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Journal of Banking and Finance

DOI:
https://doi.org/10.1016/j.jbankfin.2022.106451

Published: 01/05/2022

Peer reviewed version

Market Power and Bank Systemic Risk: Role of Securitization and Bank Capital [1]

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Abstract

We examine how bank competition in the run-up to the 2007-2009 crisis affected banks' systemic risk during the crisis. We then investigate whether this effect was influenced by two key bank characteristics: securitization and bank capital. Using a sample of the largest listed banks from 15 countries, we find that higher bank market power prior to the crisis is connected to larger levels of realized systemic risk during the crisis. The results suggest that the use of securitization exacerbates the effects of market power on the systemic dimension of bank risk, while capitalization partially mitigates its impact.

JEL Classification Numbers: G21; D22

Keywords: Securitization; competition; bank risk

[1] This work was completed while David Marques-Ibanez was a visiting scholar at the IMF's Macro Financial Division of the Research Department. We are grateful to Giovanni Dell'Ariccia, Soledad Martinez Peria and the colleagues at the IMF's Macro Financial Research division for their kind hospitality and fruitful discussions. We would also like to thank Leonardo Gambacorta, Florian Heider, Simone Manganelli, Agnese Leonello, Alex Popov. We are also grateful to participants at seminars at the European Central Bank, Bangor University, Bank of England as well as at conferences including IFABS 2016 conference Risk in Financial Markets and Institutions: New challenges, New solutions, Wolpertinger 2016 and EBA's 5th Annual Research Workshop on Competition in Banking for useful comments for their constructive suggestions. Our special thanks also to Jacob Bikker for generously providing some of the data used on some of the estimations of this paper and his useful suggestions. We are also most grateful to Francesca Fabbri and Luiz Paulo for their help constructing the dataset. Authors' E-Mail Addresses: y.altunbas@bangor.ac.uk; david.marques @ecb.int; michiel.van.leuvensteijn@acm.nl; T.Zhao@bham.ac.uk.

Market Power and Bank Systemic Risk: Role of Securitization and Bank Capital

Abstract

We examine how market power in the run-up to the 2007-2009 crisis affected banks' systemic risk during the crisis, and whether this effect was influenced by two key factors: securitization and bank capital. Using a sample of the largest listed banks from 15 countries, we find that more market power prior to the crisis is connected to larger levels of realized systemic risk during the crisis. The use of securitization exacerbated the effect of market power on systemic risk, while capitalization partially mitigated it.

JEL Classification Numbers: G21; D22

Keywords: market power; bank risk; securitization; capitalization

1. Introduction

Following the global 2007-2009 financial crisis, there has been intensified interest in the sources of systemic fragility, which includes a deeper understanding of the role of market power and bank competition in the build-up, and eventual materialization of systemic risk. In this direction, it is also important to asess how market power interacts with securitization and bank capital—two major factors affecting banks' incentives in the pre-crisis period—on the development of systemic risk (Leroy and Lucotte, 2017; Anginer et al., 2014).

The aim of this paper is hence to shed light on the relationship between market power and systemic risk by distinguishing between bank-specific market power and banking industry competition. It emphasizes the time dimension of this relationship showing how market power prior to the crisis impacted on realized systemic risk during the crisis. While competition would be expected to influence on risk-taking in real time, most of the credit risk taken in the upswing of a financial cycle usually materializes at a later stage, when the financial cycle turns. We also investigate how the relationship between market power and systemic risk is shaped by bank capital and securitization (Crockett, 2002; Freixas and Ma, 2015; Schliephake, 2016). We conduct our empirical analysis using an international sample composed of the largest banks in the United States, Denmark, Sweden, United Kingdom, and 11 Eurozone countries, encompassing some banking systems that experienced systemic crises during the 2007-2009 financial crisis.

The empirical literature provides conflicting results on the impact of competition on banking stability, mostly depending on the focus and modelling approach.[2] Although there is no consensus either on the most accurate theoretical model, we find useful to emphasize the role of banks as producers of information on borrowers as this role is at the center of modern

[2] See for instance Schaeck et al. (2009) and Beck et al. (2013).

financial intermediation theory (Carletti, 2008). This characteristic of banks as "producers of information" also carries implications on how market competition impacts on systemic bank risk-taking (Caminal and Matutes, 1997; 2002; Dell'Ariccia and Marquez, 2006). Following this literature, we hypothesize that more market power allows banks to utilize borrowers' higher switching costs to improve revenues. Hence higher market power can substitute for costly screening and monitoring encouraging more aggressive lending and augmented systemic risk.

We would also expect that bank capital and securitization influence the intensity of screening and monitoring and, as a result, the relationship between market power and systemic risk. Well-capitalized banks would exert more screening and monitoring efforts on their lending as they suffer from higher private costs when internalizing their downside credit losses (Bolt and Tieman, 2004). In contrast, higher levels of securitization will lower screening and monitoring incentives (Rajan, et al., 2015; Boot and Ratnovski, 2016). More securitization lengthens the informational distance between the originator and the bearer of credit risk diminishing the value of private information of securitized loans. Following this hypothesis, we would expect a stronger impact of bank market power on systemic risk for lowly capitalized banks and for those securitizing a larger percentage of their loans.

Our results show that higher market power of individual banks and, to a lesser extent, more competitive market conditions are connected to greater systemic risk during the crisis. Securitization amplifies the effects of market power on systemic risk while capitalization, partially, mitigates them. This catalyst effect of securitization on systemic risk was found to be stronger for more information intensive types of securitization.

The results are statistically and economically significant. The difference in bank systemic risk between a monopolist and a price taker is about 64%. One standard deviation of capitalization will mitigate the difference between a monopolist and a price taker bank by about

10%. One standard deviation of securitization increases the difference between a monopolist bank and a price taker by around 15%. The findings are robust to the use of different measures of bank risk or capitalization. They findings are also resilient to be inclusion of additional controls accounting for bank-specific characteristics, to the use of instrumental variables (IV) estimation and subsample analyses. While the results are suggestive, we are cautious about presenting them as causal.[3]

Our results provide empirical evidence that complements the theoretical work emphasizing the effects of banks' market power on screening and monitoring of borrowers and how bank capital and securitization could alter this relationship. They suggest that regulators would benefit from paying closer attention to how financial innovation interact with competition in banking markets.

The remainder of this paper is organized as follows. Section 2 sets out the empirical model after providing a discussion of the connected literature. Section 3 reviews the data sources, provides the empirical results and robustness tests. The paper's conclusions are presented in Section 4.

2. Theoretical framework, literature review and empirical strategy

2.1 Bank market power, industry competition and systemic risk

The role of banks screening and monitoring borrowers makes them pivotal for the efficient allocation of capital in the economy (Caminal and Matutes, 2002). This key role is naturally shaped by banks' competitive environment (Carletti, 2008). From a competitive perspective, banks' role as producers of proprietary credit information helps them to retain existing borrowers, as it increases the threat of adverse selection problems for rivals trying to poach

[3] A related limitation is that the estimation performed is a reduced form estimation, so these partial equilibrium results would not be able to reflect general equilibrium considerations.

borrowers from them (Hauswald and Marquez, 2006). At the same time, it enables them to poach borrowers from competitors more easily, as it reduces the threat of adverse selection created by their rivals.

Bank-specific market power and competitive conditions at the industry level can have different effects on their incentives to screen and monitor borrowers. A bank with greater market power has fewer incentives to gather proprietary information on their borrowers, as these borrowers face higher switching costs (Boot and Thakor, 2000). Market power can thus be utilized by banks to negotiate financial contracts and maintain their existing market share (Qian and Strahan, 2007). Given these effects, banks with higher market power are more likely to loose lending standards, and over time exhibit higher levels of systematic risks (Caminal and Matutes, 1997; 2002). [4]

At the industry level, some models suggest that a more competitive banking sector leads to higher systemic risk. More competition implies lower market power by rival banks so *borrowers* will shop around to obtain credit in the most favorable conditions, and *banks* are more likely to face unknown new borrowers.[5] This lessens the quality of information on borrowers and increases the costs of a given standard of information quality. As a result, banks find it profitable to reduce their information production in the provision of bank credit (Dell'Ariccia and Marquez, 2006). In this setting, a more competitive banking system would imply an increase in systemic risk (Bolt and Tieman, 2004).

The literature on herding behavior also models the relationship between competition and systemic risk. Higher levels of herding lead to an increase in systemic risk, as banks would

[4] Apart from the literature cited above there are other models that find that *higher market power* lead to *higher portfolio risk* (Allen and Gale, 2004, Boyd and De Nicolo, 2005) while other models show that it could lead to lower risk due to its impact on banks' franchise value (Keeley, 1990). We do not focus on these models as they do not consider the role of banks' as information producers explicitly.

