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The Role of Securitization and Bank Capital

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Abstract

We examine how bank competition in the run-up to the 2007–2009 crisis affects banks’ systemic risk during the crisis. We then investigate whether this effect is influenced by two key bank characteristics: securitization and bank capital. Using a sample of the largest listed banks from 15 countries, we find that greater market power at the bank level and higher competition at the industry level lead to higher realized systemic risk. 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

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I. INTRODUCTION

The effect of competition on the stability of the banking system has been a subject of intense academic debate. Interestingly, this literature tends to focus on the standalone or idiosyncratic risk of banks, rather than on the systemic dimension (Carletti, 2008; Allen and Carletti, 2013).

Following the global 2007–2009 financial crisis, there has been intensified interest in systemic fragility, and macro-prudential regulation, which warrants a deeper understanding of the impact of competition on the systemic dimension of bank risk (Leroy and Lucotte, 2017).

In this paper, we first examine the impact of bank competition on systemic bank risk. In a second step, we consider how the two major changes in the banking system taking place in the run-up to the crisis (i.e. capital regulation and financial innovation) impact on the relationship between competition and systemic bank risk through their influence on the behavior of individual banks (Crockett, 2002).

We test the effect of bank-specific market power and industry-level competition on banks’ systemic risk using an international sample of financial institutions composed of the largest, listed, banks from the United States, Denmark, Sweden, United Kingdom, and 11 Eurozone countries.

Our empirical setting is supported by previous literature that emphasizes the role of banks as producers of information on borrowers. In such a framework, the impact of market competition on bank risk works via the intensity of screening and monitoring (Caminal and Matutes, 1997; 2002).

Following this literature, we distinguish between market power at the individual bank level and competition at the banking industry level. Higher market power allows individual banks to utilize their higher borrowers’ switching costs to improve loan repayment rates while maintaining their borrowers’ base. Higher bank-specific market power can thus substitute for costly screening and monitoring, and encourage more aggressive lending strategies. As such, higher market power increases banks’ exposure to common shocks to the economy and leads to higher systemic risk.

Regarding competition at the banking industry level, more competitive banking markets reduce the value of information production and increase its relative associated costs. This lowers the incentives of all banks to generate costly information to attract business from competitors. Hence banks operating in credit markets with high levels of competition exhibit more lax screening and monitoring, eventually resulting in high levels of systemic risk.

This paper adds to the existing literature in several ways. First, we investigate the distinct impact of bank market power and banking industry competition on systemic risk. Second, we emphasize the time dimension of this relationship, as the credit risk taken by banks in the upswing of a financial cycle usually materializes at a later stage, when the financial cycle turns.

Third, we investigate the effect of two key variables (i.e. securitization and capitalization) on the market power–systemic risk relationship. This is motivated by

Namely: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain.
We find that higher market power of individual banks and more competitive market conditions in the pre-crisis period lead to higher bank systemic risk during the crisis. Securitization amplifies, while capitalization mitigates, partially, the effects of market power on the systemic dimension of bank risk. These empirical results are statistically and economically significant. Our estimations suggest that the difference in systemic risk between a monopolist bank and a price taker is about 34 percent. One standard deviation of capitalization will mitigate the difference between a monopolist bank and a price taker by about 6 percent, and one standard deviation of securitization increases the difference between a monopolist bank and a price taker by around 9 percent. Our findings are robust to the use of different measures of bank risk, competition, and capitalization, as well as additional controls accounting for bank-specific characteristics. Findings are also robust to the use of Instrumental Variables. Our results are related to the literature emphasizing the effects of competition on the intensity of screening and monitoring services and how bank capital and securitization could strengthen or weaken this relationship. The financial crisis has shown that it is necessary to take a more detailed look at how changes to the banking system (such as securitization or enhanced solvency regulations) alter the behavior of banks. Our findings suggest that regulators should pay close attention to how these changes interact with competition in banking markets. The finding that capitalization does not fully counterbalance the impact of securitization on the market power-systemic risk relationship implies that capital adequacy requirements might need to be supplemented with additional supervisory tools to strengthen banks’ incentives to screen and monitor their borrowers more intensively.

II. THEORETICAL BACKGROUND AND LITERATURE REVIEW

A. Bank market power, industry competition and systemic risk

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Bank-specific market power and competitive conditions at the industry level can have different impacts on the incentives of banks to screen and monitor existing and new borrowers and thus be expected to have different effects on systemic risk. In this respect, a bank with greater market power engages less in gathering proprietary information on existing borrowers, as these borrowers face higher switching costs if their main bank has higher market power (Boot and Thakor, 2000). Therefore, market power can be utilized by banks to enforce financial contracts and maintain their existing market share (Qian and Strahan, 2007).

Given these effects of market power, banks with higher market power are more likely to expose themselves to excessive lending, characterized by more lax lending standards, and to eventually exhibit higher levels of realized risks (Caminal and Matutes, 1997; 2002).

At the industry level, a more competitive banking sector results in higher systemic bank risk. Higher competition implies lower average market power, which suggests that borrowers will shop around to obtain credit, and banks are more likely to face unknown new borrowers when attempting to expand their market share. This worsens the quality of information on borrowers and increases the costs associated with a given standard of information quality. As a result, banks find it profitable to reduce their information production to undercut competitors and increase market share (Dell'Ariccia and Marquez, 2006). This leads to an industry-wide higher lending growth supplied with minimal levels of screening.

Consequently, a more competitive banking system implies an increase in banks’ systemic risk (Bolt and Tieman, 2004). The literature on the herding behavior of banks also models the impact of competition on the systematic risk of banks. A higher level of herding leads to an increase in systemic risk, as banks contribute more to common shocks and are more exposed to their effects (Rajan, 1994). Some of this literature emphasizes that bank herding can result from information contagion (Acharya and Yorulmez, 2008). In this setting, the returns on bank loans comprise systematic and idiosyncratic components, and the failure of one bank transmits adverse information about the systematic component. That is, individual bank failure generates a negative externality in the cost of loanable funds and expected profit for surviving banks. The impact is greater when bank loan returns have less commonality, so banks herd undertaking correlated investments to minimize the impact of such information contagion on the negative externality.

While market power allows the bank to appropriate a higher proportion of information rents due to banks’ engagement in screening and monitoring, charging information rents will discourage the demand for bank credit, implying a negative impact on bank profitability.

This channel is in sharp contrast with the positive impact of market power on the average riskiness of the pool of applicants (Allen and Gale, 2004) and the negative relationship between franchise value and risk taking (Keeley, 1990).

Excessive lending, characterized by lower levels of screening and monitoring, exposes banks to overinvestment with existing borrowers. Since investment is subject to decreasing returns to scale and multiplicative uncertainty, banks become more vulnerable to shocks to the economy.
Competition in the banking industry influences banks’ incentives to herd and, therefore, the systemic dimension of bank risk. The direction of this effect is, however, uncertain. On one hand, banks operating in a less competitive market may herd more, since the need to engage in differentiated investment 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, such that bank owners favor individual rather than collective survival (Acharya, 2009).

Also, the impact of competition on bank herding could be increased due to considerations of managerial reputation and career concern (Rajan, 1994). Industry competition encourages bank managers to outperform and outgrow their competitors, with such banks driving each other into strong credit expansions, characterized by lax lending standards (Rötheli, 2001). This competition-induced herding behavior renders the banking system systemically riskier and predicts a positive relationship between higher competition at the industry level and systemic risk.

