the use of NPLs securitization may be a detrimental tool for financial stability. To the best of our knowledge, this hypothesis has never been tested for NPLs securitizations. Only the paper of (Arif 2020) has tested the hypothesis for the covered bond and securitization market. However, we differentiate from this paper because we investigate the effect of a particular type of securitization on systemic risk. Third, our chapter contributes to the ongoing debate on the important issue of designing suitable systemic risk indicators that act as Early Warning Systems (EWS) for predicting incoming financial crises. Assessing the impact of NPLs securitization on the contribution to systemic risk provides empirical evidence on the real impact of the propagation of bank's risk on the financial system and, thus, on the effectiveness of the risk transferring process in the financial markets via securitizations. Finally, we construct an original dataset in which we include the main characteristics of the NPLs securitizations. We analyze a sample of EU banks during the period 2012–2020. We include in our sample 35 EU banks that have performed 133 NPLs securitizations.

We report different key results. First, it holds a U-shape relationship between systemic risk and NPLs securitizations implying that, though the initial positive effects of NPLs securitization on the systemic risk, the greater involvement of the banks in the NPLs resolution plans via securitizations exacerbates the bank's systemic risk and damages the financial stability. Therefore, the banks heavily involved in the NPLs securitization market experience greater exposure to a potential financial crisis and maybe a propagation mechanism of the individual financial crisis. Second, we identify the threshold below which the NPLs securitization is a good tool to transfer distressed loans to institutional investors but above this threshold, the issuance of an NPLs securitization is detrimental to bank systemic risk. On average, the securitizations performed by banks in our sample are well above the maximum amount identified by the empirical model. The only banks showing, on average, NPL securitizations lower than the estimated average are the Global Systemically Important Banks (G-SIB) in Portugal, Ireland, Italy, Greece, and Spain (PIIGS countries). These findings underline that the main problem lies in the way in which this instrument is used and not in the features of the tool itself. Shedding light on the effect of NPLs divestitures on financial stability could provide useful information on the determinants of financial contagion and, at the same time, on the involvement of the bank

sector in the propagation of financial crises. This information may act as EWS and, thus, can be incorporated into systemic risk indicators to predict financial crises.

The rest of the chapter is organized as follows. In the next section, we review the relevant literature and develop our hypotheses. Section "Data and Methodology" presents our methodology and data. Our empirical results are in section "Empirical Results". Section "Robustness" verifies the robustness of our empirical analysis and section "Conclusion" concludes.

Literature Review

Despite the rapid development of securitizations as a tool to solve the NPLs problems in EU banks, the dynamics of the relationship between NPLs securitizations and systemic risk have been partially unexplored. The very scarce literature examining the effects of the NPLs resolution plans on systemic risk (Vuković and Domazet 2013; Pedisic 2019) has underlined the important role played by the NPLs reduction measures on systemic risk. Vuković and Domazet (2013), focusing on macroeconomic contagion with non-performing loans and the infection of the financial sector with non-performing loans, find that the NPLs are the main generator of systemic risk in the financial and real sectors of Serbia. Pedisic (2019) highlights that the NPLs reduction measures and the statutory framework affect the EU systemic risk.

Despite the very few studies focusing on the impact of NPLs securitization on the systemic risk in EU banks, our chapter can be related to the literature examining the use of securitization and its impact on the banks' systemic risk. In this direction, different studies have analyzed the issue of financial stability related to the use of credit derivatives, especially in the aftermath of the US financial crisis. The advent of the US financial crisis has changed the previous positive role associated with credit derivatives in supporting financial stability (Wagner and Marsh 2006; Loutskina 2011) and in managing and diversifying effectively the credit risk portfolio of banks (Cebenoyan and Strahan 2004; Duffie 2008). The US financial crisis has highlighted that securitization may undermine financial stability by weakening the bank's credit standards and increasing risk-taking (Diamond 1984; Chiesa 2008; Minton et al. 2009; Keys et al. 2010; Kara et al. 2016) and by increasing the complexity of the financial markets and reduced the monitoring role of US banks (Halili et al. 2021). In the aftermath of the US financial crisis, several studies have demonstrated the negative impact of credit derivatives on financial stability. Specifically, focusing on the Italian listed banks, Battaglia and Gallo (2013) show that the use of securitization increases the expected losses in case of extreme events. They add that the impact of securitization on systemic risk does not change with the inception of the financial crisis by concluding that there is a severe implication of securitization for financial stability both before and after the financial crisis. Focusing on US banks' contribution to systemic risk, Mayordomo et al. (2014) find that the impact of financial derivatives on systemic risk differs among the types of financial derivatives. There is

a positive association between systemic risk and foreign exchange and credit derivatives and a negative association between systemic risk and interest rate derivatives. Furthermore, the NPLs and leverage ratios have a stronger impact on systemic risk than financial derivatives. Studying the impact of bank competition in the run-up to the 2007–2009 crisis on the banks' systemic risk, Altunbas et al. (2022) highlight that the use of securitization acts as a transmission mechanism channel and exacerbates the effects of market power on the systemic dimension of bank risk. Ivanov and Jiang (2020) underline the different roles of the underlying assets on systemic risk by showing that systemic risk is more sensitive to the securitization of residential mortgages. Finally, Arif (2020) explains the negative and positive association between the use of securitization and systemic risk through the theory of the "scalability view" of securitization suggesting the impact of the securitization on the systemic risk depends on the involvement of the bank in this market. On the same line, the paper of Mazzocchetti et al. (2020), by developing an agent-based model including the securitization position of banks, highlights that the involvement of a bank in securitizations weakens the financial stability of banks with relevant effects on different sectors of the economy.