[5] When attempting to poach customers from other banks.

contribute more, and be more exposed, to common shocks (Rajan, 1994).[6] Competition in the banking industry would influence banks' incentives to herd and, therefore, the systemic dimension of bank risk. The direction of this effect is, however, uncertain. On the one hand, banks operating in a less competitive market may herd more, since the need to engage in differentiated investments to soften price competition is weaker (Acharya and Yorulmazer, 2008). On the other hand, they might herd less if lower competition supports their franchise value, and bank owners favor individual rather than collective survival (Acharya, 2009).

2.2. Capitalization, securitization and systemic risk

Bank capital and securitization are two key variables impacting banks' risk-taking incentives and therefore the market power and risk-taking nexus. In general, more capital reduces the incentives towards excessive risk-taking induced by limited liability and deposit insurance (e.g. Freixas and Rochet, 2008; Acharya et al., 2011). Higher capital strengthens incentives to screen and monitor borrowers (Beck et al., 2017), encourages banks to exert stricter lending standards for existing borrowers, and to be less aggressive competing for new borrowers (Brander and Lewis, 1986; Bolt and Tieman, 2004). Also well-capitalized banks face less asymmetric information problems when raising loanable funds as capitalization acts as a signaling mechanism (Gambacorta and Mistrulli, 2004; Repullo, 2004). Also, well capitalized banks have a higher cushion to internalize losses (Berger and Bouwman, 2013) and are less vulnerable to information contagion risks (Acharya and Yorulmazer, 2008). Following this literature, well-capitalized banks are expected to exhibit lower levels of systemic risk.

[6] Some of this literature emphasizes that bank herding results from information contagion (Acharya and Yorulmazer, 2008). In this setting, the returns on bank loans comprise a systematic and an idiosyncratic component and the failure of one bank transmits adverse information about the systematic component and increases the cost of loanable funds for surviving banks.

In contrast, other studies suggest that higher capitalization might induce bank risk. The rationale is that more capital leads to lower returns per unit of capital and banks may invest in riskier assets to compensate for lower returns (Calem and Rob, 1999). Structurally, there seems to be a trade-off between banks' incentives to preserve capital by reducing risk taking on the one hand; and their incentives to boost short-term returns to capital by incurring higher risks, on the other (Hellmann et al., 2000). Such a trade-off is expected to be smaller for banks with greater market power since they enjoy a higher level of franchise value and, therefore, prioritize long-term survival rather than short-term profits (Agoraki et al., 2011).

Regarding the impact of securitization on bank risk, some early theories suggested that securitization made banks more resilient and, consequently, reduces systemic risk (Greenspan, 2005). This is because the pooling and tranching of loans create safer and more liquid securities, reducing the average cost of loanable funds. This allows banks to lower the cost of credit, which, in turn, reduces adverse selection and moral hazard problems, making banks safer (DeMarzo, 2004).

By providing banks with an additional funding source, securitization increases their dependence on non-deposit sources of funding that might be less stable than deposits. In fact, more recent work, tends to find that securitization increases systemic risk by making banks more vulnerable to financial markets changes in sentiment (Loutskina, 2011; Laeven et al., 2016). Also, securitization increases the informational distance between the originator and the bearer of the credit risk so that banks have lower incentives to screen and monitor the borrowers of securitized loans thereby increasing systemic risk (Maddaloni and Peydró, 2011; Rajan, et al., 2015).[7]

[7] The empirical evidence suggests a limited impact of business diversification (i.e. including a greater reliance of securitization as a source of income) on banks' soundness (Apergis, 2014; Fiordelisi and Marques-Ibanez, 2013; Boot and Ratnovski, 2016).

An assessment of the mentioned channels through which capitalization and securitization affect the relationship between market power and systemic risk provides valuable hypotheses for the empirical tests used in this paper. Overall, the literature on the impact of competition on banks' incentives to collect and process proprietary credit information implies that higher capitalization *mitigates* the impact of market power on systemic risk. Higher securitization, on the other hand, *exacerbates* the effect of market power on systemic risk. In contrast, the literature on the herding behavior of banks suggests that higher capitalization can either strengthen or offset the impact of market power on systemic risk.

2.3.Empirical model, variables, and data

A major challenge for the empirical literature analyzing the relationship between competition and risk concerns *when* to time the measurement of the variable accounting for bank risk as there is an important time lag between the period in which risk-taking takes place and the realization of losses (Beck, 2008).

This paper explores the realization of bank risk during the 2007-2009 crisis. We assess whether the variability in bank market power and banking industry competition prior to the crisis are related to the materialization of systemic risk during the crisis. Our approach assumes that, to a large extent, the measurement of risk can only be gauged when an extreme event, such as a crisis, occurs. As in previous crises, most of the excessive systemic risk-taking is originated during the period leading up to the financial crisis (Ruckes, 2004). Indeed, as our focus is on the systemic component of bank risk, it is reasonable to expect that this risk would materialize in the event of a banking crisis (Rajan, 2006).

The dataset used in the study consists of banks from 15 countries: 11 Eurozone countries,[8] Denmark, Sweden, the UK, and the United States. It is a highly representative sample that covers around three-quarters of the total aggregate balance sheets of banks operating in these countries. We focus on the parent company of all listed banking groups headquartered in those countries.[9]

Our main specification aims to assess the impact of bank-specific market power and industry competition faced by individual banks in the run-up to the crisis (i.e. 2003Q4 to 2007Q3) on bank systemic risk during the crisis (i.e. 2007Q4 to 2009Q4):

$$Risk_{i,k,post} = constant + \alpha * Market\_power_{i,k,pre} + b * Competition_{,k,pre} + \beta * CAPITALIZATION_{i,k,pre} + \gamma * SECURITIZATION_{i,k,pre} + \tau * CONTROL_{i,k,pre} + \delta_k + \varepsilon_{i,k} \quad (1)$$

In Model (1), *i* refers to each bank, *k* refers to the country, *pre* refers to the pre-crisis period (2003Q4 to 2007Q3) and *post* to the crisis period (2007Q4 to 2009Q4).

The measurement of realized bank risk has several dimensions so for each bank we calculate three alternative bank-specific measures of risk ($Risk_{i,k,post}$) via indicators commonly used in recent literature that incorporate input signals derived from stock market prices, aiming to capture the systemic dimension of bank risk (Hansen, 2012; Bisias et al., 2012). The first is the Marginal Expected Shortfall (*MES*) (Acharya et al., 2012) which is based on the view that a shortage of capital for an individual bank becomes more hazardous for the whole economy if it happens when other institutions are also undercapitalized. Following

[8] Namely: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain.

[9] For a full description of the characteristics of the database and variable definitions, see Table 1. The number of sample banks for the empirical estimation eventually reduced to 495, which is smaller than the initial dataset because of the missing values for some of the variables (i.e. beta for non-listed banks) used in the estimation.

previous work, we collect stock market data from Datastream for the 2007Q4 to 2009Q4 period and compute the average daily stock returns of each bank on days when the country's banking sector stock price index experiences their lowest 5 percent of daily returns during the crisis period (2007Q4-2009Q4) (DeJonghe, 2010). Higher absolute *values* of *MES* are associated with higher levels of systemic risk. *MES* are the preferred measure of risk in our empirical estimation as it accounts the bank's downside risk conditional on the left tail of financial system returns and which is closer to the concept of systemic risk.

Our second measure, called *beta*, measures *systematic* risk as the average responsiveness of each bank's stock market prices to movements in the overall stock market estimated via a simple capital asset pricing model. Bank-specific *beta* accommodates the idea that banks more affected by market upheavals would contribute more to the severity of a crisis. To ensure comparability in our cross-country sample, we use the broad stock market index for each country, available from Datastream. For each bank *i*, separate regression are run to derive beta values, using its daily data over the period from 2007Q4 to 2009Q4. A larger beta indicates a higher level of bank risk.

Our third measure of bank risk is the expected default frequency (*EDF*) computed by Moody's KMV building on Merton's (1974) model. The *EDF* value,[10] expressed as a one-year ahead probability of default of each bank, is calculated by combining banks' financial statements, stock market information and a proprietary default database. Because of the systemic nature of banking, the *EDF* of an individual bank is expected to include the fragility from other financial and non-financial institutions. For each bank, its average *EDF* for the

[10] Despite their simplifying assumptions, *EDF* estimations of default risk show strong robustness to model misspecifications (Jessen and Lando, 2015). During the 2007-2009 financial crisis, the *EDF* performed relatively well as a predictor of firms' risk on a cross-sectional perspective. That is, the relative positions of firms ranked according to their EDF levels in the year before the crisis were good predictors of rank ordering of default risk during the crisis (Munves et al., 2009).

2007Q4 to 2009Q4 period is calculated. A higher *EDF* indicates a higher likelihood of bank default.