B. Capitalization, securitization and systemic risk

In general, well-capitalized banks tend to choose a more prudent loan portfolio as capital attenuates the excessive incentives towards risk-taking induced by limited liability and deposit insurance (e.g. Freixas and Rochet, 2008; Acharya et al., 2011). Higher capital levels, therefore, strengthen incentives to screen and monitor borrowers (Beck et al., 2017), encouraging banks to apply stricter lending standards to existing borrowers and be less aggressive in competing for new borrowers (Brander and Lewis, 1986; Bolt and Tieman, 2004).

Higher capital also implies lower herding incentives for banks. Well-capitalized banks face less asymmetric information problems when raising loanable funds (Gambacorta and Mistrulli, 2004; Repullo, 2004) and have a higher probability of survival (Berger and Bouwman, 2013). Well-capitalized banks are therefore less vulnerable to information contagion risks and prefer surviving individually to surviving jointly (Acharya and Yorulmazer, 2008). Following this literature, therefore, well-capitalized banks are expected to empirically exhibit lower levels of systemic risk.

In contrast, other studies suggest that higher capitalization might induce bank risk. The rationale is that higher capital leads to lower returns per unit of capital so that 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, reducing risk, and their incentives to boost short-term returns to capital, incurring higher risks (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 (Agoraki et al., 2011) and, therefore, prioritize long-term survival rather than short-term profits.

This effect is particularly pronounced when expectation of the occurrence of the normal state in the long-run is much higher than expectation of the adverse state, and managers have short-term concerns (Rajan, 1994). While the performance of the bank consists of systematic and idiosyncratic components, the labor market for bank managers appears more likely to associate better performance with managers’ ability in the normal rather than adverse state (Thakor, 2016).
Regarding the impact of securitization on bank risk, some pre-crisis theories suggest that securitization may make banks more resilient to negative shocks and, consequently, reduces systemic risk. This is because the pooling of loans and trancheing of securities create lower-risk and more liquid securities for investors, 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 (DeMarzo, 2004).

By allowing banks to convert illiquid, hard-to-sell loans into marketable securities, securitization can also decrease the sensitivity of bank lending to the availability of deposits, which may make the supply of credit more stable for borrowers and strengthen their incentives to honor loan obligations. In addition, securitization provides banks with opportunities to quickly redeploy loanable resources to more profitable business opportunities (Greenspan, 2005).

More recent work, on the other hand, tends to find that securitization increases systemic risk by making banks more vulnerable to market sentiment and economic shocks (Loutskina, 2011; Laeven et al., 2016). Also, securitization has transformed the traditional role of banks in credit markets from "buying and holding" to "buying and selling". This increases the distance between the originator of loans and the bearer of their default risk so that banks have lower incentives to carefully screen and monitor the borrowers of securitized loans (Rajan, et al., 2015; Maddaloni and Peydró, 2011). This effect is likely to be more pronounced if banks use securitization as a tool for risk transfer (Boot and Ratnovski, 2016).

An assessment of the channels through which capitalization and securitization affect systemic bank risk (as detailed above) provide valuable insights for the formulation of the empirical tests used in this paper to analyses the relationship between market power and systemic risk. The empirical tests are important for a better understanding of the main driving forces behind the relationship.

The literature on the impact of competition on banks' incentives to collect and process proprietary information on their existing and potential borrowers implies that higher capitalization, due to its effect strengthening incentives for banks to screen and monitor borrowers, mitigates the impact of market power on systemic risk. Higher securitization, on the other hand, because of its influence in lowering screening standards and reducing the monitoring of borrowers, exacerbates the impact of market power on systemic risk.

In contrast, the literature on the herding behavior of banks suggests higher capitalization can either strengthen or offset the impact of market power on systemic risk, due to the higher survival rate and lower level of limited liability of well capitalized banks. This literature, however, provides no evidence of the impact of securitization on the market power-systemic risk relationship.

Empirical evidence on the impact of business diversification (from traditional to higher reliance on securitization as a source of income) on banks' soundness and profitability suggest very limited impact during good times (Apergis, 2014). The impact seems to diminish with the increase in the scale of securitization (Fiordelisi and Marques-Ibanez, 2013; Boot and Ratnovski, 2016).
III. DATA AND MODEL

A major challenge of the empirical literature analyzing the relationship between competition and risk concerns when to time the measurement of the variable accounting for bank risk (Beck, 2008), as there is an important lag between the period in which risk-taking takes place and materialization of losses arising from these risks. This paper exploits the realization of bank risk during the 2007–2009 crisis. This choice corresponds to the notion that the problem of risk-taking of banks originated during the period leading up to the financial crisis (Ruckes, 2004).

We assess whether the ex-ante cross-sectional variability in bank-specific market power and competitive conditions at the industry level prior to the crisis are related to the ex-post materialization of bank 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. Indeed, when the focus is on the systemic component of bank risk, it is reasonable to expect it would mostly be realized in the event of a banking crisis (Rajan, 2006).

The initial dataset used in the study consists of more than 1,100 listed banks from 15 countries: 11 Eurozone countries, Denmark, Sweden, the UK, and the United States. It is a highly representative sample that covers around three-quarters of the total aggregate balance sheet of banks operating in these countries.

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

\[
\text{Risk}_{i,k,post} = \text{constant} + \alpha \times \text{Lerner}_{i,k,pre} + \beta \times \text{CAPITALIZATION}_{i,k,pre} + \gamma \times \text{SECURITIZATION}_{i,k,pre} + \tau \times \text{CONTROL}_{i,k,pre} + b \times \text{Lerner}_{k,pre} + \\
\varepsilon_{i,k,post}
\]

(1)

For a full description of the characteristics of the database and variable definitions, see Altunbas et al. (2011) and Table 1.
Finally, during the recent financial crisis, compared to other measures of default risk, Moody’s KMV methodology has various advantages. First, it is not based on accounting information, which might be biased indicators of corporate risk due to conflicts of interest. Second, unlike measures of default risk derived exclusively from accounting information, our measure of bank risk is not a backward-looking indicator. Instead, the measurement is built on Merton’s model (Merton, 1974). Our third measure of bank risk is the Marginal Expected Shortfall (MES), which indicates a higher likelihood of bank default in one year’s time.

To ensure comparability in our cross-country sample, we use the broad Lerner index (Lerner, 2000) as a measure of bank market power during the crisis (Munves et al., 2009). Compared to other measures of expected bank risk, the KMV methodology has various advantages. First, it is not based on market power, which might be biased indicators of corporate risk due to conflicts of interest. Second, unlike measures of default risk, the KMV methodology has performed relatively well as a predictor of firms’ risk on a cross-sectional perspective. That is, the relative levels in the year before the crisis were good predictors of rank ordering of firms’ risk, and estimations of default risk show strong robustness to model misspecifications (Jessen and Lando, 2015). Finally, during the recent financial crisis, compared to other measures of default risk, Moody’s KMV. The measurement is built on Merton’s model (Merton, 1974). A higher estimated bank beta indicates a higher likelihood of bank default in one year’s time.

For each bank, we use the other two measures. A higher stock market information and loan demand beta, the Lerner index is accounted for by combining banks’ financial statements, Moody’s KMV, and the Lerner index (Lerner, 2000) as a measure of market power during the crisis (Munves et al., 2009). Compared to other measures of expected bank risk, the KMV methodology has various advantages. First, it is not based on market power, which might be biased indicators of corporate risk due to conflicts of interest. Second, unlike measures of default risk, the KMV methodology has performed relatively well as a predictor of firms’ risk on a cross-sectional perspective. That is, the relative levels in the year before the crisis were good predictors of rank ordering of firms’ risk, and estimations of default risk show strong robustness to model misspecifications (Jessen and Lando, 2015). Finally, during the recent financial crisis, compared to other measures of default risk, Moody’s KMV. The measurement is built on Merton’s model (Merton, 1974). A higher estimated bank beta indicates a higher likelihood of bank default in one year’s time.

