Ownership structure and systemic risk: evidence from European banks

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Abstract

We empirically test whether ownership concentration contributes to explain the cross-variation in systemic risk contribution for a sample of European banks over the 2004-2016 period and how this effect may vary depending on the largest controlling shareholder category. The results show that higher ownership concentration is associated with greater banks' systemic risk contribution. Deeper analysis indicates that banks' systemic risk contribution is even stronger for banks where institutional investors and states are the largest controlling owners. Overall, our findings contribute to the literature examining the determinants of banks' systemic risk in particular and financial stability as a whole and have several policy implications.

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1. Introduction

The global financial crisis of 2008 highlights the inherently unstable nature of banking institutions and their incentives toward excessive risk taking, with a renewed debate on systemic fragility and macro-prudential regulation. As such, beyond re-examining systemic risk assessment practices (e.g., Huang et al., 2012; Girardi and Tolga Ergün, 2013; Adrian and Brunnermeier, 2016; Brownlees and Engle, 2012, 2017; Acharya et al., 2017), a growing strand of literature has investigated the factors behind the cross-sectional variation in banks' systemic risk and some works (e.g., Anginer et al., 2014; Weiß et al., 2014; De Jonghe et al., 2015; Jamshed et al., 2015; Laeven et al., 2016) have specifically examined the role played by environmental factors (regulation, network, competition) and financial institutions characteristics (e.g., size, diversification, profitability). Importantly, these papers perceive systemic risk as the correlation of banks' risk-taking and highlight the relevance to not only focus on the risk of individual financial institutions, but also on the individual bank's contribution to the risk of the financial system as a whole. While the literature on the measurement of systemic risk is amplified, studies on the determinants of financial institutions systemic risk exposure are only burgeoning. Despite the ongoing interest toward the driving factors of systemic risk exposure, surprisingly so far no study tests whether corporate governance mechanisms and specifically ownership structure of banks may be responsible on the correlation among banks' risk-taking. The objective of this paper is to fill this gap in the literature.

More precisely, in this paper we investigate the relationship between ownership structure and the systemic risk of banking institutions. Specifically, we look at the effect of ownership concentration on banks' systemic risk contribution and how this effect may vary depending on the category of controlling shareholders involved in banks' decision-making. Ownership structure is known to be the driving force behind the risk-taking incentives in nonfinancial firms in general and banks in particular (e.g., Jensen and Meckling, 1976; Galai and Masulis, 1976; Laeven and Levine, 2009). In this paper we presume that beyond affecting the individual risk of banks, ownership structure (i.e., ownership concentration and the category of shareholders) may be responsible on the correlation of banks' risk-taking behavior at the aggregate level, leading to more systemic fragility.

We frame our empirical investigation around two theoretical keystones: *systemic risk-shifting* and *systemic diversification* phenomena. First, risk-taking incentives and culture depend on ownership concentration. Banks with controlling owners tend to be riskier than

widely held banks (i.e., with no controlling shareholder), holding other factors constant (Shleifer and Vishny, 1986; Laeven and Levine, 2009). Risk-taking incentives may also vary across different shareholder categories. For instance, diversified owners like banking institutions and other institutional investors may have stronger incentives to undertake risky strategies (e.g., Galai and Masulis, 1976; Saunders et al., 1990; Esty, 1998). In contrast, atomistic shareholders like families or manager controlled banks may be less willing to undertake risky strategies to preserve their human capital skills and private benefits of control (Morck et al., 2000). Those risk incentives taken at the individual level may result in a herding behavior and could directly translate into greater systemic risk exposure of banking institutions. As in any limited liability firm, diversified owners have incentives for risk-shifting after collecting funds from bondholders and myopic depositors (e.g., Galai and Masulis, 1976; Esty, 1998). In this context, Acharya (2009) theoretically shows that such a risk shifting behavior could translate into higher systemic risk. This kind of contagion is referred to as *systemic risk-shifting* phenomenon.

Second, unlike atomistic individual owners (such as families), diversified owners –especially institutional investors– are known to have prior experience in loans syndication (Lim et al., 2014), securities and insurance underwriting, brokerage and mutual fund activities and, as a consequence, banks may find it easier to invest in different areas and to choose very diversified portfolios. Such a behavior may allow for risk diversification at the individual level but for higher risk correlation at the aggregate level because activity diversification increases the likelihood of overlapping strategies across banks. In this context, Acharya (2009) and Wagner (2011) theoretically show that although diversification and risk sharing reduce the risk exposure of individual institutions, the financial system may become more fragile and vulnerable because the risk is reallocated (and not eliminated) across the system. In the same vein, Winton (1997) argues that pooling (diversification) elevates the joint failure risk. More recently, Battiston et al. (2012) recognize that the interdependence among banks that arises from financial network relationships, that were developed for the sake of risk diversification, led financial institutions to contribute more systemic risk to the financial system and at the same time, become more vulnerable to contagion risk. In short, while diversification reduces the risk of an individual bank, it increases systemic risk. This systemic risk contagion is referred to as *systemic diversification phenomenon*.