Our measurement of market power and the degree of competition at the industry-level (i.e. the market power of the industry rivals of the bank) are bank-specific measurements. *Market power* at the bank level (i.e. $Market\_power_{i,k,pre}$) is accounted for by a bank-specific Lerner index, adjusted for the price elasticity of loan demand. The yearly financial statements of individual banks in our sample for the 2003-2007 period (sourced from Bankscope) are used to make separate estimations of the translog cost function for each country. The elasticity adjusted bank-specific Lerner index is derived from the joint estimation of the translog cost function and the supply equations (see details in Appendix C). A higher value of the elasticity adjusted Lerner index suggests a higher degree of market power (Van Leuvensteijn et al., 2011).

To calculate the degree of competition in the industry faced by banks during the pre-crisis period (i.e. $Competition_{i^-k,pre}$), we use the average of the elasticity adjusted *Lerner* values of all other banks in the same country (excluding the bank in question). A higher *Lerner index* of other banks indicates a lower degree of competition at the industry level, therefore higher degree of market power of the bank's industry rivals.

Bank capital ($CAPITALIZATION_{i,k,pre}$) is measured using the average Tier I capital to total risk weighted assets during the pre-crisis period (2003Q4 to 2007Q3), based on consolidated quarterly financial statements from Bloomberg. Tier I (i.e. core) capital is expected to be more effective in safeguarding bank solvency than broader measures of bank capital (Demirguc-Kuntand Huizinga, 2010). The analysis also uses the sum of Tier I and II capital to risk-weighted assets (*Total capital ratio*) and Tier I capital to total assets (*Core capital leverage ratio*) during the pre-crisis period (2003Q4 to 2007Q3) as robustness checks.

The securitization variable ($SECURITIZATION_{i,k,pre}$) is measured by computing the natural log of the average of quarterly securitization flows prior to the crisis (2003Q4 to 2007Q3). We take the natural log due to the high skewness of the data. Securitization data are originally obtained from Bondware, a commercial database compiled by Dealogic, and calculated by aggregating deal-by-deal data for each quarter for each bank's individual issuance. The sample includes mortgage-backed securities (*MBS*), funded public asset-backed securities (*ABS*), as well as cash-flow (balance-sheet) collateralized debt obligations (*CDOs*). The securitized loans included in the sample involve a transfer of funding from market investors to originators so synthetic structures (such as synthetic CDOs, in which there is only transfer of credit risk) are not included.

Finally, as regards controls ($CONTROL_{i,k,pre}$), a vector of bank-specific variables is introduced as averages calculated from the quarterly consolidated balance sheet of banks, obtained from Bloomberg for the 2003Q4 to 2007Q3 period. *Size* is the natural logarithm of total assets, *Excess loan growth* is the difference between the loan growth of an individual bank and the average of all banks in the country, and *Deposit funding* is the ratio of retail deposits to total assets. Selection of the bank-specific control variables is motivated by the existing literature, which identifies bank size, loan growth rate and funding structure as important drivers of bank risk (Altunbas et al., 2017).[11]

Regarding *Size*, there is evidence to suggest that due to too-big-to-fail considerations, supervisors may be more lenient in disciplining the excessive risk-taking of large banks (Laeven and Levine, 2007). With respect to *Excess loan growth*, a higher growth rate imposes

[11] We also control for non-interest income divided by total income (other earning assets divided by total earning assets) as an additional robustness check although we believe that our measurement of securitization is already largely capturing diversification of income sources.

a direct challenge to the screening ability of banks. More directly, excessive loan growth damages banks' abilities to maintain certain lending standards, leading to higher credit risk (Jiménez et al., 2013; Altunbas et al., 2017). By controlling for loan growth, it is also possible to better focus on the impact of competition on changes in information production related to the provision of bank credit. In fact, the expansion of credit need not be coupled with higher bank systemic risk if the incentives for banks to screen and monitor remain unchanged during credit expansion (Dell' Ariccia et al., 2014). The *Deposit funding* control variable aims to capture the vulnerability of the bank to liquidity shocks (Huang and Ratnovski, 2011).

We include country-fixed effects, δ_k, to account for all the country factors (including economic conditions, safety net, supervision and regulation, and other features of the banking industry) which could influence the risk-taking of individual banks.

As stated previously, we also examine the impact of capitalization and securitization on the relationship between market power and systemic risk.[12] For this purpose, Model (1) is modified by the addition of the interactions of $CAPITALIZATION_{i,k,pre}$ and $SECURITIZATION_{i,k,pre}$ with $Market\_power_{i,k,pre}$:

$$Risk_{i,k,post} = constant + \alpha * Market\_power_{i,k,pre} + b * Competition_{i,k,pre} + \beta * CAPITALIZATION_{i,k,pre} + \gamma * SECURITIZATION_{i,k,pre} + \varphi * CAPITALIZATION_{i,k,pre} * Market\_power_{i.k,pre} + \theta * SECURITIZATION_{i,k,pre} * Market\_power_{i.k,pre} + \tau * CONTROL_{i,k,pre} + \delta_k + \varepsilon_{i,k} \quad (2)$$

[12] Capitalization and securitization variables are de-meaned using their respective sample means. The estimated φ and θ, therefore, indicates the impact of market power on systemic risk if they were to have capitalization and securitization values equaling their sample mean.

The statistical sources and a brief description of the variables used are provided in Table 1. Table 2 provides descriptive statistics and Table 3 shows the distribution of banks by country. Detailed information regarding the estimation of *MES*, bank-specific *beta,* and elasticity-adjusted *Lerner index* are presented in Appendices A, B, and C, respectively.

3. Results, robustness tests and additional analysis

3.1. Main results

Models (1) and (2) are estimated using Ordinary Least Squares (OLS). The results are first presented using *MES* as the measure of systemic risk, and the ratio of Tier I capital to total risk weighted assets as *Capitalization*. We cluster standard errors at the bank level to account for within-bank serial correlation between the pre and during the crisis period.

The estimated results of Model (1) are presented in Table 4 (Columns 1 and 2). They show that higher levels of bank-specific market power (i.e. higher levels of $Lerner_{i,k,pre}$) positively contribute to systemic risk (*MES*). Competition at the banking industry level also led to higher systemic risk during the crisis. Both results are statistically significant. Regarding the economic significance, the difference in the systemic risk between a monopolist and a bank which is a price taker is 2.06 (see Table 4, Column 1), which is 64% of the sample mean of *MES*. Also, comparison of the estimated coefficient of bank-specific market power and that of the banking industry suggests the former carries more economic significance, while the latter seems to have a negligible impact. We conjecture the higher economic significance of the impact of bank-specific market power might to due to the nature of monopolistic competition and the presence of market segmentation in the banking industry (e.g. Zhao et al., 2013).

Table 4 also suggest that well-capitalized banks ($CAPITALIZATION_{i,k,pre}$) have lower levels of systemic risk during the crisis which is consistent with the role of capital mitigating

the incentives for banks to exploit their limited liability and safety net arrangements. In contrast, higher levels of securitization activity ($SECURITIZATION_{i,k,pre}$) are negatively related to systemic risk so there is no evidence that banks that are more active in securitization markets take more risks. As far as control variables are concerned, in line with previous work (Altunbas et al., 2017), we that bank size (*Size*), higher loan growth compared to other banks in the same country (*Excess loan growth*), and lower share of deposit funding (*Deposit funding*) relate to higher systemic risk during the crisis.

We now turn to the augmented model (Model 2), which includes the two interactions of bank-specific market power with capitalization and securitization, respectively. Results indicate that the interaction with capitalization is negative (at the 1% level), while that with securitization is positive (at the 5% level). These findings suggest that capitalization reduces the impact of market power on systemic risk, while higher levels of securitization exacerbate it. These results are economically significant: One standard deviation of capitalization would decrease the difference in *MES* between a monopolist bank and a price taker by around 10%, and one standard deviation of securitization increases the difference in *MES* between a monopolist bank and a price taker by around 15%.[13] While capitalization appears to weaken the positive relationship between bank market power and systemic risk, its effect is not strong enough to fully counterbalance the effect of securitization. As seen, the estimated impact of bank market power on systemic risk remains positive and statistically significantly for banks where the value of capitalization and securitization equals the sample mean (i.e. the estimated coefficient of the bank-specific Lerner index: 2.4). This would suggest that exclusive reliance on capitalization for the stability of the banking system is questionable.

[13] The economic effect is based on the estimation with normalized beta. The Table with normalized beta's is available on request.

The impact of capitalization and securitization on the relationship between market power and bank systemic risk can be connected with the influential literature highlighting the role of the credit screening and monitoring function of banks in driving the impact of market power on bank systemic risk. With respect to capitalization, better capitalized banks tend to internalize a larger proportion of the costs of skipping screening and monitoring. Hence higher capitalization would lead to stronger incentives to invest in information on borrowers' credit risk and to set stricter lending standards for granting new loans. This mitigates the potential effect of market power on systemic risk.