Moody’s KMV. The measurement is built on Merton’s model (Merton, 1974). A higher estimated bank beta indicates a higher likelihood of bank default in one year’s time.
Lerner index measures the degree of competition in each country during the pre-crisis period (2003Q4 to 2007Q3) as perceived by banks is estimated via specific Lerner values.

For the analysis, securitization is measured by computing the cumulated securitization flows over total assets during the pre-crisis period (2003Q4 to 2007Q3) introduced. These variables are included in the sample involve a transfer of funding from market investors to originators so that pure synthetic structures (such as synthetic CDOs issued by euro area originators).

The sample includes ABS, MBS, and CDOs backed debt obligations issued by euro area originators.

Deposit funding is measured by the difference between the loan growth of banks and their core capital.

Several variables are included in the analysis does not follow the literature that uses the ratio of non-interest income divided by total income (and/or that of other earning assets divided by total earning assets) as an additional control variable. Nevertheless, we control for size, in each country during crisis period (2003Q4 to 2007Q3) as the ratio of total capital to risk weighted assets is measured using average ratio of Tier I capital and Tier I leverage ratio.

The Lerner index is introduced. It is calculated by aggregating the data for each quarter for each individual bank and the average of the specific control variables is motivated by the analysis does not follow the literature that uses the ratio of non-interest income divided by total income (and/or that of other earning assets divided by total earning assets) as an additional control variable. Nevertheless, we control for size, in each country during crisis period (2003Q4 to 2007Q3). The Lerner index is introduced. It is calculated by aggregating the data for each quarter for each individual bank and the average of the specific control variables is motivated by the authors believe their measurement of securitization is a better measurement to serve this end.
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 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 (Jimenez 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 in 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’Arria et al., 2014). The deposit funding control variable aims to capture the vulnerability of the bank to liquidity shocks because of funding structure (Huang and Ratnovski, 2008).

As a further robustness check, the degree of banking competition is replaced at the country level by country-fixed effects. This aims to account for all the country factors (including economic conditions, safety net, supervision and regulation, and features of the banking industry) which could influence the risk-taking of individual banks.

An additional estimation that specifically accounts for economic growth is also included. This is calculated as the average of quarterly changes in real GDP (GDP growth) at the country level during the pre-crisis period.

As stated previously, we also examine the impact of capitalization and securitization on the relationship between market power and systemic risk. For this purpose, Model (1) is modified by the addition of the interactions of CAPITALIZATION$_{i,k,pre}$, Lerner$_{i,k,pre}$, and SECURITIZATION$_{i,k,pre}$ with Lerner$_{i,k,pre}$:

\[
Risk_{i,k,post} = constant + \alpha \times Lerner_{i,k,pre} + \beta \times CAPITALIZATION_{i,k,pre} + \\
\gamma \times SECURITIZATION_{i,k,pre} + \varphi \times CAPITALIZATION_{i,k,pre} \times Lerner_{i,k,pre} + \varphi \times SECURITIZATION_{i,k,pre} \times Lerner_{i,k,pre} + \tau \times CONTROL_{i,k,pre} + b \times Lerner_{k,pre} + \\
\epsilon_{i,k,post}
\] (2)
IV. RESULTS, ROBUSTNESS TESTS AND ADDITIONAL ANALYSIS

Both the baseline Models (1) and Model (2) are estimated using Ordinary Least Squares (OLS). The results are first presented using MES as the measure of systemic risk, the Lerner index as the measure of bank-specific market power and competition at industry level, and the ratio of Tier I capital to total risk weighted assets as capitalization. The estimated results of Model (1) are presented in Table 4 (Columns 1 and 2). They show that higher levels of competition (i.e. lower levels of Lerner\(_{k,pre}\), p) in the banking industry in the pre-crisis period lead to higher systemic risk during the crisis. At the individual level, bank-specific market power (i.e. higher levels of Lerner\(_{k,pre}\), p) positively contributes to systemic risk (MES). Both results are statistically significant. Regarding the economic significance, the difference in the systemic risk between a monopolist bank and a bank which is a price taker is 1.11 (see Table 4, Column 1), which is 34.3 percent of the sample mean of MES.

Table 4 results also suggest that well-capitalized banks (CAPITALIZATION\(_{k,pre}\)) in the pre-crisis period have a lower level of systemic risk during the crisis. The finding is consistent with the effect of capital in mitigating the adverse incentives for banks to exploit their limited liability and safety net arrangements. Higher levels of securitization activity in the pre-crisis period (SECURITIZATION\(_{i,k,pre}\)) is negatively related to systemic risk. Hence, 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 find larger 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. Column 2 (Table 4) shows the results of re-estimating Model (1) by replacing the competitiveness conditions at the industry level with the real average GDP growth rate at the country level (GDP growth). None of the estimated coefficients are qualitatively different from those in the baseline Model 1 (Column 1, Table 4).

Turning to the augmented model (Model 2), which includes the two interactions of bank market power with capitalization and securitization respectively, results indicate that the interaction with capitalization is negative while that with securitization is positive, and both terms are significant at the 10 percent level. These findings suggest that higher capitalization reduces the impact of market power on the systemic risk faced by a bank, while higher levels of securitization exacerbate the effect. These results are economically significant. One standard deviation of capitalization will mitigate the difference in MES between a monopolist bank and a price taker by 62.0 percent, and one standard deviation of securitization increases the difference in MES between a monopolist bank and a price taker by 93.9 percent. While capitalization appears to weaken the positive relationship between bank market power and ©International Monetary Fund. Not for Redistribution
systemic risk, its effect does not seem to be strong enough to counterbalance the effect of securitization. As seen, the estimated impact of bank market power on systemic risk remains statistically significantly positive for banks where the value of capitalization and securitization equals the sample mean. This would, therefore, suggest that exclusive reliance on capitalization for the stability of the banking system is questionable.

The impact of capitalization and securitization on the relationship between market power and bank systemic risk can be connected with previous literature highlighting the role of the credit screening and monitoring behavior 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 downside cost of skipping screening and monitoring. Hence higher capitalization leads 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 in Section II, acquisition of proprietary information about borrowers of securitized banks is particularly costly as this type of information cannot be credibly communicated to outside investors. While a traditional bank with higher market power may be inclined to take higher aggregate risks, the scope to generate 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, since the price an outside investor offers for a securitized loan is not able to incorporate proprietary information that banks produce (Parlour and Plantin, 2008). A higher level of securitization could therefore further undermine banks’ fundamental relationship with borrowers, and intensify the positive relationship between bank-specific market power and systemic risk.

The results of re-estimating Model (2) by replacing banking industry competition with real GDP growth rate at the country level (GDP growth) are reported in Column 4 of Table 4. These estimates replicate our previous findings with regard to the impact of capitalization and securitization on the market power-systemic risk relationship. The time dimension of our empirical design, namely the analysis of how bank-specific market power prior to the crisis period impacts on systemic risk during the crisis, should ease concerns about reverse causality. However, the relationship identified so far could be biased by the omission of variables which correlate with bank-specific market power in the pre-crisis period, particularly if they are persistent up to the crisis. For example, sound banks with a reputation for stricter risk management probably have a higher lending rate to marginal cost because of a lower lemon discounts on their funding costs (Chen et al., 2017). More broadly, banks with an overall better reputation may be less subject to declines in their share prices during the crisis period due to uncertainty about banks’ practices. Also, banks with
To assuage concerns about these types of potential endogeneity, Models (1) and (2) are run with instrumental variable(s), using instruments 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). Table 5 summarizes the results of these instrumental variable estimations (IV). The Kleibergen-Paap Wald F statistic rejects the null hypothesis for weak instruments at the 5 percent level. The Hansen J statistic suggests that the instruments are coherent with each other and confirms the validity of the instruments as a group (at the 10 percent level).