Regardless of the contagion channel (systemic risk-shifting or systemic diversification), in this article, we assume that ownership structure can affect the systemic risk not only through

the total risk taken by a financial institution but also through specific exposure to systemic risk. We refer to these two contagion channels as the *risk culture hypothesis*. If this conjecture is empirically supported, we expect ownership concentration to be associated with greater systemic exposure and that such an effect should be stronger in banks controlled by diversified owners like institutional investors.

Specifically, in this paper we use detailed ownership information on 79 publicly-listed banks based in 16 Western European countries[1] over the 2004-2016 period to test the effect of ownership structure on banks' systemic risk contribution and how this effect might differ depending on the largest controlling shareholder category. More precisely, the objective of this paper is to test whether the risk taking incentives of controlling owners at the individual level translate into higher systemic risk exposure at the aggregate level.

We account for various factors and, consistent with the *risk culture conjecture*, we find that higher ownership concentration leads to higher banks' systemic risk contribution as measured by the ΔCoVaR. This result suggests that shareholders risk-taking incentives at the individual level lead to a herding behavior and greater correlated risk-taking at the aggregate level, making banks more vulnerable to systemic shocks.

We go deeper in our investigation and test whether the effect of ownership concentration on banks' systemic risk contribution may vary depending on the category of the bank's largest controlling shareholder. In line with the risk culture hypothesis, we find that the effect of ownership concentration on systemic risk contribution is higher for banks controlled by other banking institutions, institutional investors or states.

Our paper makes several contributions to the systemic risk and corporate governance literature. First, we build a bridge between the two strands of the literature by investigating the effect of ownership structure on banks' systemic risk exposure. Instead of focusing on systemic risk measurement (e.g., Brownlees and Engle, 2012, 2017; Adrian and Brunnermeier, 2016; Acharya et al., 2017), in this paper we rather examine differences in the systemic risk contribution. In doing so, we also contribute to the ongoing literature investigating the determinants of systemic risk (e.g., Brunnermeier et al., 2012; Anginer et al., 2014; De Jonghe et al., 2015; Acharya and Thakor, 2016) and introduce ownership structure as a new driving force behind systemic fragility. Our study further adds to the literature exploring the effect of ownership structure on banks individual risk (e.g., Laeven and Levine,

[1] Because our objective is to test the effect of ownership concentration on systemic risk exposure we focus on European countries where ownership is known to be more concentrated compared to other countries, for instance, the U.S. (La Porta et al., 1998).

2009). Instead of focusing on the risk of individual financial institutions, we explore the role of ownership structure in explaining the individual bank's contribution to the risk of the financial system as a whole. We hence contribute on the recent debate on systemic fragility.

Our study also contributes to the post-crisis debate on systemic fragility. Our findings support the regulatory perspective arguing that the contribution of an individual financial institution to the system's risk may be more relevant than the individual risk of that institution. Finally, our results also address the concerns of the Basel Committee on Banking Supervision (BIS, 2010) highlighting the importance of sound corporate governance schemes in the banking industry and requiring the disclosure of banks' ownership for further monitoring.

The remainder of the paper is structured as follows. In Section 2, we describe the data and the empirical model. Section 3 reports the sample characteristics and performs some univariate analyses. In Section 4, we present the econometric results. Section 5 provides the robustness checks and Section 6 concludes the paper.

2. Data, variables and model

Before presenting the empirical findings and results, we describe the sample, variables and the model.

2.1. Sample selection

Our study spans the 2004-2016 period and focuses on publicly traded banks based in 16 Western European countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Norway, Netherlands, Portugal, Sweden, Spain, Switzerland and the United Kingdom.[2] Our ownership data come from Orbis database while accounting and market data used in this study come primarily from the Bloomberg database. All banks in the sample report unconsolidated annual financial statements following an accounting period from January 1st to December 31st.

For the time period and countries covered by our study, we identify 163 banks for which the Orbis database provides detailed information on banks' ownership structure. We then collect for these banks information on balance sheets and income statements from the Bloomberg database. We also obtain weekly market data necessary to compute systemic risk indicators from the Bloomberg database. We eliminate observations for which Bloomberg does not

[2] We do not include Luxembourg within the set of Western European countries because no bank provides ownership data consistent with the criteria we use to define our cleaned sample.

provide information on the accounting and market variables of interest as well as banks with discontinuously traded stocks. To minimize the effect of outliers, we winsorize the main accounting variables at the 1% and 99% levels. We then end up with a final sample of 79 banks corresponding to 528 year observations (see Table 1 for a breakdown of the sample by country and year).[3]

[Insert Tables 1 and 2 about here]

2.2. Variables definition

In this paper, we question whether banks' ownership structure affects their systemic risk contribution. To achieve that, we first define our dependent variable reflecting banks' systemic risk. Then we define our independent variable of interest (ownership structure). Finally, we describe the set of control variables introduced in our regressions. Descriptive statistics and other details on all the variables used in our regressions are reported in Table 3.