Turning to securitization, as emphasized above, securitization increases the dependence of bank lending on readily tradeable arm's length activities as the main sources of loanable funds. While a traditional bank with higher market power may be inclined to take more aggregate risks, the scope to generate this risk might be more restricted when securitization is not available. The attempt of banks to scale up securitization may compromise their willingness to acquire proprietary information *ex ante,* as the price that investors would offer for securitized loans is not able to incorporate fully proprietary information that is produced by banks due to the difficulty of credibly communicating such information to outside investors (Parlour and Plantin, 2008). A higher level of securitization could, therefore, further undermine banks' fundamental relationships with borrowers, and intensify the positive relationship between bank-specific market power and systemic risk.

3.2. Robustness tests

The time dimension of our empirical design, namely the analysis of how bank-specific market power *prior* to the crisis impacts on systemic risk *during* the crisis, should ease concerns about reverse causality. However, the relationships identified so far could be conceivably biased by the omission of variables which correlate with bank-specific market power in the pre-crisis period. For example, sound banks with a reputation for stricter risk management probably have

a higher lending rate to marginal cost-price margin because of lower lemon discounts on their funding costs (Chen et al., 2017). Or, banks with an overall better reputation may be less subject to declines in their share prices during the crisis period. Also, banks with more shareholder-friendly boards might price their lending in a way that generates more value for shareholders before a crisis but may lead to larger declines in value during crisis periods (Beltratti and Stulz, 2012).

To assuage concerns about these types of potential endogeneity, we run Models (1) and (2) using instrumental variables (IVs) for bank-specific market power in the pre-crisis period constructed from the average size, excess loan growth rate, deposit funding, securitization and capitalization of other banks in the same country for the 2003Q4 to 2007Q3 period (Laeven and Levine, 2009).[14] Table 5 summarizes the results of these IV estimations. The Kleibergen-Paap rk Wald F statistic rejects the null hypothesis of weak instruments at the 5 percent level. The Hansen *J* statistic suggests that the instruments are coherent with each other and confirms their validity as a group (at the 10 percent level).[15] All in all, the results estimated with IV are in line with our main findings.

Our main estimations are further replicated by replacing the proxy for capitalization (Tier I capital to risk-weighted assets) with two alternative measures of bank capital: first,

[14] Such instruments follow the spirit of Berry, Levinsohn, and Pakes (1995) type instruments calculated as the average product characteristics of a bank's competitors. The concern regarding the endogeneity of the bank-specific market power is that the quantities of loans and the price of loans are jointly determined by the demand and the supply of the bank in the credit market. In our setting which effectively analyses the impact of bank-specific market power (prior to financial crisis) on bank systemic risk (during the financial crisis), the supply shocks for a given bank would influence the Lerner index and risk-taking behaviour. The use the average of competitors' characteristics to capture the competitor's supply behaviour appears reasonable.

[15] We also ran separate estimations of Models (1) and (2) with instrument variables used as additional control variables, none of which appears to be statistically significant. Therefore, the exclusion restriction of our instruments should not be a matter for concern.

capital to total assets ratio (*Total capital ratio*); second, core capital to total assets ratio (*Core capital ratio*) (see Table 6). The aim is to assess the robustness of our results to any distortion derived from the use of risk-weighted measures of total assets as opposed to simpler leverage ratios.

The estimations are also repeated using two alternative measures of bank risk: an indicator of systematic risk, proxied by a bank-specific *beta,* and a structural measure, indicated by the expected default frequency of each individual bank (*EDF*) (see Table 7).

To assuage concerns about endogeneity related to the risk-taking behavior of certain banks, our sample is separated into those banks involved (and those not involved) in Mergers and Acquisition (M&A) in the pre-crisis period (see Table 8). The motivation is that banks involved in M&As might have different risk seeking behavior that would impact on their business strategies and could affect our crisis estimations. Also, banks involved in M&As need to integrate the financial reporting of the acquirer and targets, thereby introducing noise into the information content of our control variables. Furthermore, we investigate whether the results are sensitive to certain subsamples, as different countries experienced different degrees of exposure to the global crisis. We show that our results also hold in the subsamples in which only US or non-US banks are included (see Tables 9 and 10). In addition, our main results are robust to the inclusion of additional bank-specific variables, including those accounting for diversification (non-interest income to total income, other earning assets to total assets), profitability (net income to total assets) and asset quality (loan loss provisions to total loans) (see Table 11).

Our results suggest that bank-specific market power and banking competition at the industry level prior to the crisis exert a significant impact on bank systemic risk during the crisis. In line with previous literature, the results support the idea of competition directly impacting on banks' incentives to collect and process proprietary information on borrowers.

The results are also consistent with bank capital acting as an incentive for banks to produce private information on borrowers and constrain risk taking, mitigating the impact of higher market power on systemic risk. In contrast, we find that securitization negatively affects banks' incentives to screen and monitor borrowers, exacerbating the impact of higher market power on systemic risk.

While the evidence appears suggestive, it is not possible to unequivocally conclude that bank investment in information gathering is the sole driver of our results. To further understand the findings, we investigate whether the impact of securitization differs according to the type of securitization adopted by banks, distinguishing between mortgage and non-mortgage securitization. The former is usually based on "harder" and more quantifiable information, such as borrowers' income or real estate values, as opposed to non-mortgage loans, in which "softer" proprietary information plays a more significant role and is costlier for the bank to acquire and process (Stein, 2002). If our empirical findings are to a large extent related to banks' incentives to produce proprietary information on borrowers, it can be expected that the impact of securitization would be mainly driven by non-mortgage securitization.

We therefore re-estimate the Model (2) considering each type of securitization separately. The empirical results (see Tables 12 and 13) suggest that non-mortgage securitization is the main driver behind the overall impact of securitization on the relationship between market power and systemic risk. Regarding the effect of securitization on systemic risk *per se*, both types of securitization appear to be negatively related to systemic risk. Therefore, securitization by itself does not appear to increase systemic risk, which is in line with some previous research (Albertazzi et al., 2015). In countries which did not experience a housing bubble[16] (see Column (2) of Table 13), mortgage-backed securitization even appears

[16] Countries in our sample experiencing a housing bubble are the US, UK, Spain, Portugal, and Ireland.

to mitigate the positive relationship between bank-specific market power and systemic risk, once other factors are taken into account.

4. Conclusion

This paper examines how bank competition in the run up to the 2007-2009 crisis, impacts on bank systemic risk during the crisis. It also investigates the extent to which capitalization and securitization affect the relationship between bank-specific market power and systemic risk, particularly with regard to their role in shaping banks' incentives to screen and monitor borrowers in the provision of credit. It uses a sample of the largest listed banks of the US, UK, Sweden, Denmark and 11 Eurozone countries, building on previous empirical and theoretical literature.

Our results show that bank-specific market power and, to a lesser extent, banking industry competition in the pre-crisis period lead to higher systemic risk during the crisis. The positive relationship between market power and systemic risk decreases with capitalization but increases with securitization. Furthermore, bank capital does not fully counterbalance the effect of securitization on the relationship between market power and systemic risk. The results are robust to a number of tests, including different measures of systemic risk, capitalization, the inclusion of additional bank-specific characteristics, estimations using instrumental variables and the subsample analyses. From our results, it follows that banking supervisors and macro-prudential regulators should collaborate closely with competition authorities to prevent the build-up of high levels of systemic risks. The findings also suggest that bank capital alone is not sufficient to offset the adverse impact of market power and securitization on banks' systemic risks.

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Appendix A: Marginal expected shortfall (*MES*)

The measure of marginal expected shortfall (*MES*) used in this paper is based on the expected capital shortfall framework, as in Acharya et al. (2012). *MES* estimates the average bank returns on days when the banking market as a whole is in the tail of the loss distribution of its returns:

$$MES_{ti} = 1/T \sum_1^T (R_{i,k,t} \mid R_{m,k,t} < \Gamma) \quad \text{(A.1)}$$

$R_{,i,k,t}$ is the stock returns of bank *i* in country *k* at time *t,* and $R_{m,k,t}$ is the banking stock market index in country *k* at time *t*. A systemic event is defined as a drop of the market index below a threshold Γ, over a given time horizon. Following Acharya et al. (2012), we adopt the standard risk level of 5%, and take the 5% of worst days for the banking sector index ($R_{m,k,t}$) during the crisis period (2007Q4-2009Q4). The average returns of each of individual bank ($R_{,i,k,t}$) are then computed for these days. Daily stock returns for individual banks and countries' banking sectors are gathered from Datastream.

Appendix B: Bank-specific *beta*

Our second measure of bank risk, i.e. bank-specific *beta*, describes the average stock market reaction of each bank to movements in the overall stock market index. It is constructed using a simple capital asset pricing model, based on the following equation:

$$R_{i,k,t} = \beta_{i,k,t} * R_{m,k,t} + \varepsilon_{i,k,t} \quad \text{(B.1)}$$

where $R_{i,k,t}$ represents the daily excess stock returns for each bank i in country k at time t; $R_{m,k,t}$ is the daily excess stock market returns for the broad stock market index m for country k. We take the 10-year government bond yield as the risk-free rate of interest for the country concerned. The term $\varepsilon_{i,k,t}$ is the error term. To ensure comparability in our cross-country sample, we use the broad stock market index for each country, available from Datastream. For each bank i, separate regressions are run to derive beta-bank estimations, using its daily data over the period from 2007Q4 to 2009Q4. A larger estimated bank-specific beta indicates a higher level of bank risk.