All in all, the results estimated with IV are in line with our main findings and also show that the positive relationship between bank-specific market power and systemic risk decreases with capitalization, and increases with securitization. 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, a capital to total assets ratio (i.e. Total capital ratio); second, a core capital to total assets ratio (i.e. Core capital ratio) (see Table 6). The aim is to assess the robustness of our results to any distortion that might be 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, as proxied by a bank-specific beta, and a structural measure, as indicated by the expected default frequency of each individual bank (EDF) (see Table 7). An alternative measure of bank competition at the country level is also employed. This measure is the average percentage of banks reporting a tightening in credit conditions due to changes in bank competition in the period from 2003Q4 to 2007Q3, based on data collected in the quarterly Bank Lending Survey conducted by the European Central Bank, and Senior Loan Officer Surveys of other national central banks (BLS) (see Table 8).

Information is also collected on Mergers and Acquisitions and the sample is separated into those banks involved (and not involved) in Mergers and Acquisition (M&A) in the pre-crisis period (see Table 9). The motivation is that banks involved in M&As might have different business and market strategies, and therefore different risk profiles that might 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.

We also run separate estimations of Models (1) and (2) with instruments 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.

The source is the Thomson Reuters-SDC Platinum database.
Furthermore, it is necessary to investigate whether the results are sensitive to examining subsamples of banks and we show that our results also hold when only US banks are included (see Table 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 country level prior to the crisis exerts a significant impact on bank systemic risk during the crisis. As suggested by previous literature, we argue that competition directly impacts on banks’ incentives to collect and process proprietary information on their actual and potential borrowers. We also propose that bank capitalization incentivizes banks to produce private information on borrowers and constrains 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 quite robust, it is not possible to unequivocally conclude that bank investment in information gathering, to enhance the screening and monitoring of borrowers, is the sole driver of our results. To further understand the findings, it is necessary to investigate whether the impact of securitization on bank systemic risk 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 we are correct in our contention that our empirical findings can be largely explained by banks’ incentives to produce costly proprietary information about their borrowers, it is expected that the impact of securitization, in intensifying the positive relationship between bank-specific market power and systemic risk, should be mainly driven by non-mortgage securitization. To confirm this, we re-estimate the Model (2) to consider 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 impact 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 (see in Column (2) of Table 13), mortgage-backed securitization even appears to mitigate the positive relationship between bank-specific market power and systemic risk.

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V. CONCLUSION

This paper examines how bank competition, both bank and industry levels, 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 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. In this respect, our empirical study, which uses a sample of the largest listed banks of the US, UK, Sweden, Denmark, and 11 Eurozone countries, builds on previous empirical and theoretical literature.

Our results show that bank-specific market power in the pre-crisis period leads to higher systemic risk during the crisis and that a higher level of competition at the industry level is associated with a higher level of bank 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, competition, and capitalization, as well as inclusion of additional bank-specific characteristics and additional estimations using instrumental variables.

From our results, it follows that banking supervisors and macro-prudential regulators should collaborate closely with competition authorities to prevent the build-up of large systemic risks. The findings also suggest that bank capital alone is not sufficient to offset the adverse impact of competition and securitization on banks’ systemic risks. In particular, the higher capital requirements in Basel III may need to be supplemented with additional regulatory tools, which can incentivize banks to increase screening and tighten lending standards for certain borrowers to mitigate the creation of 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 return on days when the banking market as a whole is in the tail of the loss distribution of its returns:

\[
MES_{ti} = \frac{1}{T} \sum_{t}^T (R_{i,k,t} \mid R_{m,k,t} < \Gamma) 
\]

where \(R_{i,k,t}\) 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 \(\Gamma\), over a given time horizon. Following Acharya et al. (2012), we adopt the standard risk level of 5 percent, and take the 5 percent 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:

\[
R_{i,k,t} = \beta_{i,k,t} * R_{m,k,t} + \epsilon_{i,k,t} 
\]

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 \(\epsilon_{i,k,t}\) is the error term. To ensure comparability, we use the broad stock market index for each country available from Datastream. For each bank \(i\), the \(\beta_{i,k,t}\) is estimated by running regressions on daily data for every quarter \(q\) from 2007Q4 to 2009Q4. The average beta for each bank during this crisis period is then calculated.

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 percent and 5 percent; and finally, the equity-to-assets ratio is higher than 1 percent. We first estimate a translog cost function \(TCF\) for each country, using the financial statements of individual banks for the period 2000–2007. 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. Toward this end, we simultaneously estimate the \(TCF\).
and the supply equation.

Finally, the Lerner index at the industry level is computed by averaging the elasticity-adjusted bank-specific Lerner indices of banks 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:

$$\ln c_{it} = \alpha_0 + \sum_{t=1}^{T-1} \gamma_t d_t + \sum_{j=1}^{K} \delta_j \ln x_{ijt} + \sum_{j=1}^{K} \sum_{k=1}^{K} \varepsilon_{jk} \ln x_{ijt} \ln x_{ikt} + v_{it}$$

The TCF is estimated separately for each of our 15 sample countries. We apply linear homogeneity in the input prices and cost-exhaustion and also the 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:

$$mc_{ilt} = \frac{c_{ilt} \delta_1 + 2 \varepsilon_{1l} \ln x_{ilt} + \sum_{k=1}^{K} \sum_{l \neq k} \varepsilon_{1k} \ln x_{ikt}}{x_{ilt}}$$

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

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

However, this traditional Lerner index cannot distinguish markets that have high margins due to inelastic demand for the market as a whole from that because market participants face lower degree of competition or perhaps collusive (Corts, 1999). To overcome this problem, the elasticity-adjusted Lerner index has been developed (Genesove and Mullin, 1998; Corts, 1999). More precisely, this measure normalises the Lerner index for the price elasticity of
To estimate the elasticity-adjusted Lerner index, we follow Angelini and Cetorelli (2003):

Bank $i$ solves the following profit-maximising problem:

$$\max_{q_i} \pi_i = p(Q)q_i - C(q_i, w_i)$$

where $Q = \sum_i q_i$, the total amount of bank loans in loan market as a whole, and $q_i$ is the loan 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:

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

where $\Theta_i$ is the conjectural elasticity of total loans of the industry with respect to loans of bank $i$, $\varepsilon = \frac{dQ}{dp}/Q < 0$ and involves both the bank's loans share and its conjectural variation.