Based on this literature, several assumptions can be made to build the conceptual framework of this study. Previous theories have underlined that the use of securitization made banks more resilient and, thus, reduced systemic risk (Greenspan 2005). The development of NPLs securitization has provided banks with a range of flexible instruments for selling distressed loans, transferring loan risk, and managing credit risk. The use of NPLs securitizations has helped to mitigate informational problems and acted as a mechanism to clean up the bank's balance sheet resulting in an increase in credit supply and a reduction of systemic risk. Therefore, our hypothesis is a negative association between NPLs securitization and systemic risk. Nevertheless, securitization creates an alternative funding source for banks that is less stable if compared to deposits. This may increase systemic risk because the banks are more vulnerable to changes in financial markets (Loutskina 2011; Laeven et al. 2016). Also, the view that banks reduce the credit standards and increase risk-taking may turn the relationship between systemic risk and NPLs securitization. The excessive involvement of a bank in NPLs securitizations could result in the weakening of the bank's credit standards and increasing risk-taking. Against this backdrop, the following hypotheses hold:

H1: There exists a quadratic relationship between NPL securitization and systemic risk.

H2: There is a threshold beyond or below which the issuance of NPLs securitizations reduces the systemic risk.

Our chapter is also closely related to the literature studying the determinants of systemic risk. Previous literature has used several bank-specific factors (Laeven et al. 2016; Bostandzic and Weiß 2018; Brunnermeier et al. 2020; Mazzocchetti et al. 2020) to evaluate how these can affect financial instabilities within the financial system. Brunnermeier et al. (2020) show a positive association between noninterest income and the total systemic risk of U.S. banks. Laeven et al. (2016) underline the role of bank size on systemic risk showing that, in EU and U.S. banks, the systemic risk grows with bank size and is inversely related to bank capital, and this effect exists above and beyond the effect of bank size and capital on standalone bank risk. Bostandzic and Weiß (2018) by investigating the reasons why some banks are more exposed and contribute more to systemic risk in the global financial system find that the quality of loan portfolio and the interconnectedness with the rest of the global financial system increase the contribution to the global systemic risk. Furthermore, they show that the average exposure of banks to systemic risk decreases in response to the higher capital regulations.

In light of the above literature, the threshold previously identified may be affected by different factors such as the complexity of the financial system, the country's financial condition, and the bank's network (Bakkar and Nyola 2021). These factors may increase the contribution of a bank to systemic risk. Therefore, we formulate our third hypothesis as follows:

H3: NPL, country, and bank characteristics change the threshold that minimizes the systemic risk of EU banks.

Data and Methodology

Data

To investigate the relationship between the NPLs securitizations and the systemic risk, we use a Panel of quarterly data spanning between Q1 2012–Q3 2020 for 35 EU-listed banks. This study focuses on European banks because they are the most active players in the NPLs market (EBA 2019). It has deep roots in Europe, especially in Portugal, Ireland, Italy, Greece, and Portugal (PIIGS countries).

Our analysis uses data coming from multiple sources. First of all, we collect data regarding SRISK and LRMES from V-lab maintained by the NY Stern Business School.[1] After identifying the banks with data on the V-lab website, we check Debtwire's NPL Coverage database and, one by one, the website of each bank to collect information about the NPLs securitizations.[2] Bank-level data, comprising the information from the financial statements, are obtained from Datastream. Non-listed banks are excluded from the sample. Banks with missing information about total

[1] https://vlab.stern.nyu.edu/welcome/srisk.

[2] Only for the Italian banks, we use the Securitization website (www.securitisation.it/index.htm) in which we can collect information about the securitizations performed by Italian banks.

assets, loans, and non-performing loan ratios are also excluded. All the variables are winsorized at a 1% level. Specifically, we replace all the data points less than the 1st percentile of each variable equal to the 1st percentile and all the data points exceeding the 99th percentile equal to the 99th percentile, thereby excluding extreme observations from the sample.

Table 15.7 in the appendix reports a detailed description of our variables whereas Table 15.1 provides the descriptive statistics of the dependent variables (Panel A) and independent variables divided by variable of interest and NPLs-specific characteristics (Panel B) and control variables (Panel C). Furthermore, Table 15.8 in the appendix provides detailed descriptive statistics of our dependent variables and variables of interest.

Table 15.1 Descriptive statistics

	Mean	Median	Std	Min	Max
Panel A: Dependent variable- Bank's level systemic risk					
SRISK (%)	25.98	19.75	26.07	0	100
LRMES	46.98	48.21	13.36	−6.1	89.13
Panel B: Variable of interest-NPLs securitizations					
Securitization of NPLs	1,560	1,000	1,680	15	11,000
Number of deals	2.55	2	1.75	1	11
Guarantee	14				
Type of loans					
CRE	29				
Consumer	21				
Corporate	22				
Legacy	2				
Mixed	19				
Mortgage	34				
Shipping	6				
Panel C: Control variables					
Banks size	19.57	19.49	1.54	16.45	22.59
Funding structure	48.9	48.33	16.83	5.92	96.6
Leverage	0.43	0.05	7.35	0	1.42
Capital adequacy	12.72	12.78	3.87	−7.3	27.9
NPL ratio	7.89	4.1	10.48	1.03	64.07
ROA	0.54	0.61	1.29	−12.4	4.99
Stock Price volatility	31.84	29.48	11.32	10.92	70.5
Sovereign CDS spread	703.4	48.5	455.9	5.95	3703.5