Appendix C: Calculating the elasticity adjusted *Lerner Index*

To derive measures for bank-specific market power and the degree of competition at the industry level, the following steps are adopted. We include banks which satisfy the following conditions: total assets, loans, deposits, equity and other non-interest income are positive; the net income to total assets ratio is below 20 percent; personnel expenses to total assets and other expenses-to-assets ratios are between 0.05% and 5%; and finally, the equity to assets ratio is higher than 1%. We first estimate a translog cost function (*TCF*) for *each country*, using the financial statements of individual banks for the 2003 -2007 period. We then calculate the bank-specific *Lerner index* using the difference between the average price of loans and marginal cost of loans, derived from the *TCF,* divided by the average price of loans. We further adjust the bank-specific *Lerner index,* allowing for the price elasticity of loan demand for the overall market. To this end, we simultaneously estimate the TCF and the supply equation. Finally, the *Lerner index* at the industry level is computed by the average of the elasticity-adjusted bank-specific *Lerner indices* of all other banks (excluding the bank in question) in each country.

The *TCF* function assumes that the technology of an individual bank can be described by one multiproduct production function. A dual cost function can be derived from such a production function, taking output levels and factor prices as exogenous. The *TCF* is a second-order Taylor expansion around the mean of a generic dual cost function. Translog is a flexible functional form that is proven to be an effective tool in explaining multiproduct bank services.

Following Van Leuvensteijn et al. (2011), we specify the *TCF* as:

$$lnc_{it} = \alpha_0 + \sum_{t=1}^{T-1} \gamma_t d_t + \sum_{j=1}^{K} \delta_j lnx_{ijt} + \sum_{j=1}^{K} \sum_{k=1}^{K} \epsilon_{jk} lnx_{ijt} lnx_{ikt} + v_{it} \qquad \text{(C.2)}$$

where the dependent variable c_{it} reflects the production costs of bank i (i = 1,..., N) in year t (t = 1, .., T); d_t represents year dummies. The explanatory variables x_{ikt} represent three groups of variables (K= 1,..., *3*). The first group consists of (K_1) bank output components: loans, securities and other services (proxied by other income). The second group consists of (K_2) input

prices: wage rates proxied as personnel expenses to total assets, deposit rates (as cost of funding) calculated by interest expenses to total funding and the price of other expenses (proxied as the ratio of other expenses to fixed assets). The third group (K_3) consists of the equity ratio (equity to total assets), which is treated as the quasi-fixed input factor in line with Berger and Mester (1997). v_{it} is the error term.

The *TCF* is estimated separately for each of our 15 sample countries. We apply linear homogeneity in the input prices and cost-exhaustion, and symmetry restrictions before the estimation. The marginal costs of loans for bank *i* at time *t* are obtained by differentiating the *TCF* with respect to loans:

$$mc_{ilt} = \frac{c_{it}}{x_{ilt}}\left(\delta_1 + 2\epsilon_{1l} lnx_{ilt} + \sum_{k=1\ldots K; k\neq l} \epsilon_{1k} lnx_{ikt}\right) \quad \text{(C.3)}$$

The *Lerner index* for bank *i* is defined as:

$$L_{it} = \frac{p_{it} - mc_{ilt}}{p_{it}} \quad \text{(C.4)}$$

where x_{ilt} refers to the quantity of bank loans for bank *i* at time *t*, p_{it} denotes the average price of loans for bank *i* at time *t*, which is measured as total interest income divided by total loans, while mc_{ilt} are marginal costs of loans derived via Equation (C.3).

However, this traditional *Lerner index* cannot distinguish between markets that have high margins due to inelastic demand for the market as a whole, from lower degrees of competition, or market collusion (Corts, 1999). To overcome this problem, the elasticity-adjusted *Lerner index* has been developed (Genesove and Mullin, 1998; Corts, 1999). More precisely, this measure normalizes the *Lerner index* for the price elasticity of demand for the overall market in order to derive the competitiveness pressure faced by individual banks. To estimate the elasticity-adjusted *Lerner index* we follow Angelini and Cetorelli (2003):

Bank *i* solves the following profit-maximizing problem:

$$\max_{q_i} \Pi = p(Q)q_i - C(q_i, w_i) \quad \text{(C.5)}$$

where $Q = \sum_i q_i$, the total amount of bank loans in loan market as a whole and q_i is the loans provided by bank *i*. $C(q_i, w_i)$ is the cost function of bank *i*, and w_i represents the vector of factor input prices. The corresponding supply function (first-order condition) is:

$$p_i = C'(q_i, w_i) - \frac{\Theta_i}{\varepsilon} \qquad \text{(C.6)}$$

where Θ_i is the conjectural elasticity of total loans of the industry with respect to loans of bank *i*, $\Theta_i = \frac{dQ/dq_i}{Q/q_i}$ and involves both the bank's loans share and its conjectural variation. $\varepsilon = \frac{dQ/dp}{Q} < 0$ and is the market demand semi-elasticity to the price. In a perfectly competitive market, Θ_i equals zero for all banks, while in a monopolistic market Θ_i equals one. Appelbaum (1982) suggests that it is sufficient to estimate the ratio $\lambda_i = \frac{\Theta_i}{\varepsilon}$ if the goal is to evaluate the price-marginal cost margin of a particular firm which depends on both the elasticity of market demand and the degree of competition, measured by conjectural variation. The elasticity-adjusted *Lerner index,* the relative mark-up of price over marginal cost, will then be defined as $L_e = \frac{\lambda}{p}$, where *p* is the average price of loans in the industry.

Substituting the marginal costs Equation (C.3) into the supply Equation (C.6), we obtain:

$$p_{it} = \frac{c_{it}}{x_{ilt}}\left(\delta_1 + 2\epsilon_{1l} lnx_{ilt} + \sum_{k=1\ldots K; k\neq l} \epsilon_{1k} lnx_{ikt}\right) + \sum_{t=1\ldots T-1} \lambda_t d_t + \varepsilon_{it} \qquad \text{(C.7)}$$

where d_t is a year dummy and ε_{it} *i*s the error term. To identify λ_t and the elasticity-adjusted *Lerner index*, we simultaneously estimate the *TCF* (C.2) and the supply equation (C.7). We impose linear homogeneity in the input prices, cost-exhaustion in input shares, symmetry restrictions on *TCF,* and cross-equation restrictions. The elasticity-adjusted *Lerner index*, $L_{e,it}$, is then equal to:

$$L_{e,it} = \mu_t \frac{p_{it} - mc_{ilt}}{p_{it}}$$

(C.8)

μ_t equals to λ_t /(p_{avg} –mc_{avg}). The elasticity-adjusted *Lerner index* is thus equal to the *Lerner index* of each bank for each year times this yearly parameter to correct for the price elasticity of demand for the whole market, where p_{it} denotes the price of loans for bank i at time t, measured as total interest income divided by total loans, while mc_{ilt} are the marginal costs of loans derived via Equation (C.3). The elasticity adjusted *Lerner index* for our sample banks is calculated by the average yearly elasticity adjusted *Lerner index* of the bank during the pre-crisis period. The elasticity adjusted *Lerner index* for the bank's industry rivals during the pre-crisis period is computed by the average of yearly elasticity adjusted Lerner index for all other banks (excluding the bank in question) in the same country.