In a perfectly competitive market, $\Theta_i$ equals zero for all banks, while in a monopoly market $\Theta_i$ equals one. Appelbaum (1982) suggests that it is sufficient to estimate the ratio $\lambda_i = \Theta_i \varepsilon$ if the goal is to evaluate price-marginal cost margin of a particular firm in the industry 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 markup of price over marginal cost, will then be defined as

$$L_{e,i} = \lambda_i$$

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:

$$p_{it} = \frac{c_{it}}{x_{it}} \left( \delta_1 + 2\varepsilon_1 lnx_{it} + \sum_{k=1..K, k \neq i} \varepsilon_1 k lnx_{ikt} \right) + \sum_{t=1..T-1} \lambda_t d_t + \varepsilon_{it}$$
\[ L_{e, it} = \mu_t \frac{p_{it} \lambda p_{it}^m}{p_{it}} \]

The elasticity-adjusted Lerner index thus equals 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 Lerner index of the bank during the pre-crisis period. The yearly elasticity-adjusted Lerner index for the industry, \( L_t \), is computed by averaging the individual \( L_{it} \) in each country for each year.
Table 1: Definitions, data sources and the description of main variables

| Variable                                      | Source                                                                 | Description                                                                 |
|-----------------------------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| **Panel A: Bank risk variables**              |                                                                        |                                                                             |
| Marginal expected shortfall (MES)             |                                                                        | $\alpha$-5% percent, $\alpha$=5% mes, $\alpha$-5% shortfall, $\alpha$-5% |
| Bank-specific beta                            |                                                                        |                                                                             |
| Expected default frequency (EDF)              |                                                                        | computed by Moody’s, building on Merton’s default probability; EDF is calculated by combining banks’ financial statements with stock market information and a proprietary default database. |
| **Panel B: Bank competition variables**       |                                                                        |                                                                             |
| Lerner (firm level)                           | Author’s calculation                                                   | $\text{Lerner index} = \frac{\text{average interest rate charged by the bank}}{\text{average interest rate charged by all banks in the industry}} - 1$ |
| Lerner (industry level)                       | Author’s calculation                                                   | $\text{Lerner index} = \frac{\text{average interest rate charged by the bank}}{\text{average interest rate charged by all banks in the industry}} - 1$ |
| BLS                                           |                                                                        |                                                                             |
| **Panel C: Balance sheet variables**          |                                                                        |                                                                             |
| Size                                           |                                                                        |                                                                             |
| Capitalization (percent)                      |                                                                        |                                                                             |
| Total capital ratio (percent)                 |                                                                        |                                                                             |
| Core capital ratio (percent)                  |                                                                        |                                                                             |
| Securitization (percent)                      |                                                                        |                                                                             |
| Non-mortgage backed securitization (percent)  |                                                                        |                                                                             |
| Mortgage backed securitization (percent)      |                                                                        |                                                                             |
| Variable                          | Source          | Description                                                                 |
|----------------------------------|-----------------|-----------------------------------------------------------------------------|
| Deposit funding (percent)        | Bloomberg       | Average of the quarterly ratios of customer deposits to total assets during the pre-crisis period (2003Q4 to 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 to 2007Q3). |
| Other earning assets ratio (percent) | Bloomberg       | Average of the quarterly ratios of other earning assets to total assets during the pre-crisis period (2003Q4 to 2007Q3). |
| Profitability (percent)          | Bloomberg       | Average of the quarterly ratios of net income to total assets during the pre-crisis period (2003Q4 to 2007Q3). |
| Asset quality (percent)          | Bloomberg       | Average of the quarterly ratios of total loan loss provisions to total loans during the pre-crisis period (2003Q4 to 2007Q3). |
| Non-Interest Income (percent)    | Bloomberg       | Average of the quarterly ratios of non-interest income to total income during the pre-crisis period (2003Q4 to 2007Q3). |

**Panel D: Other Control variables**

| Variable              | Source          | Description                                                                 |
|-----------------------|-----------------|-----------------------------------------------------------------------------|
| 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. |
| GDP growth            | Bank for International Settlements. | Average of quarterly changes in real GDP during the pre-crisis period (2003Q4 to 2007Q3). |

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

| Country          | Number of banks: Systemic risk/bank-specific beta | Number of banks: EDF |
|------------------|---------------------------------------------------|----------------------|
| **Eurozone countries** |                                                   |                      |
| Austria (AT)     |                                                   |                      |
| Belgium (BE)     |                                                   |                      |
| Germany (DE)     |                                                   |                      |
| Spain (ES)       |                                                   |                      |
| Finland (FI)     |                                                   |                      |
| France (FR)      |                                                   |                      |
| Greece (GR)      |                                                   |                      |
| Ireland (IE)     |                                                   |                      |
| Italy (IT)       |                                                   |                      |
| The Netherlands (NL) |                                             |                      |
| Portugal (PT)    |                                                   |                      |
| Non-Eurozone countries |                                               |                      |
| Denmark (DK)     |                                                   |                      |
| Sweden (SE)      |                                                   |                      |
| United Kingdom (GB) |                                             |                      |
| United States (US) |                                             |                      |
| **Total**        | **546**                                           | **545**              |

Note: This table provides information regarding the distribution of the sample banks in each of our 15 sample countries.
| Variables                       | N  | Average | Median | Standard Deviation | Q1  | Q3  |
|---------------------------------|----|---------|--------|-------------------|-----|-----|
| **Panel A: Bank Risk**          |    |         |        |                   |     |     |
| Marginal expected shortfall (MES) |    |         |        |                   |     |     |
| Bank-specific beta              |    |         |        |                   |     |     |
| Expected default frequency (EDF) |    |         |        |                   |     |     |
| **Panel B: Bank competition variables** |    |         |        |                   |     |     |
| Lerner (firm level)             |    |         |        |                   |     |     |
| Lerner (industry level)         |    |         |        |                   |     |     |
| BLS                             |    |         |        |                   |     |     |
| **Panel C: Balance Sheet Variables** |    |         |        |                   |     |     |
| Size                            |    |         |        |                   |     |     |
| Capitalization (percent)        |    |         |        |                   |     |     |
| Total capital ratio (percent)   |    |         |        |                   |     |     |
| Core capital ratio (percent)    |    |         |        |                   |     |     |
| Securitization (percent)        |    |         |        |                   |     |     |
| Non-mortgage backed securitization (percent) |    |         |        |                   |     |     |
| Mortgage backed securitization (percent) |    |         |        |                   |     |     |
| Deposit funding (percent)       |    |         |        |                   |     |     |
| Excessive loan growth           |    |         |        |                   |     |     |
| Other earning assets ratio (percent) |    |         |        |                   |     |     |
| Profitability (percent)         |    |         |        |                   |     |     |
| Asset quality (percent)         |    |         |        |                   |     |     |
| Non-Interest Income (percent)   |    |         |        |                   |     |     |
| **Panel D: Other Control Variables** |    |         |        |                   |     |     |
| Housing bubble dummy            |    |         |        |                   |     |     |
| GDP growth                      |    |         |        |                   |     |     |

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 2.094, reported for US banks in Balla et al. (2014, p. 201).
Table 4: Impact of bank level market power (Lerner) and industry competition on systemic risk and the impact of capitalization and securitization on this relationship

| Variable                          | Systemic Risk | Systemic Risk | Systemic Risk | Systemic Risk |
|-----------------------------------|---------------|---------------|---------------|---------------|
|                                   | (1)           | (2)           | (3)           | (4)           |
| Lerner (firm level)               | 1.1071***     | 1.8536***     | 1.3075***     | 1.1162***     |
|                                   | (0.4750)      | (0.6989)      | (0.6243)      | (0.5257)      |
| Securitization                    | −0.7781***    | −0.7773***    | −0.7513***    | −0.7153***    |
|                                   | (0.2174)      | (0.3111)      | (0.2019)      | (0.3418)      |
| Capitalization                    | −0.1262***    | −0.1419***    | −0.1363***    | −0.1181***    |
|                                   | (0.0543)      | (0.0518)      | (0.0484)      | (0.0370)      |
| Size                              | 0.4644***     | 0.5614***     | 0.5686***     | 0.6359***     |
|                                   | (0.1779)      | (0.1985)      | (0.1010)      | (0.0862)      |
| Excessive loan growth             | 0.4076***     | 0.3597*       | 0.2968*       |               |
|                                   | (0.1638)      | (0.1859)      | (0.1683)      |               |
| Deposit funding                   | −0.0342       | −0.0484***    | −0.0406***    | −0.0515***    |
|                                   | (0.0176)      | (0.0172)      | (0.0154)      | (0.0184)      |

| Macro-Economic variables          |               |               |               |               |
|                                   | (1)           | (2)           | (3)           | (4)           |
| Lerner (industry level)           | −0.1027***    | −0.0924***    | −0.0941***    |               |
|                                   | (2.1327)      | (2.0288)      | (2.1932)      |               |
| GDP growth                        | 2.3427***     | 3.0223***     |               |               |
|                                   | (1.1343)      |               |               |               |

| Competition interactions          |               |               |               |               |
|                                   | (1)           | (2)           | (3)           | (4)           |
| Capitalization * Lerner (firm level) |               | −0.0845***   | −0.0941***    |               |
| Securitization * Lerner (firm level) |               | 0.7054***    | 0.6986***     |               |
| Constant                          | −4.3572***    | −7.2602***    | 4.0853*       | −6.8198***    |
|                                   | (2.1142)      | (2.1932)      | (1.1343)      | (2.1932)      |