In line with the previous literature, as a dependent variable, we use two different measures of systemic risk: SRISK and Long-run marginal expected shortfall (LRMES) (Laeven et al. 2016; Arif 2020; Halili et al. 2021). First, we use the SRISK which measures the systemic risk contribution of a financial firm to the overall systemic risk. The systemic contribution of EU banks to the overall systemic risk ranged from 0 to 100%. On average, the EU banks show a systemic risk contribution of 25%. This indicates that banks will need around 25% of capital to cover the losses in case of a decline in the market index. The second measure of systemic risk is the LRMES which indicates the decline in equity values to be expected if there is a financial crisis. The analysis of the LRMES shows that the values ranged from − 6.10% to 83.13%. On average, the equity values of EU banks will decline by around 47% in case of a financial crisis. The country-level data of our systemic risk variables shows that the SRISK is lower for banks in PIIGS countries whereas the LMRES is more or less equal across the countries. Therefore, the systemic risk contribution of a bank in PIIGS countries to the overall systemic risk is lower than in other EU countries, whereas the decline in equity values in case of the financial crisis in banks in PIIGS countries is in line with the EU average.

Focusing on our variable of interest, Table 15.1 shows that the NPL securitization values ranged from USD 15 million to 11,000 USD million. The country-level values of NPLs securitization show that the most active banks in the NPLs market are those in PIIGS countries performing more than 33,998 USD million. The total gross book value (GBV) of NPLs securitizations performed by Italian banks is the highest (GBV of 14, 835 USD million) among EU banks immediately followed by Greek banks (GBV of 9,150 USD million). The Danish, Austrian and Norwegian banks have performed a lower amount of NPLs securitization compared to the other EU banks. The NPL-specific variables indicate that the EU banks, on average, have performed more than 2 NPLs securitizations. The maximum number of deals performed by one bank is 11 over the analysis period. Among the 133 NPL securitizations announced by EU banks, 14 are guaranteed by the government. In particular, the State-backed guarantee is from the Italian and Greek governments.[3] Different types of loans are the object of NPLs securitization. Based on a quantitative approach, in EU banks, 21.60% of the collateral are Commercial Real Estate (CRE) loans, 15.79% consumer loans, 16.54% corporate loans, 1.50% legacy loans, 14.29% mixed loans,[4] 25.56% mortgage loans and 4.51% shipping loans.

[3] In Italy, the public scheme that guarantees the senior tranche of NPL securitization is named *GACS- Garanzia sulla Cartolarizzazione delle Sofferenze* whereas in Greece, it is named *Hercules*.

[4] The mixed loans represent a mixture of the other loan types in an unknown proportion.

Empirical Methodology

This chapter aims to study the relationship between NPLs securitization issuance and bank stability and investigates the possible non-linearity in the target relationship. The main idea is that the relationship may vary with the level of involvement of a bank in the issuance of NPLs securitizations.

The issuance of NPL securitization can initially assist banks in mitigating systemic risk by offering advantages such as enhanced liquidity, meeting capital requirements, and facilitating NPL resolutions. However, the dynamics of this relationship may shift as a bank increases its use of this specific financial instrument. The financial market may interpret a rise in NPLs securitization as a sign of substantial bank exposure to distressed loans, potential errors in the ex-ante assessment of credit risk, and excessive risk-taking. These factors alter the correlation between NPL securitization and systemic risk. Beyond a certain threshold, an escalation in the use of NPLs securitizations implies an increase in systemic risk, attributed to the outlined issues. For these reasons, we examine a quadratic relationship between NPLs securitization and systemic risk. The extent of a bank's involvement in NPLs securitizations may influence systemic risk dynamics. EU banks derive systemic risk benefits up to a specific level of NPLs securitizations; however, surpassing this level results in drawbacks for EU banks engaged in further NPLs securitizations.

To mitigate potential endogeneity concerns,[5] we estimate our model employing the system GMM instrumental variables approach suggested by (Arellano and Bond 1991) and (Arellano and Bover 1995). We run two specification tests. The first is the Hansen test of over-identifying restrictions, which examines the validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation procedure. The second test is the AR2 test (Arellano and Bond 1991) for the hypothesis of no autocorrelation in the error term where the presence of second-order autocorrelation in the differenced residuals implies that the estimates are inconsistent. The applied model is the following regression model:

$$\begin{aligned} SRISK_{i,t} =& \alpha + \beta * SRISK_{i,t-1} + \gamma * NPLs_{Sec\ i,t} \\ &+ \delta * NPLs^2_{Sec\ i,t} + *PIIGS * NPLs_{Sec\ i,t} \\ &+ \theta * G - SIBs * NPLs_{Sec\ i,t} + \vartheta * Z_{i,t} + \mu * X_{i,t-1} \\ &+ \tau * SovereignCDS_{j,t} + \varepsilon \end{aligned} \tag{15.1}$$

where the dependent variable, $SRISK_{i,t-1}$, is the systemic risk measure of the *i*th bank in period *t–1*, $NPLs_{Sec\,i,t}$ is a variable that measures the *i*th bank's GBV of NPLs securitization at the time *t*.

To measure the systemic risk, we employ various proxies, with the primary measure being SRISK, which is calculated by V-Lab at the NY Stern Business

[5] Endogeneity might arise, for example, from inverse causality between some of the covariates or because of omitted variable bias.

School.[6] SRISK assesses the capital required by a bank in the event of a 40% market index decline over six months. The bank's contribution to systemic risk is quantified as its systemic expected shortfall (SES), reflecting its likelihood of being undercapitalized when the entire system faces undercapitalization (Acharya et al. 2017). SRISK represents the bank's percentage of the financial sector's capital shortfall, capturing its sensitivity to a market index decline. As a secondary measure of systemic risk, we employ LRMES, an extension of the Marginal Expected Shortfall (MES) introduced by Acharya et al. (2012). While MES serves as a short-term indicator, LRMES functions as a long-term indicator by categorizing a crisis as a 40% decline in the market index over the subsequent six months (Acharya et al. 2012). For these events, the LMRES is the expected loss of equity value of the firm *i*th.