Table 1: Definitions, data sources and the descriptions of main variables

Variable	Source	Description
Panel A: Bank risk variables		
Systemic risk	Datastream and authors' calculations following Acharya et al. (2012).	Marginal expected shortfall (*MES*), as in Acharya et al. (2012), using α=5%, calculated for the crisis period (2007Q4-2009Q4), based on individual bank and country banking sector daily stock market returns. We take the absolute value in the estimation.
Systematic risk	Datastream and authors' calculations.	Estimated bank-specific beta via a capital asset pricing model using daily excess stock returns for each bank *i* on the broad market index of country *j* during the crisis period (2007Q4-2009Q4).
Expected default frequency (EDF)	Moody's KMV.	One-year ahead probability of default, computed by Moody's KMV, building on Merton's (1974) model to price corporate bond debt. The *EDF* value, expressed as a percentage, is calculated by combining banks' financial statements with stock market information and a proprietary default database. We calculate the average of quarterly data during the crisis period (2007Q4-2009Q4).
Panel B: Bank competition variables		
Bank market power	Authors' calculations (see appendix C for details).	The elasticity adjusted Lerner index of banks in the pre-crisis period. The marginal costs of loans are derived from the Translog Cost Function (TCF) estimated by country for the 2003-2007 period. For each bank for each year, the Lerner index is calculated as the difference between the average charged interest rate on loans and their estimated marginal cost divided by the average interest rate charged by the bank. The Lerner index of the bank is the average of yearly bank-specific Lerner index values over the 2003-2007 period. The index is then adjusted for price elasticity of demand.
Industry competition	Author's calculations.	Average of yearly elasticity adjusted *Lerner index* for all other banks (excluding the bank in question) in the same country over the period 2003-2007, multiplied by minus 1.
Panel C: Balance sheet variables		
Size	Bloomberg.	Average of the natural logarithm of total assets (USD millions) during the pre-crisis period (2003Q4-2007Q3).
Capitalization (%)	Bloomberg.	Average of the quarterly ratios of Tier I capital to risk-weighted assets during the pre-crisis period (2003Q4-2007Q3).
Total capital ratio (%)	Bloomberg.	Average of the quarterly ratios of total capital (Tier I and Tier II) to risk-weighted assets during the pre-crisis period (2003Q4-2007Q3).
Core capital ratio (%)	Bloomberg.	Average of the quarterly ratio of tier I capital to total assets during the pre-crisis period (2003Q4-2007Q3).
Securitization	DCM Analytics Dealogic.	Natural log of the average of the quarterly total securitization flow originated by each bank during the pre-crisis period (2003Q4-2007Q3).
Non-mortgage backed securitization	DCM Analytics Dealogic.	Natural log of the average of the quarterly total non-mortgage backed securitization flow originated by each bank during the pre-crisis period (2003Q4-2007Q3).
Mortgage-backed securitization	DCM Analytics Dealogic.	Natural log of the average of the quarterly total mortgage backed securitization flow originated by each bank during the pre-crisis period (2003Q4-2007Q3).
Deposit funding (%)	Bloomberg.	Average of the quarterly ratios of customer deposits to total assets during the pre-crisis period (2003Q4-2007Q3).
Excessive loan growth	Bloomberg and authors' calculations.	Average of the quarterly differences between the individual bank lending growth and the average loan growth of all banks in each country during the pre-crisis period (2003Q4-2007Q3).
Other earning assets ratio (%)	Bloomberg.	Average of the quarterly ratios of other earning assets to total assets during the pre-crisis period (2003Q4-2007Q3).

Variable	Source	Description
Profitability (%)	Bloomberg.	Average of the quarterly ratios of net income to total assets during the pre-crisis period (2003Q4-2007Q3).
Asset quality (%)	Bloomberg.	Average of the quarterly ratios of total loan loss provisions to total loans during the pre-crisis period (2003Q4-2007Q3).
Non-interest income (%)	Bloomberg.	Average of the quarterly ratios of non-interest income to total income during the pre-crisis period (2003Q4-2007Q3).
Panel D: Other Control variables		
Housing bubble dummy	Authors' calculations.	Binary variable which takes the value of 1 if observation is from the USA, UK, Spain, Portugal and Ireland, and 0 otherwise.

Note: This table presents the names of the variables employed in our empirical analysis, indicates the data sources and gives a brief description of each variable. More detailed information, plus all publicly available data, are available upon request.

Table 2: Sample distribution across countries

(Number of banks)

Country	*Systemic/systematic risk*	*EDF*
Eurozone countries		
Austria (AT)	6	6
Belgium (BE)	2	2
Germany (DE)	17	17
Spain (ES)	10	11
Finland (FI)	2	0
France (FR)	16	17
Greece (GR)	8	8
Ireland (IE)	3	3
Italy (IT)	18	18
The Netherlands (NL)	2	2
Portugal (PT)	5	5
Non-Eurozone countries		
Denmark (DK)	28	28
Sweden (SE)	3	3
United Kingdom (UK)	5	5
United States (US)	370	370
Total	495	495

Note: This table provides information regarding the distribution of the sample banks in each of the 15 sample countries.

Table 3: Descriptive statistics

Variables	N	Average	Median	Standard deviation	Q1	Q3
Panel A: Bank risk						
Systemic risk	495	3.22	2.91	2.61	1.17	5.09
Systematic Risk	495	0.67	0.44	0.57	0.16	1.26
Expected default frequency	495	0.91	0.32	2.22	0.13	0.79
Panel B: Competition variables						
Bank market power	495	0.78	0.77	0.09	0.72	0.83
Industry competition	495	-0.74	-0.75	0.14	-0.75	-0.79
Panel C: Balance sheet variables						
Size	495	7.29	6.62	2.00	5.87	8.20
Capitalization (%)	495	9.63	8.82	5.62	7.31	10.91
Total capital ratio (%)	495	13.73	12.83	3.24	11.69	14.64
Core capital ratio (%)	495	4.72	4.53	2.49	3.08	6.00
Securitization	495	3.13	2.84	2.09	1.51	4.27
Non-mortgage backed securitization	495	3.184	3.02	2.16	1.96	4.23
Mortgage-backed securitization	495	2.19	1.55	1.87	0.94	2.79
Deposit funding (%)	495	71.41	75.12	13.99	66.32	81.10
Excessive loan growth	495	6.27	5.75	2.33	4.72	7.47
Other earning assets ratio (%)	495	26.37	23.59	13.98	17.59	32.18
Profitability (%)	495	0.97	0.96	0.95	0.65	1.26
Asset quality (%)	495	1.20	1.13	1.82	0.84	1.34
Non-interest income (%)	495	20.01	16.53	14.24	10.98	24.79
Panel D: Other control variables						
Housing bubble dummy	495	0.83	1.00	0.370	0	1.00

Note: The average *MES* over the post-crisis period (2007Q4-2009Q4) was 3.22 percent, which is in line with the marginal expected shortfall (*MES*) of 2.09, reported for US banks in Balla et al. (2014, p. 201).

Table 4: Bank market power and industry competition on systemic risk and the impact of capitalization and securitization on this relationship

	Systemic risk		*Systemic risk*	
	(1)		(2)	
Bank market power	2.06	**	2.38	*
	(1.02)		(1.22)	
Securitization	-0.97	**	-1.50	***
	(0.44)		(0.30)	
Capitalization	-0.12	**	-0.13	
	(0.06)		(0.10)	
Size	1.26	**	1.70	***
	(0.50)		(0.36)	
Excessive loan growth	0.48	***	0.39	***
	(0.16)		(0.15)	
Deposit funding	-0.04	**	-0.05	**
	(0.02)		(0.02)	
Industry competition	0.09	***	0.08	**
	(0.03)		(0.03)	
Competition interactions				
*Capitalization * Bank market power*			-0.10	***
			(0.03)	
*Securitization * Bank market power*			0.24	**
			(0.12)	
Constant	-1.13		-3.02	
	(3.12)		(2.86)	
Country dummies	Yes		Yes	
No. of observations	495		495	
R^2	0.39		0.40	

Note: This table provides the estimated results of Model (1) and Model (2). Systemic risk is measured by the *MES*. Columns (1)-(2) show the estimated results of Model (1). Column (1) shows the effect of bank balance sheet variables, *Bank market power* and *Industry competition* on systemic risk. Columns (3)-(4) introduce the interaction terms of *Securitization* and *Capitalization* with *bank market power* and present the estimated results of Model (2). The dependent variable is calculated during the crisis period (2007Q4-2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4-2007Q3) unless otherwise indicated. Clustered standard errors at the bank-level are in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The definition of variables can be found in Table 1.

Table 5: Results using IV

	Systemic risk		*Systemic risk*	
	(1)		(2)	
Bank market power	2.32	**	2.59	*
	(0.96)		(1.32)	
Securitization	-1.78	***	-1.56	***
	(0.35)		(0.33)	
Capitalization	-0.08	***	-0.18	**
	(0.03)		(0.08)	
Size	2.01	***	1.72	***
	(0.31)		(0.34)	
Excessive loan growth	0.45	***	0.40	***
	(0.14)		(0.15)	
Deposit funding	-0.05	**	-0.05	***
	(0.02)		(0.01)	
Industry competition	0.09	***	0.10	***
	(0.02)		(0.03)	
Competition interactions				
*Capitalization * Bank market power*			-0.07	*
			(0.04)	
*Securitization * Bank market power*			0.14	**
			(0.06)	
Constant	-3.01		2.52	
	(2.35)		(1.88)	
Country dummies	Yes		Yes	
No. of observations	495		495	
Weak identification test				
Kleibergen-Paap rk Wald F statistic	19.65		23.06	
Stock-Yogo weak ID test critical values at 5% level	18.38		18.88	
Overidentification test				
Hansen J statistic	4.02		8.13	
(P-value)	0.43		0.12	
R^2	0.39		0.39	

Note: The table contains the estimated results of Model (1) (Column (1)) and Model (2) (Column (2)) using the IV approach. *Systemic risk* is measured by the *MES*. The dependent variable is calculated during the crisis period (2007Q4-2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4-2007Q3) unless otherwise indicated. Column (1) shows the effect of bank balance sheet variables and *Bank market power and Industry competition on Systemic risk*. Column (2) introduces the interaction terms of *Securitization* and *Capitalization* with *Bank-market power* and shows the estimated results of Model (2). The instruments used for *Bank market power* are: *Size, Excessive loan growth, Deposit funding, Capitalization,* and *Securitization* of other banks in the same country during the pre-crisis period in the estimation of Model (1). They also include the product of capitalization of other banks in the same country during the pre-crisis period, the *Bank market power* during the pre-crisis period, and the product of securitization of other banks in the same country during the pre-crisis and *Bank market power* during the pre-crisis period in the estimation of Model (2). Clustered standard errors at the bank-level are in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The definition of other variables can be found in Table 1.