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, Lerner (firm level) and Lerner (industry level) on systemic risk. Column (2) replaces Lerner (industry level) with real GDP growth. Columns (3)-(4) introduce the interaction terms of Securitization and Capitalization with bank-specific market power and present the estimated results of Model (2). The dependent variable is calculated during the crisis period (2007Q4 to 2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4 to 2007Q3) unless otherwise indicated. Robust standard errors are in parentheses. *, ** and *** indicate statistical significance at the 10 percent, 5 percent and 1 percent levels, respectively. The definition of variables can be found in Table 1.
Table 5: Estimated results via IV approach

| Variable                          | Systemic risk | Systemic risk | Systemic risk | Systemic risk |
|----------------------------------|---------------|---------------|---------------|---------------|
|                                   | (1)           | (2)           | (3)           | (4)           |
| Lerner (firm level)              | 2.9082***     | 2.5658***     | 2.7888***     | 2.7477***     |
| Securitization                   | -0.9291***    | -0.7338***    | -0.6955***    | -0.6677***    |
| Capitalization                   | -0.0586***    | -0.1967***    | -0.1603***    | -0.1536***    |
| Size                             | 0.5437***     | 0.5197***     | 0.5479***     | 0.6754***     |
| Excessive loan growth            | 0.3083*       | 0.3878***     | 0.3038**      | 0.2244*       |
| Deposit funding                  | -0.0479***    | -0.0479***    | -0.0403**     | -0.0487***    |

| Macro-Economic variables         |               |               |               |               |
| Lerner (industry level)          | -0.1066***    |               | -0.0937***    |               |
| GDP growth                       |               | 2.4449***     |               | 3.4920***     |

| Competition interactions         |               |               |               |               |
| Capitalization * Lerner (firm level) |               |               | -0.0746*     | -0.0944***    |
| Securitization * Lerner (firm level) |               |               | 0.7371***    | 0.7658***    |
| Constant                         | 4.1756**      | -7.8448***    | 2.9956*      | -8.7299***    |
| Capitalization * Lerner (firm level) |               |               |               |               |
| Securitization * Lerner (firm level) |               |               |               |               |
| Constant                         |               |               |               |               |

Note: The table contains the estimated results of Model (1) (Columns (1)-2) and Model (2) (Columns (3)-4) using the IV approach. Systemic risk is measured by the MES. The dependent variable is calculated during the crisis period (2007Q4 to 2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4 to 2007Q3) unless otherwise indicated. Columns (1) and (2) present the estimated results of Model (1). Column (1) shows the effect of bank balance sheet variables and Lerner (firm level) and Lerner (industry level) on systemic risk. Column (2) replaces Lerner (industry level) with real GDP growth. Columns (3) and (4) introduce the interaction terms of securitization and capitalization with bank-specific market power and show the estimated results of Model (2). The instruments used for bank-specific market power are: Size, Excessive loan growth, Deposit funding, Capitalization, Securitization of other banks in the...
same country during the pre-crisis period in the estimation of Model (1) and also include the product of capitalization of other banks in the same country during the pre-crisis period, the bank-specific Lerner index during the pre-crisis period, and the product of securitization of other banks in the same country during the pre-crisis period in the estimation of Model (2). Robust standard errors are in parentheses. *, ** and *** indicate statistical significance at the 10 percent, 5 percent and 1 percent levels, respectively. The definition of other variables can be found in Table 1.

Table 6: Estimated results using alternative measurements of capitalization

| Variable                        | Systemic risk | Systemic risk | Systemic risk | Systemic risk |
|--------------------------------|---------------|---------------|---------------|---------------|
|                                | (1)           | (2)           | (3)           | (4)           |
| Lerner (firm level)            | 1.3209***     | 2.1687***     | 2.0240***     | 1.7420***     |
|                                | (0.4685)      | (0.4772)      | (0.4085)      | (0.3329)      |
| Securitization                 | −0.7666***    | −0.8255***    | −0.8403***    | −0.8040***    |
|                                | (0.2171)      | (0.2169)      | (0.2222)      | (0.1826)      |
| Total capital ratio            | −0.1284**     | −0.1496**     |               |               |
|                                | (0.0544)      | (0.0619)      |               |               |
| Core capital ratio             | −0.1439***    |               | −0.0961*      |               |
|                                | (0.0554)      |               | (0.0540)      |               |
| Size                           | 0.4500**      | 0.4917***     | 0.6296***     | 0.7145***     |
|                                | (0.1863)      | (0.1743)      | (0.0976)      | (0.0995)      |
| Excessive loan growth          | 0.4130**      | 0.3804**      | 0.2536        | 0.1810        |
|                                | (0.1706)      | (0.1632)      | (0.1720)      | (0.1693)      |
| Deposit funding                | −0.0363**     | −0.0354**     | −0.0348**     | −0.0322*      |
|                                | (0.0172)      | (0.0166)      | (0.0155)      | (0.0165)      |

Macro-Economic variables

| Variable                        | Systemic risk | Systemic risk | Systemic risk | Systemic risk |
|--------------------------------|---------------|---------------|---------------|---------------|
|                                | (1)           | (2)           | (3)           | (4)           |
| Lerner (industry level)        | −0.1060***    | −0.1042***    | −0.0932***    | −0.0899***    |
|                                | (0.0233)      | (0.0234)      | (0.0315)      | (0.0286)      |

Competition interactions

| Variable                        | Systemic risk | Systemic risk | Systemic risk | Systemic risk |
|--------------------------------|---------------|---------------|---------------|---------------|
|                                | (1)           | (2)           | (3)           | (4)           |
| Total capital ratio*Lerner (firm level) | −0.0519***    |               | −0.1210***    |               |
|                                | (0.0084)      |               | (0.0181)      |               |
| Core capital ratio*Lerner (firm level) |               | −0.1210***    |               |               |
|                                |               | (0.0181)      |               |               |
| Securitization*Lerner (firm level) | 0.6457***     | 0.8250***     |               |               |
|                                | (0.1879)      | (0.2129)      |               |               |
| Constant                       | 4.5446**      | 3.6873*       | 3.1239        | 2.7278        |
|                                | (2.0792)      | (2.0484)      | (2.3664)      | (2.1299)      |

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Table 7: Estimated results using alternative measurement of bank risk

| Variable                      | Bank-specific beta | EDF         |
|-------------------------------|--------------------|-------------|
|                               | (1)                | (2)         |
| Lerner (firm level)           | 0.4675***          | 5.5974***   |
|                               | (0.1320)           | (0.1371)    |
| Securitization                | -0.2189***         | -1.2587*    |
|                               | (0.0825)           | (0.6646)    |
| Capitalization                | -0.0776***         | -0.0545***  |
|                               | (0.0106)           | (0.0061)    |
| Size                          | 0.0922***          | -0.1965***  |
|                               | (0.0269)           | (0.0305)    |
| Excessive loan growth         | 0.1492***          | -0.1436***  |
|                               | (0.0421)           | (0.0143)    |
| Deposit funding               | -0.0108***         | -0.0098**   |
|                               | (0.0018)           | (0.0039)    |