Our main interests in Eq. (15.1) are the coefficients on $NPLs_{Sec\,i,t}$ and $NPLs^{2}_{Sec\,i,t}$ (γ and δ). If our hypothesis is verified, we would observe $\gamma < 0$ and $\delta > 0$. In this case, the function in Eq. (15.1) has a minimum that represents the maximum amount of NPLs securitizations that a bank can perform to minimize the systemic risk. Furthermore, we insert two binary variables, the PIIGS indicator,[7] and the G-SIBs indicator,[8] that allow us to understand if the impact on systemic risk may change with the bank's country and the G-SIBs designation by the Financial Stability Board (FSB).[9] We consider the PIIGS dummy because these countries have been shown to be in an ongoing systemic crisis by the European Systemic Risk Board (ESRB)[10] and the G-SIBs dummy to understand how the size of the bank can impact the transmission channel of a systemic crisis. The coefficients ∂ and ϵ measure the additional effect on systematic risk when the NPLs securitization is performed by a bank in a PIIGS country and/or by a G-SIBs bank.

The vector $Z_{i,t}$ includes key characteristics of the NPLs transaction. Our interest is to verify whether NPL characteristics are more or less conducive to risk-taking behavior. Thus, the vector $Z_{i,t}$ includes a dummy variable taking value 1 if the NPLs securitization is guaranteed by the government (only for Italian and Greek banks) and 0 otherwise, the number of deals for each bank and the type of securitized loan.

The vector $X_{i,t-1}$ contains a set of control variables consisting of bank-specific characteristics. We include indicators of bank size, leverage, capital adequacy, profitability, funding structure, nonperforming loans, and stock price volatility. Finally, we control for the country risk ($SovereignCDS_{j,t}$).

After studying the relationship between systemic risk and the use of NPLs securitization to manage the banks' NPLs stocks, our focus lies on assessing the quantity

[6] https://vlab.stern.nyu.edu/welcome/srisk.

[7] The PIIGS indicator is a dummy variable taking the value of 1 if the countries are Portugal, Ireland, Italy, Greece, and Spain and 0 otherwise.

[8] The G-SIBs indicator is a dummy variable taking the value of 1 if the banks are designed as Global systemically important banks and 0 otherwise.

[9] The *Financial Stability Board* (FSB) defines the *Global Systemically Important banks* (G-SIBs) as those companies whose default could cause the blackout of the entire financial and economic system given the breadth, complexity, and strong systemic connection. See FSB, "Policy Measures to Address Systemically Important Financial Institutions", November 2011.

[10] For more details, see https://www.esrb.europa.eu/pub/financial-crises/html/index.en.html.

Table 15.2 Possible estimated vertices

Scenarios	Conditions	Estimated Vertex
I scenario	PIIGS = 0 G-SIB = 0	$NPLs\_Sec^* = -\frac{\gamma}{2*\delta}$
II scenario	PIIGS = 1 G-SIB = 0	$NPLs\_Sec^* = -\frac{\gamma+\epsilon}{2*\delta}$
III scenario	PIIGS = 0 G-SIB = 1	$NPLs\_Sec^* = -\frac{\gamma+\theta}{2*\delta}$
IV scenario	PIIGS = 1 G-SIB = 1	$NPLs\_Sec^* = -\frac{\gamma+\epsilon+\theta}{2*\delta}$

This table provides the calculation of the possible vertex of the function in Eq. (15.1). We consider all possible scenarios

of NPLs securitizations necessary for an EU bank to minimize systemic risk. In case of a U-shaped relationship between NPLs securitizations and systemic risk, we can assess the optimal level of engagement in NPLs securitizations for minimizing systemic risk. We need to determine the minimum point of the quadratic model in Eq. (15.1), computing the first derivative of SRISK as a function of NPLs securitizations and assuming that the first derivative is equal to zero. In symbols, we would have:

$$\frac{\Delta SRISK}{\Delta NPLs\_Sec} = \gamma + 2\delta * NPLs_{Sec}{}^* + \epsilon * PIIGS + \theta * G - SIBs = 0 \qquad (15.2)$$

The systemic risk of a bank varies with the issuance of securitization if $\gamma \neq \delta \neq 0$. The vertex ($NPLs\_Sec^*$) of the function in Eq. (15.2) changes in relation to the country in which the bank is based and the G-SIB designation. We can have four possible scenarios in relation to different conditions. We summarize the calculation of the vertex of the function in Eq. (15.2) in Table 15.2.

Empirical Results

This section presents the empirical results of various tests. We first run Eq. (15.1) by including only the variables indicating the NPL securitization position. In the second model, we add the NPL securitization characteristics and in the third model, we add the control variables. Overall, the results show the existence of a quadratic relationship between systemic risk and the use of NPLs securitizations. Therefore, we can identify in EU banks a threshold below which the use of the NPLs securitization can lower the systemic risk. However, above it the NPLs securitization increases the systemic risk and, thus, the issuance of an NPLs securitization could be detrimental to financial stability.