Table 6: Results using alternative measures of capitalization

	Systemic risk		*Systemic risk*		*Systemic risk*		*Systemic risk*	
	(1)		(2)		(3)		(4)	
Bank market power	2.29	**	2.21	**	2.31	*	2.29	*
	(0.90)		(1.05)		(1.31)		(1.23)	
Securitization	-1.51	***	-1.76	***	-1.45	***	-1.46	***
	(0.34)		(0.37)		(0.34)		(0.35)	
Total capital ratio	-0.05	**			-0.13	**		
	(0.03)				(0.06)			
Core capital ratio			-0.14	***			-0.13	*
			(0.05)				(0.07)	
Size	1.74	***	2.18	***	1.70	***	1.70	***
	(0.31)		(0.37)		(0.35)		(0.34)	
Excessive loan growth	0.46	***	0.32	**	0.37	**	0.37	**
	(0.14)		(0.15)		(0.15)		(0.15)	
Deposit funding	-0.05	***	-0.03	*	-0.04	**	-0.04	**
	(0.02)		(0.02)		(0.02)		(0.02)	
Industry competition	0.11	***	0.12	***	0.08	***	0.08	***
	(0.02)		(0.03)		(0.03)		(0.03)	
Competition interactions								
Total capital ratio Bank market power*					-0.06	*		
					(0.04)			
Core capital ratio Bank market power*							-0.06	**
							(0.02)	
*Securitization * Bank market power*					0.21	**	0.22	*
					(0.10)		(0.12)	
Constant	-1.11		-2.59		-3.00		-3.15	
	(2.26)		(2.53)		(2.38)		(2.48)	
Country dummies	Yes		Yes		Yes		Yes	
No. of observations	495		495		495		495	
R^2	0.40		0.40		0.41		0.39	

Note: The table contains the estimated results of Models (1) and (2) using total and core capital ratios as alternative measures of the capitalization. Systemic risk is measured by the *MES*. Columns (1)-(2) present the estimated results of Model (1). Columns (1) and (2) shows the results of using total capital and core capital ratios as proxies for capitalization respectively. Columns (3)-(4) introduce the interaction terms of *Securitization* and *Capitalization* with *Bank market power* (Model, 2). Columns (3) and (4) and shows the results using total capital and core capital ratio as the measures of capitalization respectively. The dependent variable is calculated during the crisis period (2007Q4-2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4- 2007Q3) unless otherwise indicated. Standard errors are clustered at the bank-level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The definition of variables can be found in Table 1.

Table 7: Results using alternative measures of bank risk

	Systematic risk		*EDF*	
	(1)		(2)	
Bank market power	0.50	**	2.35	***
	(0.24)		(0.68)	
Securitization	-0.42	***	-0.998	***
	(0.08)		(0.30)	
Capitalization	-0.05	***	-0.11	***
	(0.02)		(0.01)	
Size	0.42	***	-0.52	**
	(0.08)		(0.20)	
Excessive loan growth	0.17	***	-0.30	***
	(0.03)		(0.05)	
Deposit funding	-0.02	**	-0.01	
	(0.01)		(0.01)	
Industry competition	0.03	***	0.02	
	(0.01)		(0.02)	
Country dummies				
Competition interactions				
*Capitalization * Bank market power*	-0.05	***	-0.09	***
	(0.01)		(0.03)	
*Securitization * Bank market power*	0.06	**	0.43	***
	(0.3		(0.15)	
Constant	-1.10	**	-3.59	*
	(0.54)		(2.12)	
Country dummies	Yes		Yes	
No. of observations	495		495	
R^2	0.53		0.41	

Note: This table provides the estimated results of Model (2). Bank risk is measured by *Systematic* risk (Column (1)) and *EDF* (Column (2)). The dependent variable is calculated during the crisis period (2007Q4-2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4-2007Q3) unless otherwise indicated. Clustered standard errors at the bank-level are in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The definition of variables can be found in Table 1.

Table 8: Results for banks involved (Y), and not involved (N) in Mergers and Acquisitions

Dependent variable: Systemic risk	M&A (Y)		M&A (N)		M&A (Y)		M&A (N)	
	(1)		(2)		(3)		(4)	
Bank market power	2.21	*	2.78	**	2.61	**	2.83	*
	(1.26)		(1.38)		(1.25)		(1.53)	
Securitization	-0.83	*	-1.54	***	-1.46	***	-1.55	***
	(0.50)		(0.44)		(0.53)		(0.39)	
Capitalization	-0.25	**	-0.10	*	-0.31	**	-0.12	***
	(0.11)		(0.05)		(0.15)		(0.04)	
Size	1.59	***	2.08	***	1.78	***	2.03	***
	(0.50)		(0.41)		(0.46)		(0.42)	
Excessive loan growth	-0.11		0.42	***	-0.13		0.39	***
	(0.27)		(0.15)		(0.43)		(0.05)	
Deposit funding	0.02		-0.08	***	0.02		-0.08	***
	(0.02)		(0.02)		(0.02)		(0.01)	
Industry competition	0.08	***	0.12	***	0.08	*	0.10	***
	(0.03)		(0.03)		(0.04)		(0.02)	
Competition interactions								
*Capitalization * Bank market power*					-0.08	***	-0.06	**
					(0.022)		(0.05)	
*Securitization * Bank market power*					0.57	***	0.12	**
					(0.15)		(0.06)	
Constant	-1.30		-3.22		-1.53		-4.27	
	(3.02)		(2.94)		(3.37)		(3.05)	
Country dummies	Yes		Yes		Yes		Yes	
No. of observations	193		302		193		302	
R^2	0.39		0.40		0.45		0.41	

Note: This table provides the estimated results of Models (1) and (2) for banks involved in Mergers and Acquisition (Columns (1) and (3)) and those not involved (Columns (2) and (4)) in the pre-crisis period. The dependent variable, *Systemic risk*, is measured by the *MES*. The dependent variable is calculated during the crisis period (2007Q4-2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4-2007Q3) unless otherwise indicated. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Clustered standard errors at the bank level are in parentheses. The definition of variables can be found in Table 1. The information regarding Mergers and Acquisition is gathered from the Thomson Reuters - SDC Platinum database.

Table 9: Results for US banks in the sample

	Systemic risk		*Systematic risk*		*EDF*		*Systemic risk*		*Systematic risk*		*EDF*	
	(1)		(2)		(3)		(4)		(5)		(6)	
Bank market power	3.21	**	1.06	***	2.45	**	2.55	**	1.37	***	2.77	***
	(1.46)		(0.34)		(1.03)		(1.27)		(0.27)		(0.770)	
Securitization	-1.52	*	-0.51	***	-1.81	***	-0.84	***	-0.56	***	-1.82	***
	(0.82)		(0.12)		(0.36)		(0.32)		(0.07)		(0.28)	
Capitalization	-0.11	***	-0.02	**	-0.17	***	-0.03	***	-0.02	*	-0.15	***
	(0.04)		(0.01)		(0.03)		(0.01)		(0.01)		(0.02)	
Size	2.20	***	0.57	***	2.03	***	1.67	***	0.64	***	1.64	***
	(0.66)		(0.10)		(0.41)		(0.30)		(0.06)		(0.27)	
Excessive loan growth	0.34	**	0.19	***	0.03		0.28	**	0.1	***	-0.08	
	(0.17)		(0.04)		(0.31)		(0.11)		(0.02)		(0.08)	
Deposit funding	-0.04	*	-0.02	**	-0.08	**	-0.053	***	-0.01	***	-0.01	
	(0.02)		(0.01)		(0.04)		(0.02)		(0.00)		(0.03)	
Industry competition	0.21		0.06		0.08		0.24		0.011		0.04	
	(0.23)		(0.05)		(0.05)		(0.17)		(0.04)		(0.24)	
Competition interactions												
*Capitalization * Bank market power*							-0.15	***	-0.03	***	-0.06	*
							(0.04)		(0.01)		(0.03)	
*Securitization * Bank market power*							0.15	***	-0.02	**	-0.16	**
							(0.05)		(0.01)		(0.06)	
Constant	-12.58	***	-3.83	***	-12.48	***	-9.74	***	-4.33	***	-9.45	***
	(3.24)		(0.53)		(1.77)		(1.67)		(0.28)		(1.24)	
No. of observations	370		370		370		370		370		370	
R^2	0.41		0.58		0.15		0.56		0.66		0.18	

Note: This table provides the estimated results of Model (1) (Columns (1)-(3)) and Model (2) (Columns (4)-(6)) for U.S. banks. Columns (1)-(3) shows the effect of bank balance sheet variables and *bank market power*. Columns (4)-(6) introduce the interaction terms of *Securitization* and *Capitalization* with *Bank market power*. *Systemic risk* is measured by the *MES* in Columns (1) and (3), by *Systematic Risk* in Columns (2) and (4), and by *EDF* in Columns (3) and (6). The dependent variable is calculated during the crisis period (2007Q4-2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4-2007Q3) unless otherwise indicated. Clustered standard errors at the bank level are in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The definition of variables can be found in Table 1.