Macro-Economic variables

| Variable                      | (1)                | (2)         |
|-------------------------------|--------------------|-------------|
| Lerner (industry level)       | -0.0209**          | -0.0134*    |
|                               | (0.0090)           | (0.0073)    |

Competition interactions

| Variable                      | (1)                | (2)         |
|-------------------------------|--------------------|-------------|
| Capitalization * Lerner (firm level) | -0.0114***    | -0.1744***  |
|                               | (0.0025)           | (0.0092)    |
| Securitization * Lerner (firm level) | 0.1640**       | 1.2876*     |
|                               | (0.0675)           | (0.7268)    |
| Constant                      | 0.4592             | 2.6905***   |
|                               | (0.5533)           | (0.5967)    |

Note: This table provides the estimated results of Model (2). Systemic risk is measured by bank-specific beta (Column (1)) and EDF (Column (2)), respectively. The dependent variable is calculated during the crisis period (2007Q4 to 2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4 to 2007Q3) unless otherwise indicated. Robust standard errors are in parentheses. *, ** and *** indicate statistical significance at the 10percent, 5percent and 1percent levels, respectively. The definition of variables can be found in Table 1.
Table 8: Estimated results using alternative measurement of competition at the country level

| Variable                        | Systemic risk (1) | Systemic risk (2) |
|---------------------------------|-------------------|-------------------|
| Lerner (firm level)             | 2.1774***         | 2.1091***         |
|                                 | (0.3994)          | (0.7182)          |
| Securitization                  | 0.2019**          | −0.5564***        |
|                                 | (0.0936)          | (0.1771)          |
| Capitalization                  | −0.0822***        | −0.0654*          |
|                                 | (0.0094)          | (0.0389)          |
| Size                            | 1.1842***         | 0.6331***         |
|                                 | (0.0708)          | (0.0806)          |
| Excessive loan growth           | 0.0960            | 0.2706*           |
|                                 | (0.0816)          | (0.1502)          |
| Deposit funding                 | −0.0293**         | −0.0302*          |
|                                 | (0.0116)          | (0.0159)          |
| Macro-Economic variables        |                   |                   |
| BLS                             | −0.0628***        | −0.0209**         |
|                                 | (0.0025)          | (0.0090)          |
| Competition interactions        |                   |                   |
| Capitalization * Lerner (firm level) | −0.0556***      |                   |
|                                 | (0.0094)          |                   |
| Securitization * Lerner (firm level) | 0.5176***       |                   |
|                                 | (0.1619)          |                   |
| Constant                        | −11.1850***       | −5.3942***        |
|                                 | (0.6131)          | (1.4620)          |

Note: This table provides the estimated results of Model (1) and Model (2). Systemic risk is measured by the MES. The results use the answers in Bank Lending Surveys (BLS) from each country to the question of whether banks report a tightening (or loosening) of credit conditions due to competition during the pre-crisis period as the measurement of competition. Column (1) reports the estimated results of Model (1). Columns (2) introduces the interaction terms of securitization and capitalization with bank-specific market power and provides the estimated results of Model (2). The dependent variable is calculated during the crisis period (2007Q4 to 2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4 to 2007Q3) unless otherwise indicated. Robust standard errors are in parentheses. *, ** and *** indicate statistical significance at the 10 percent, 5 percent and 1 percent levels, respectively. The definition of variables can be found in Table 1.
Table 9: Estimated results for banks involved/not involved in Merger and Acquisition in the pre-crisis period

|                       | MandA Involved | MandA Non-involved | MandA Involved | MandA Non-involved |
|-----------------------|----------------|--------------------|----------------|--------------------|
|                       | Systemic risk  | Systemic risk      | Systemic risk  | Systemic risk      |
|                       | (1)            | (2)                | (3)            | (4)                |
| Lerner (firm level)   | 2.8102***      | 0.9581***          | 2.8652***      | 1.3552***          |
|                       | (1.2811)       | (0.3032)           | (1.3086)       | (0.4979)           |
| Securitization        | −0.6626**      | −0.6971**          | −0.7273**      | −0.7458***         |
|                       | (0.2654)       | (0.2709)           | (0.2852)       | (0.2547)           |
| Capitalization        | −0.0671**      | −0.0314**          | −0.1610**      | −0.0277*           |
|                       | (0.0282)       | (0.0152)           | (0.0679)       | (0.0151)           |
| Size                  | 0.5449         | 0.7511***          | 0.7583**       | 0.7992***          |
|                       | (0.3731)       | (0.1276)           | (0.3425)       | (0.1014)           |
| Excessive loan growth | −0.0004        | 0.3679***          | −0.1212        | 0.3063***          |
|                       | (0.4507)       | (0.0430)           | (0.4291)       | (0.0482)           |
| Deposit funding       | 0.0036         | −0.0782***         | 0.0130         | −0.0728***         |
|                       | (0.0146)       | (0.0113)           | (0.0142)       | (0.0112)           |

Macro-Economic variables

|                       | Systemic risk  | Systemic risk      | Systemic risk  | Systemic risk      |
|                       | (1)            | (2)                | (3)            | (4)                |
| Lerner (industry level)| −0.1071**     | −0.0977***         | −0.0909**      | −0.0888***         |
|                       | (0.0446)       | (0.0261)           | (0.0406)       | (0.0264)           |

Competition interactions

|                       | Systemic risk  | Systemic risk      | Systemic risk  | Systemic risk      |
|                       | (1)            | (2)                | (3)            | (4)                |
| Capitalization * Lerner (firm level) | −0.1225*** | −0.0898*** | (0.0267)       | (0.0196)           |
| Securitization * Lerner (firm level) | 1.2758*** | 0.3801**  | (0.3777)       | (0.1802)           |
| Constant              | 6.0070*        | 3.0903             | 3.9195         | 1.9840             |
|                       | (3.3494)       | (1.9118)           | (2.8390)       | (2.0543)           |

Number of observations 193 302 193 302

R2 0.363 0.385 0.440 0.390

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

| Variable                  | MES   | Bank-specific beta | EDF   | MES   | Bank-specific beta | EDF   |
|---------------------------|-------|--------------------|-------|-------|--------------------|-------|
|                           |       |                    |       |       |                    |       |
| **Lerner (firm level)**   | 2.9766** | 0.6389**           | 2.9752*** | 2.8090** | 0.5733**           | 2.5936** |
|                           | (1.7860) | (0.3349)           | (0.6470) | (1.3535) | (0.2632)           | (1.1968) |
| **Securitization**        | −0.6453** | −0.4358**           | −0.3544** | −0.5715*** | −0.6611***           | −0.6226* |
|                           | (0.2828) | (0.2154)           | (0.1674) | (0.1626) | (0.0823)           | (0.3573) |
| **Capitalization**        | −0.0478** | −0.0237**           | −0.0586** | −0.0205* | −0.0154*           | −0.0808*** |
|                           | (0.0232) | (0.0092)           | (0.0241) | (0.0122) | (0.0088)           | (0.0204) |
| **Size**                  | 1.1379*** | 0.3182***           | 0.1738 | 0.9907*** | 0.2184***           | 0.2185 |
|                           | (0.1954) | (0.0499)           | (0.1755) | (0.1357) | (0.0438)           | (0.1648) |
| **Excessive loan growth** | 0.2352* | 0.0857**           | 0.2581* | 0.2756*** | 0.1190***           | 0.3984*** |
|                           | (0.1388) | (0.0387)           | (0.1440) | (0.0907) | (0.0252)           | (0.1380) |
| **Deposit funding**       | −0.0503** | −0.0517***         | −0.0522** | −0.0525*** | −0.0578**           | −0.0187 |
|                           | (0.0234) | (0.0152)           | (0.0209) | (0.0154) | (0.0239)           | (0.0191) |