Table 15.3 reports the results of the system GMM model with robust standard errors. In columns (1), (2) and (3) we report the results for the SRISK whereas in

columns (4), (5) and (6) we report the results for the LRMES. The coefficients of the NPLs securitization in all specifications are negative and significant, suggesting a negative relationship between the use of NPLs securitization and the systemic risk measured by short and long-term indicators. The square term of the NPLs securitization is positive and significant in all our specifications suggesting that the issuance of NPLs securitizations initially helps the bank to control its systemic risk, but this relationship is reversed when the bank increases its NPLs securitization issuance. These results endorse our first hypothesis H_1. The issuance of NPLs securitizations initially helps the banks reduce their systemic risk by providing multiple benefits related to the management of distressed loans, liquidity, funding cost and risk transfer. However, the nature of this relationship changes when banks increase their reliance on this particular instrument. The reliance on ABS may result in main effects: (i) the bank's incentive to monitor the loans decreases because the bank can use the securitization to clean up the balance sheet (Chiesa 2008); (ii) the reduction of banks' incentives to work to a more efficient procedure to internally work out NPLs; (iii) the increase of banks' risk-taking behavior (Cordella et al. 2018).

In models (2) and (5) we insert in Eq. (15.1) the NPLs characteristics variables and we find a different effect on SRISK and LRMES. First, the positive effect of a State-backed guarantee is incorporated only in the long–term implying that the involvement of the government in the management of NPLs acts as a mitigation mechanism for systemic risk in the long term (Broccardo and Mazzuca 2017; Bolognesi et al. 2020). Second, an increase in the number of NPLs securitizations leads to a systemic risk reduction, suggesting that the decision of a bank to manage the NPLs via securitizations is beneficial in terms of contribution to a systemic crisis. Furthermore, the types of impaired loans sold through securitization impact the systemic risk of EU banks differently. Specifically, the sale of consumer loans narrows the SRISK indicator more than the sale of Commercial Real Estate (CRE) loans. This difference in impact may be due to the guarantee that is associated with the CRE loans. They are a particular type of mortgage secured by a lien on a commercial property. On the contrary, the sale of residential loans narrows the LRMES indicator more than the sale of mixed loans. Finally, the results show country and size effects on the systemic risk. Specifically, the banks in PIIGS countries and designed as G-SIB banks show a higher LRMES than those in non-PIIGS countries and no G-SIB banks. Taken at face value, these results provide empirical evidence in favor of the view of (Laeven et al. 2016) that large banks in riskier countries pose excessive systemic risk. However, the excessive systemic risk is mitigated by the NPL's resolution plans. The issuance of NPLs securitization by G-SIB banks and banks in PIIGS countries would narrow the expected shortfall.

The country and size effects previously identified are absorbed by the banks and country-specific variables in columns (3) and (6). Indeed, among the control variables, the coefficients on size and sovereign CDS spreads are shown to be positive and statistically significant whereas the coefficients on PIIGS countries and G-SIB banks lose significance. This suggests that the contribution to the overall systemic risk of a big bank is greater than the contribution to the overall systemic risk of a small bank (Laeven et al. 2016) and the country risk is incorporated in the systemic

Table 15.3 System GMM estimates the impact of NPL securitization on systemic risk

	Srisk			LRMES		
	(1)	(2)	(3)	(4)	(5)	(6)
Lag of systemic risk	1.012*** (0.007)	1.015*** (0.010)	0.945*** (0.030)	0.583*** (0.041)	0.407*** (0.058)	0.119** (0.054)
NPL securitization	−0.081** (0.038)	−0.112*** (0.040)	−0.196** (0.085)	−0.586*** (0.095)	−0.316** (0.130)	−0.619*** (0.177)
NPL securitization square	0.004** (0.002)	0.005** (0.002)	0.008** (0.004)	0.026*** (0.004)	0.012** (0.006)	0.033*** (0.009)
Public guarantee		0.001 (0.011)	−0.006 (0.009)		−0.153*** (0.055)	−0.040** (0.017)
Number of deals		−0.063* (0.036)	−0.186** (0.074)		−0.262 (0.102)	−0.205* (0.120)
CRE loans		−0.483** (0.240)	−0.876** (0.382)		−1.104 (0.812)	0.221 (0.817)
Consumer loans		−0.876*** (0.313)	−1.571*** (0.542)		−0.631 (0.779)	1.357 (0.948)
Corporate loans		0.288 (0.278)	0.626 (0.392)		−1.040 (0.912)	−0.203*** (0.068)
Legacy loans		0.383 (0.786)	4.345 (3.539)		−0.468** (0.237)	−1.509 (1.817)
Mixed loans		−0.249 (0.322)	−0.701 (0.490)		0.069 (1.024)	−1.426** (0.695)
Residential loans		−0.610*** (0.218)	−0.136 (0.334)		−0.015 (0.731)	−1.816*** (0.579)
Shipping loans		0.262 (0.680)	−1.306 (1.310)		−1.818 (3.247)	−1.075 (3.687)
PIIGS countries		−1.309* (0.714)	−0.622 (0.618)		1.081*** (0.229)	−0.099 (1.380)
PIIGS countries* NPL securitization		−0.074*** (0.021)	−0.064** (0.027)		−0.056*** (0.020)	−0.265*** (0.024)
G-SIBs banks		3.557*** (1.276)	−0.591 (1.673)		0.182*** (0.037)	−0.079 (0.066)
G-SIBs banks*NPL securitization		−0.177*** (0.065)	−0.075** (0.036)		−1.023*** (0.187)	−0.491** (0.184)
Size $_{t-1}$			0.246** (0.106)			0.503*** (0.150)
Funding $_{t-1}$			−0.039*** (0.011)			−0.024 (0.021)
Leverage $_{t-1}$			0.005 (0.012)			0.041 (0.042)

(continued)

Table 15.3 (continued)