Table 10: Results for non-US banks in the sample

	Systemic risk		*Systematic risk*		*EDF*		*Systemic risk*		*Systematic risk*		*EDF*	
	(1)		(2)		(3)		(4)		(5)		(6)	
Bank market power	1.36	*	0.63	**	1.65	***	3.18	***	0.64	***	1.91	***
	(0.73)		(0.27)		(0.08)		(0.59)		(0.12)		(0.39)	
Securitization	-0.09		-0.07		-0.58	***	-0.62	**	-0.165	***	-0.32	***
	(0.19)		(0.06)		(0.03)		(0.25)		(0.057)		(0.08)	
Capitalization	-0.13	***	-0.04	***	-0.16	***	-0.10	**	-0.01		-0.19	***
	(0.03)		(0.01)		(0.01)		(0.04)		(0.01)		(0.01)	
Size	0.66	***	0.140	**	0.31	***	1.02	***	0.14	***	0.31	
	(0.26)		(0.06)		(0.03)		(0.25)		(0.04)		(0.20)	
Excessive loan growth	-0.30		-0.07		0.11	*	-0.36		-0.07		0.04	
	(0.21)		(0.04)		(0.6		(0.38)		(0.06)		(0.05)	
Deposit funding	-0.03	***	-0.02	**	-0.02	**	-0.02	**	-0.01	**	-0.01	
	(0.01)		(0.01)		(0.01)		(0.01)		(0.00)		(0.01)	
Industry competition	0.02		0.09	***	0.03	**	0.07	*	0.02		0.02	*
	(0.12)		(0.03)		(0.01)		(0.04)		(0.02)		(0.01)	
Competition interactions												
*Capitalization * Bank market power*							-0.12	**	-0.04	**	-0.14	***
							(0.06)		(0.02)		(0.03)	
*Securitization * Bank market power*							0.58	***	0.13	***	1.29	***
							(0.12)		(0.02)		(0.07)	
Constant	-1.95		0.15		-0.46	**	-5.37	**	-0.91	**	-4.33	***
	(2.96)		(0.36)		(0.23)		(2.73)		(0.43)		(1.29)	
No. of observations	125		125		125		125		125		125	
R^2	0.51		0.66		0.15		0.56		0.60		0.18	

Note: This table provides the estimated results of Model (1) (Columns (1)-(3)) and Model (2) (Columns (4)-(6)) for non-U.S banks. Columns (1)-(3) show the effect of bank balance sheet variables and *Bank market power*. Columns (4)-(6) introduce the interaction terms of *Securitization* and *Capitalization* with *Bank market power*. *Systemic risk* is measured by the *MES* in Columns (1) and (3), by *Systematic risk* in Columns (2) and (4), and by *EDF* in Columns (3) and (6). The dependent variable is calculated during the crisis period (2007Q4-2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4-2007Q3) unless otherwise indicated. Clustered standard errors at the bank level are in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The definition of variables can be found in Table 1.

Table 11: Results with additional bank-specific control variables

	Systemic risk	*Systemic risk*	*Systemic risk*	*Systemic risk*
	(1)	(2)	(3)	(4)
Bank market power	2.95 **	2.83 ***	2.91 ***	2.19 ***
	(0.98)	(0.95)	(1.10)	(0.80)
Securitization	-1.61 **	-1.61 ***	-1.62 ***	-2.39 ***
	(0.21)	(0.27)	(0.30)	(0.51)
Capitalization	-0.14 **	-0.14 ***	-0.19 *	-0.10 ***
	(0.05)	(0.06)	(0.06)	(0.02)
Size	1.79 **	1.80 ***	1.91 ***	2.59 ***
	(0.20)	(0.25)	(0.26)	(0.56)
Excessive loan growth	0.40 *	0.38 **	0.29	0.32 ***
	(0.17)	(0.17)	(0.18)	(0.08)
Deposit funding	-0.04	-0.04 *	-0.03 **	-0.02 ***
	(0.02)	(0.02)	(0.02)	(0.01)
Additional banks' variables				
Non-Interest Income	-0.01			
	(0.01)			
Other earning assets ratio		-0.01	0.01	-0.01 **
		(0.01)	(0.01)	(0.01)
Profitability			0.63 ***	0.41 ***
			(0.13)	(0.08)
Asset quality				0.54 ***
				(0.04)
Industry competition	0.09 **	0.10 ***	0.11 ***	0.13 ***
	(0.04)	(0.04)	(0.03)	(0.03)
Competition interactions				
*Capitalization * Bank market power*	-0.07 **	-0.06 ***	-0.11 ***	-0.04 ***
	(0.02)	(0.02)	(0.02)	(0.01)
*Securitization * Bank market power*	0.22 *	0.24 ***	0.22 **	0.16 **
	(0.09)	(0.09)	(0.10)	(0.07)
Constant	-3.03	-2.55	-2.24	-4.25 **
	(2.73)	(2.81)	(2.65)	(2.16)
Country dummies	Yes	Yes	Yes	Yes
No. of observations	495	495	495	495
R^2	0.41	0.41	0.43	0.47

Note: This table provides the estimated results of Model (2), with additional bank-specific control variables in the pre-crisis period. Systemic risk is measured by the *MES*. The dependent variable is calculated during the crisis period (2007Q4-2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4-2007Q3)

unless otherwise indicated. Clustered standard errors at the bank level are in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The definition of variables can be found in Table 1.

Table 12: Results for mortgage-backed securitization

	Systematic Risk		*Systematic Risk*	
	(1)		(2)	
Bank market power	2.15	**	2.66	***
	(0.86)		(0.67)	
Mortgage-backed securitization	0.16	*	0.09	
	(0.09)		(0.09)	
Capitalization	-0.09	**	-0.02	
	(0.04)		(0.03)	
Size	0.62	***	0.67	***
	(0.08)		(0.12)	
Real Estate loan growth	0.14	**	0.14	**
	(0.07)		(0.06)	
Deposit funding	-0.05	***	-0.04	***
	(0.01)		(0.01)	
Industry competition	0.07	***	0.05	*
	(0.01)		(0.03)	
Competition interactions				
*Capitalization * Bank market power*	-0.08	***	-0.08	**
	(0.02)		(0.04)	
*Mortgage-back securitization * Bank market power*	0.11		-0.14	**
	(0.12)		(0.06)	
*Mortgage-back securitization * Bank market power * Housing bubble*			0.28	***
			(0.05)	
Constant	0.99		-0.85	
	(0.60)		(1.18)	
Country dummies	Yes		Yes	
No. of observations	495		495	
R^2	0.37		0.38	

Note: The table contains the estimated results of Model (2) for mortgage-backed securitization only. *Systemic risk* is measured by the *MES*. The dependent variable is calculated during the crisis period (2007Q4-2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4-2007Q3) unless otherwise indicated. Clustered standard errors at the bank level are in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The definition of variables can be found in Table 1.

Table 13: Results for non-mortgage backed securitization

	Systematic Risk		*Systematic Risk*	
	(1)		(2)	
Bank market power	2.04	*	3.22	*
	(1.16)		(1.64)	
Nonmortgage-backed securitization	0.05		0.54	*
	(0.06)		(0.22)	
Capitalization	-0.06	**	-0.01	
	(0.02)		(0.01)	
Size	0.76	***	0.68	**
	(0.21)		(0.21)	
Excessive loan growth	0.35	**	0.47	**
	(0.14)		(0.12)	
Deposit funding	-0.04	*	-0.05	*
	(0.02)		(0.02)	
Industry competition	0.17		0.14	
	(0.18)		(0.20)	
Competition interactions				
*Capitalization * Bank market power*			-0.09	*
			(0.04)	
*Nonmortgage-back securitization * Bank market power*			-0.66	
			(0.346)	
Constant	-5.34	***	-6.26	**
	(0.80)		(1.25)	
Country dummies	Yes		Yes	
No. of observations	495		495	
R^2	0.43		0.44	

Note: The table contains the estimated results of Model 1 (Column (1)) and Model 2 (Column (2)) for non-mortgage backed securitization only. *Systemic risk* is measured by the *MES*. The dependent variable is calculated during the crisis period (2007Q4-2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4-2007Q3) unless otherwise indicated. Clustered standard errors at the bank level are in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. The definition of variables can be found in Table 1.