**Competition interactions**

|                           |       |                    |       |       |                    |       |
| **Capitalization * Lerner (firm level)** | −0.0458** | −0.0296***         | −0.1219*** |       |                    |       |
|                           | (0.0203) | (0.0079)           | (0.0336) |       |                    |       |
| **Securitization * Lerner (firm level)** | 0.2922** | 0.3377***           | 0.5737* |       |                    |       |
|                           | (0.1181) | (0.0133)           | (0.3101) |       |                    |       |
| **Constant**              | −7.4066*** | −2.3678***         | 0.7044 | −6.7387*** | −1.8564***           | −0.0723 |
|                           | (1.3144) | (0.2893)           | (0.9154) | (1.0551) | (0.3390)           | (0.9450) |

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 Lerner (firm level). Columns (4)-(6) introduce the interaction terms of securitization and capitalization with bank-specific market power. Systemic risk is measured by the MES in Columns (1) and (3), by bank-specific beta in Columns (2) and (4), and by EDF in Columns (3) and (6). The dependent variable is calculated during the crisis period (2007Q4 to 2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4 to 2007Q3) unless otherwise indicated. Robust standard errors are in parentheses. *, ** and *** indicate statistical significance at the 10 percent, 5 percent and 1 percent levels, respectively. The definition of variables can be found in Table 1.
Table 11: Estimated results with additional bank-specific control variables during the pre-crisis period

| Variable                     | Systemic risk (1) | Systemic risk (2) | Systemic risk (3) | Systemic risk (4) |
|------------------------------|-------------------|-------------------|-------------------|-------------------|
| Lerner (firm level)          | 2.2937***         | 1.6754***         | 1.9724***         | 2.0682***         |
|                              | (0.8283)          | (0.5989)          | (0.4850)          | (0.7229)          |
| Securitization               | -0.9080***        | -0.8427***        | -0.7347***        | -1.3577***        |
|                              | (0.1341)          | (0.1748)          | (0.2183)          | (0.3393)          |
| Capitalization               | -0.0110**         | -0.1552**         | -0.1063*          | -0.0594*          |
|                              | (0.0056)          | (0.0627)          | (0.0587)          | (0.0357)          |
| Size                         | 0.6407***         | 0.6816***         | 0.7379***         | 0.8626***         |
|                              | (0.1525)          | (0.1057)          | (0.1196)          | (0.1246)          |
| Excessive loan growth        | 0.2276            | 0.2176            | 0.1371            | 0.1736*           |
|                              | (0.1998)          | (0.1647)          | (0.1864)          | (0.0948)          |
| Deposit funding              | -0.0332**         | -0.0319*          | -0.0308**         | -0.0348***        |
|                              | (0.0153)          | (0.0179)          | (0.0149)          | (0.0106)          |

| Additional bank variables    |                   |                   |                   |                   |
|------------------------------|-------------------|-------------------|-------------------|-------------------|
| Non-Interest Income          | -0.0018           |                   |                   |                   |
|                              | (0.0056)          |                   |                   |                   |
| Other earning assets ratio   | -0.0087           | -0.0045           | -0.0042           |                   |
|                              | (0.0057)          | (0.0048)          | (0.0044)          |                   |
| Profitability                | 0.6541***         | 0.3964***         |                   |                   |
|                              | (0.1092)          | (0.1363)          |                   |                   |
| Asset quality                |                   |                   | 0.5517***         |                   |
|                              |                   |                   | (0.0728)          |                   |

| Macro-Economic variables     |                   |                   |                   |                   |
|------------------------------|-------------------|-------------------|-------------------|-------------------|
| Lerner (industry level)      | -0.0910***        | -0.0789**         | -0.0949***        | -0.0912**         |
|                              | (0.0250)          | (0.0333)          | (0.0268)          | (0.0397)          |

| Competition interactions     |                   |                   |                   |                   |
|------------------------------|-------------------|-------------------|-------------------|-------------------|
| Capitalization * Lerner (firm level) | -0.2545*** | -0.0399*** | -0.0601*** | -0.0798*** |
|                              | (0.0310)          | (0.0151)          | (0.0122)          | (0.0160)          |
| Securitization * Lerner (firm level) | 0.7562*** | 0.8039** | 0.7150*** | 0.4965*** |
|                              | (0.1992)          | (0.2025)          | (0.1985)          | (0.1646)          |
| Constant                     | 3.1293**          | 2.2087            | 2.7157            | 1.1761            |
|                              | (1.5296)          | (2.4027)          | (1.9477)          | (3.2193)          |

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 to 2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4 to 2007Q3) unless otherwise indicated. Robust standard errors are in parentheses. *, ** and *** indicate statistical significance at the 10 percent, 5 percent and 1 percent levels, respectively. The definition of variables can be found in Table 1.
Table 12: Estimated results for mortgage backed securitization

| Variable                                      | Systemic risk | Systemic risk |
|-----------------------------------------------|---------------|---------------|
| Lerner (firm level)                          | 2.7997***     | 2.7071***     |
| Mortgage backed securitization               | -0.0236**     | -0.0234**     |
| Capitalization                               | -0.1572***    | -0.1341***    |
| Size                                          | 0.6275***     | 0.5672***     |
| Real Estate loan growth                       |               |               |
| Deposit funding                              | -0.0415**     | -0.0432**     |

| Macro-Economic variables                      |               |               |
| Lerner (industry level)                       | -0.0768**     | -0.0896**     |

| Competition interactions                      |               |               |
| Capitalization*Lerner                         | -0.0499***    | -0.0440***    |
| Mortgage backed securitization * Lerner      |               | -0.0398***    |
| Mortgage backed securitization * Lerner * Housing bubble | 0.4253***     |
| Constant                                     |               |               |

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 to 2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4 to 2007Q3) unless otherwise indicated. Robust standard errors are in parentheses. *, ** and *** indicate statistical significance at the 10 percent, 5 percent and 1 percent levels, respectively. The definition of variables can be found in Table 1.
Table 13: Estimated results for non-mortgage backed securitization

| Variable                          | Systemic risk | Systemic risk |
|----------------------------------|---------------|---------------|
|                                  | (1)           | (2)           |
| Lerner (firm level)              | 1.4151***     | 2.0794***     |
| Non-mortgage backed securitization | -0.9062***   | -0.8381***    |
| Capitalization                   | -0.1162**     | -0.1467**     |
| Size                             | 0.4540***     | 0.6151***     |
| Excessive loan growth            | 0.4128**      |               |
| Deposit funding                  | -0.0336       | -0.0385**     |
|                                  |               |               |
| **Macro-Economic variables**     |               |               |
| Lerner (industry level)          | -0.1041***    | -0.0940***    |
| Competition interactions         |               |               |
| Capitalization * Lerner (firm level) |               | -0.0561***    |
| Non-mortgage backed securitization * Lerner (firm level) | | 0.5259** |
| Constant                         | 4.2287**      |               |

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 to 2009Q4). Regressors are calculated as averages of quarterly data for individual banks during the pre-crisis period (2003Q4 to 2007Q3) unless otherwise indicated. Robust standard errors are in parentheses. *, ** and *** indicate statistical significance at the 10 percent, 5 percent and 1 percent levels, respectively. The definition of variables can be found in Table 1.