	Srisk			LRMES		
	(1)	(2)	(3)	(4)	(5)	(6)
Capital ratio$_{t-1}$			−0.023 (0.039)			−0.187*** (0.063)
NPL ratio$_{t-1}$			0.008 (0.012)			0.060** (0.028)
ROA$_{t-1}$			−0.143 (0.183)			−0.193 (0.286)
Price volatility $_{t-1}$			0.023* (0.012)			−0.014 (0.021)
Sovereign CDS spread$_{t-1}$			0.309** (0.157)			0.004** (0.002)
Intercept	0.012 (0.140)	0.353* (0.214)	−4.306* (2.579)	2.565*** (0.412)	4.041*** (0.684)	−2.475 (4.034)
Observations	626	626	626	626	626	626
AR2 test (p-value)	0.302	0.643	0.521	0.234	0.653	0.114
Hansen test (p-value)	0.543	0.875	0.876	0.832	0.843	0.622

This table reports the results of the model in Eq. (15.1). The dependent variable is bank Srisk (in %) in columns (1), (2) and (3) and LRMES (in %) in columns (4), (5) and (6). ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. The Hansen test reports *p* -values for the null hypothesis that the instruments used are not correlated with the error term. The Arellano and Bond (1991) test reports *p*-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation

risk contribution of a bank to the overall systemic risk. Furthermore, a less stable funding and price volatility have a significant and positive relationship with the SRISK, suggesting that the stand-alone risk of a bank increases the systemic risk (Laeven et al. 2016) and the bank's funding structure based on retail deposits is a more stable source of funding able to lower the contribution to the overall systemic risk. Despite a less stable funding structure helping the recovery of the economy by supporting the credit expansion, it may also increase default risk and, thus, undermine financial stability (Shleifer and Vishny 2010). Finally, the coefficients on capital and NPL ratio impact the LRMES. Specifically, bank with a higher capital ratio has the financial resources to cover the fall of the market index by 40% over six months and banks with greater non-performing loans are more exposed to crises than banks with an unimpaired loans portfolio.

We estimate the vertex of the quadratic function in Eq. (15.1) based on the results in columns (3) and (6) of Table 15.3 for SRISK and LRMES, respectively. The estimated vertices, reported in Table 15.4 and compared to the average sample, underline different situations among the banks designed as G-SIB and based in PIIGS countries. Specifically, No G-SIB EU banks in both PIIGS and No PIIGS countries

Table 15.4 Estimated vertices

Scenarios	Conditions	Average sample	Estimated vertex (SRISK)	Estimated vertex (LRMES)
I scenario	PIIGS = 0 G-SIB = 0	20.51	$NPLs_{Sec^*} = -\frac{(-0.196)}{2*0.008} = 12.25$	$NPLs_{Sec^*} = -\frac{(-0.619)}{2*0.033} = 9.38$
II scenario	PIIGS = 1 G-SIB = 0	20.81	$NPLs_{Sec^*} = -\frac{(-0.196-0.064)}{2*0.008} = 16.25$	$NPLs_{Sec^*} = -\frac{(-0.619-0.265)}{2*0.033} = 13.39$
III scenario	PIIGS = 0 G-SIB = 1	19.71	$NPLs_{Sec^*} = -\frac{(-0.196-0.075)}{2*0.008} = 16.94$	$NPLs_{Sec^*} = -\frac{(-0.619-0.491)}{2*0.033} = 16.82$
IV scenario	PIIGS = 1 G-SIB = 1	20.81	$NPLs_{Sec^*} = -\frac{(-0.196-0.064-0.075)}{2*0.008} = 20.94$	$NPLs_{Sec^*} = -\frac{(-0.619-0.265-0.491)}{2*0.033} = 20.83$

This table provides the estimates of the vertex of the function in Eq. (15.1). We consider all possible scenarios

show no systemic risk benefits in conducting additional NPL securitizations. These banks derive no advantages from new issuances. This conclusion holds true for G-SIB banks in non-PIIGS countries as well. In contrast, the average scenario for G-SIB banks in PIIGS countries indicates that they have not fully utilized their capacity to cleanse their balance sheets of impaired loans. These banks have a margin within which they can accrue systemic risk benefits from the issuance of new NPL securitizations.

Robustness

To further investigate the effect of NPL securitizations on systemic risk, as in (Chiaramonte et al. 2013) and (Arif 2020), we measure the bank's risk by adopting the modified version of the Altman Z-score (Demirgüç-Kunt and Huizinga 2010). The modified version of the Altman Z-score is an accounting measure of bank solvency that reflects the distance to default, and it is measured as:

$$Z - score_{i,t} = \frac{ROA_{i,t} + CAR_{i,t}}{\delta_{ROAi,t}}$$

where ROA is the return on assets, CAR is the capital assets ratio and δ_{ROA} is the standard deviation of ROA. The modified version of Altman Z-score shows the number of standard deviations that a bank's rate of return of assets has to fall for the bank to become insolvent (Demirgüç-Kunt and Huizinga 2010). Higher z-score means that the firm is in a "safe" zone and, thus, the probability of default is low. A

lower z-score suggests that the firm is in a "distress" zone implying an increase on the probability of default.

We report the results of the GMM model in Table 15.5. In column (1) we insert only the indicator of NPLs securitizations whereas, in columns (2) and (3) we add the NPLs-specific characteristics and the control variables, respectively. In all our specifications, the results confirm a quadratic relationship between the issuance of NPLs securitizations and the bank's risk. Specifically, the results of the quadratic model estimated show a positive and significant coefficient of the NPLs securitization indicator and a negative and significant coefficient of the square of the NPLs securitization indicator. These results suggest that the issuance of ABS linked to the NPLs securitizations may increase bank stability in the beginning but this relationship turns into a negative one when the ABS issuance is above a certain level in the bank. However, the maximum identified threshold of ABS is shifted for banks designed as G-SIB by the FSB. These results reinforce the earlier findings on the relationship between systemic risk and the use of NPLs securitizations.

The results in columns (2) and (3) of Table 15.5 show that the bank's risk incorporates the risk of ceded loans. The z-score of the bank improves when securitization involves consumer, corporate, and, only partially, mixed loans. By ceding riskier loans on the markets, the banks can obtain a reduction of bank risk because they reduce their exposure to credit risk by using the NPLs securitizations for capital relief purposes. Furthermore, the results provide evidence of the "too big to fail" concept. The positive and statistically significant coefficient on the G-SIB indicator suggests the existence of a size effect on the accounting measure of bank solvency. This size effect is absorbed by the size variable in the estimates reported in column (3). Finally, we find that the sovereign risk is incorporated into the bank's Z-score. Therefore, banks in risky countries experience greater insolvency.

The identification of a U-shape relationship between the issuance of NPL securitizations and the Z-score enables the determination of the optimal amount of NPL securitizations a bank can undertake to mitigate insolvency risk. The calculated vertices, as detailed in Table 15.6, are based on the findings from column (3) in Table 15.5. These estimated vertices indicate that banks in our sample have surpassed the maximum threshold of NPL securitization necessary for Z-score improvement. To derive risk-related benefits and prevent financial instability, only banks designated as G-SIB are advised to continue engaging in NPL securitizations.

Table 15.5 Robustness test: system GMM estimates the impact of NPL securitization on the bank's Z-score

	Z-score		
	(1)	(2)	(3)
$Z\text{-score}_{t-1}$	0.335*** (0.056)	0.323*** (0.048)	0.090* (0.052)
NPL securitization	0.532*** (0.164)	0.372*** (0.120)	0.292*** (0.111)
NPL securitization square	−0.023*** (0.007)	−0.015*** (0.006)	−0.012** (0.005)
Public guarantee		0.068* (0.038)	0.044 (0.035)
Number of deals		−0.055 (0.089)	0.008 (0.096)
CRE loans		0.105 (0.643)	−0.107 (0.589)
Consumer loans		2.028*** (0.622)	0.927 (0.595)
Corporate loans		0.869 (0.827)	1.462** (0.745)
Legacy loans		2.829 (2.179)	0.519 (1.967)
Mixed loans		0.566 (0.887)	1.324* (0.798)
Residential loans		0.453 (0.672)	−0.463 (0.621)
Shipping loans		−0.502 (1.932)	0.586 (1.800)
PIIGS countries		−0.306 (0.993)	0.149 (0.942)
PIIGS countries* NPL securitization		−0.008 (0.047)	−0.035 (0.043)
G-SIBs banks		5.543* (3.216)	0.649 (3.225)
G-SIBs banks*NPL securitization		0.433*** (0.168)	0.488*** (0.168)
$Size_{t-1}$			0.511*** (0.109)
$Funding_{t-1}$			−0.008 (0.013)
$Leverage_{t-1}$			0.011 (0.015)
$Capital\ ratio_{t-1}$			−0.029 (0.054)

(continued)

Table 15.5 (continued)

	Z-score		
	(1)	(2)	(3)
NPL ratio$_{t-1}$			0.001 (0.018)
Price volatility$_{t-1}$			−0.026 (0.016)
Sovereign CDS spread$_{t-1}$			−0.003** (0.001)
Intercept	0.045 (0.481)	0.509 (0.572)	11.401*** (2.642)
Observations	446	446	446
AR2 test (p-value)	0.543	0.643	0.133
Hansen test (p-value)	0.895	0.721	0.241

This table reports the results of the model in Eq. (15.1). The dependent variable is the bank's Z-score (in %). ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. The Hansen test reports *p*-values for the null hypothesis that the instruments used are not correlated with the error term. The Arellano and Bond (1991) test reports *p*-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation

Table 15.6 Robustness estimated vertices

Scenarios	Conditions	Average sample	Estimated vertex (Z-score)
I scenario	PIIGS = 0 G-SIB = 0	20.51	$NPLs_{Sec^*} = -\frac{(0.292)}{2*(-0.012)} = 12.17$
II scenario	PIIGS = 1 G-SIB = 0	20.81	$NPLs_{Sec^*} = -\frac{(0.292)}{2*(-0.012)} = 12.17$
III scenario	PIIGS = 0 G-SIB = 1	19.71	$NPLs_{Sec^*} = -\frac{(0.292+0.488)}{2*(-0.012)} = 32.50$
IV scenario	PIIGS = 1 G-SIB = 1	20.81	$NPLs_{Sec^*} = -\frac{(0.292+0.488)}{2*(-0.012)} = 32.50$

This table provides the estimates of the vertex of the function in Eq. (15.1). We consider all possible scenarios

Conclusion

The goal of this chapter is to investigate the relationship between the use of NPLs securitization and systemic risk. The main idea behind this chapter is to examine whether the use of NPL securitization increases the contribution to systemic risk and acts as a transmission mechanism channel for ongoing financial crises. Our purpose is to analyze the effect of NPL securitization on banks systemic risk of EU banks and the impact of NPLs characteristics on the systemic risk. For this purpose, we analyze a sample of EU banks over the period 2012–2020 by building on a unique dataset

of banks which includes NPLs securitizations information, and bank and country-level data. We focus on banks due to the potentially systemic nature of these firms. We examine whether the effect of NPLs securitizations on a bank's systemic risk is quadratic and depends on the G-SIB designation and country risk by employing a panel of 35 banks from European countries.

Our results suggest that the issuance of NPLs securitization may provide benefits and drawbacks. Since we find evidence of a quadratic relationship between NPLs securitization and systemic risk, the huge involvement of a bank in NPLs securitizations may trigger a banking and financial crisis by acting as a transmission mechanism channel (Karim et al. 2013). The management of NPLs volume by adopting internal solutions is useful for strengthening financial stability and restructuring the banking sector. Despite the use of NPLs securitization preserves financial stability, the huge involvement in this instrument undermines financial stability. The heavy involvement of EU banks in NPLs securitization may be translated by the financial market as huge exposures of banks in distressed loans, resulting from an ex-ante wrong assessment of the credit risk and excessive risk-taking. Therefore, we identify the threshold below which the NPLs securitization is a good tool to transfer distressed loans to institutional investors but above this threshold, the issuance of an NPLs securitization is detrimental to the financial stability of EU banks. Furthermore, we find that there is a significant interaction effect of NPLs securitizations on PIIGS countries and G-SIB designation in the systemic risk. The country risk and the G-SIB designation shift the maximum amount of NPLs securitization that an EU bank can perform to minimize the systemic risk. The turning point for NPL securitizations identified by our model is lower than the average of NPL securitization in our sample in three scenarios. As a result, Regulatory authorities should adopt policies targeting EU banks that curtail the excessive use of NPL securitization to alleviate the concerns on the systemic risk. This result holds whether we consider alternative definitions of bank systemic risk, and when we control for potential differences in country characteristics and banks designation. According to the recommendations of ESRB (ESRB 2013), the key policy implication of our result is that actions aimed at reducing NPLs to sustain financial stability should enhance the control of the use of securitization instruments and encourage the use of internal workout measures to reduce the NPL volume of EU banks to avoid that NPLs securitizations become a transmission mechanism of financial crises. Furthermore, our results contribute to the ongoing debate on the important issue of designing suitable systemic risk indicators that act as EWS for predicting incoming financial crises. Given our findings, we believe that to have a complete vision of the contribution of a bank to the systemic risk, the indicators should take into account the bank's exposure to securitizations (in line with Mazzocchetti et al. 2020) but also the bank's NPL resolution plans.

Appendix

See Tables 15.7 and 15.8.

Table 15.7 Variable definition

	Description	Source
Panel A: Dependent variable-Bank's level systemic risk		
SRISK(%)	Systemic risk contribution of a financial firm to the overall systemic risk	V-Lab
LRMES	Decline in equity values to be expected if there is a financial crisis	V-Lab
Panel B: Variable of interest-NPLs securitizations		
Securitization of NPLs	NPLs securitization amount in the US $ million	Banks web site
Number of deals	Number of NPLs securitization performed by EU banks	Banks web site /Author calculation
Guarantee	Dummy variable taking value 1 if the securitization has a public guarantee, 0 otherwise	
Panel C: Control variables		
Banks size	Natural logarithm of total assets	Datastream
Funding structure	The ratio of deposits to total liabilities	
Leverage	The ratio of liabilities to the sum of liabilities and equity	
Capital adequacy	The ratio of Tier 1 capital to total risk-weighted assets	
NPL ratio	The ratio of non-performing loans to total loans	
ROA	Return on assets	
Stock price volatility	The quarterly variance of the bank's stock price	
Sovereign CDS spread	5-year sovereign CDS spreads in bps	

Table 15.8 Summary statistics on SRISK, LMRES and NPLs securitization for sample

Country	SRISK			LMRES			NPLs sec
	Mean (std. dev.)	Min	Max	Mean (std. dev.)	Min	Max	Gross book value (GBV)
Austria	49.73 (0.23)	49.57	49.89	47.13 (4.30)	44.09	50.17	815
Belgium	34.31 (15.67)	14.62	91.14	51.39 (11.42)	31.41	80.79	1,900
Denmark	84.08 (0.54)	83.7	84.46	40.97 (5.76)	36.89	45.04	420
France	29.71 (2.97)	18.65	35.04	52.49 (7.75)	32.69	76.2	1,890
Germany	37.65 (22.85)	16.38	60.79	54.88 (6.63)	47.29	64.03	1,743
Greece	24.33 (3.28)	19.06	30.27	46.06 (9.36)	36.12	74.06	9,150
Ireland	19.77 (32.43)	0.00	93.99	41.75 (11.79)	23.11	62.42	3,545
Italy	19.64 (11.11)	4.08	34.29	46.59 (5.56)	35.07	55.10	14,835
Netherlands	27.44 (30.07)	0.00	88.70	35.14 (15.70)	7.42	77.14	3,060
Norway	72.58 (5.30)	54.25	82.74	46.66 (8.92)	30.27	64.46	1,100
Portugal	57.19 (37.02)	14.94	100.00	34.70 (17.10)	13.86	59.09	1,598
Spain	22.42 (15.95)	4.79	49.98	47.54 (6.49)	36.59	59.85	4,870
UK	12.28 (6.34)	0.00	34.09	41.29 (8.67)	21.75	81.73	3,372
Total	25.98 (26.07)	0.00	100.00	46.98 (13.36)	7.42	81.73	48,298
PIIGS countries	21.38 (21.31)	0.00	100.00	47.74 (12.62)	13.86	74.06	33,998
Non-PIIGS countries	29.49 (28.69)	0.00	91.14	46.40 (13.87)	7.42	81.73	14,300

The table reports summary statistics on SRISK, LMRES and NPLs securitizations for the 36 sample banks over the period January 2012–September 2020. Mean, minimum (Min.) and maximum (Max.) of SRIRSK and LMRES are expressed in percentage. NPLs' securitization amount is expressed in USD millions

Source Datastream database, bank website and V-Lab in the NY Stern Business School

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