2.2.1. Measuring banks' systemic risk

The dependent variable in our empirical analysis is systemic risk. In this article, we measure systemic risk using the Conditional Value at Risk (CoVaR) –as initially proposed by Adrian and Brunnermeier (2017)– for each bank of our sample. The system's CoVaR is the VaR of the financial system if a particular institution is under financial distress.[4] To estimate CoVaR, we collect from Bloomberg accouting and market data as used in Adrian and Brunnermeier (2017). We then run the following quantile regression including a vector of state variables (M_{t-1}) :

$$CoVaR_{q,t}^{s/i} = \hat{\alpha}_q^{s/i} + \hat{\beta}_q^{s/i} * VaR_{q,t}^{i} + \hat{\gamma}_q^{s/i} * M_{t-1} \quad (1)$$

where $\mathrm{CoVaR}_{\mathrm{q,t}}^{\mathrm{s/i}}$ is the VaR of the system *s* condtionnal on the distress situation of the institution *i* (i.e., when it is at its $\mathrm{VaR}_{\mathrm{q,t}}^{\mathrm{i}}$) at time *t*; $\mathrm{VaR}_{\mathrm{q,t}}^{\mathrm{i}}$ is the VaR of the institution *i* at time *t*; M_{t-1} is a vector of lagged state variables that includes: volatility index (V2X) which captures the implied volatility in the stock market, liquidity spread which is the difference between the three-month repo rate and the three-month bill rate, the change in the three-month bill rate, the change in the slope of the yield curve which is the difference between German ten-year government bond yield and the German three-month Bubill rate, the change in credit spread measured by the spread between ten-year Moody's seasoned BAA-rated corporate

[3] According to the Bloomberg classification, our sample includes mostly commercial banks (89%) but also diversified and investment banking institutions (11%).
[4] In our empirical framework, we define the financial system as the set of all banks in the sample.

bond, and finally the German ten-year government bond and the S&P 500 return index as a proxy for market equity returns.

We meaure the contribution of each bank on the system risk using the ΔCoVaR defined as the difference between the VaR of the system when a particular institution i becomes financially stressed (i.e., at the qth percentile) and the VaR of the system when the institution is at its median (50% percentile). Formally, the ΔCoVaR is expressed as follows:

$$\Delta CoVaR_q^{s/i} = CoVaR_{q,t}^{s/i} - CoVaR_{0.5,t}^{s/i} \quad (2)$$

ΔCoVaR is computed at q=1% for each bank for the 2004-2016 period, and at q=5 % for robustness test. ΔCoVaR measures each bank contribution on the system risk; with lower values of ΔCoVaR indicating higher contribution. The annual ΔCoVaR for each bank is calculated as the mean of the weekley ΔCoVaRs of each year. For robustness considerations, we also compute the annual ΔCoVaR as the median of the weekley ΔCoVaRs of each year.

2.2.2. Measuring ownership structure

In this paper we aim to investigate the effect of ownership structure on banks' contribution to systemic risk.

To measure ownership concentration, we collect from Orbis information on all direct shareholders for each bank included in the sample for the year 2016.[5] We follow previous studies on both banks (Caprio et al., 2007; Laeven and Levine, 2009) and nonfinancial firms (La Porta et al., 1999; Laeven and Levine, 2008) and set a control threshold of 10% assuming that it provides a significant proportion of votes to exert effective control and influence banks' decision-making. Based on this threshold, we consider a bank as controlled if it has at least one shareholder with 10% or more of shares and, as widely-held if it has no controlling shareholder. As a robustness check, we also consider a 20% control threshold.

In our empirical analysis, we employ two indicators to capture banks' ownership concentration. The first measure, denoted thereafter Concentration1, is the percentage of shares held by the largest controlling shareholder. The second measure we use to capture ownership concentration is the sum of ownership percentages held by all controlling shareholders of each bank (Concentration2). This allows us to capture possible coalitions among several shareholders. In both cases ownership concentration is set equal to zero if the bank is widely held, i.e. if it has no controlling shareholder. For regressions analysis, we also

[5] Ownership is collected only for one year and not for the whole sample period because of data unavailability. This is not a serious concern for our study because ownership is known to be relatively stable across time (La Porta et al., 1999; Laeven and Levine, 2008).

capture ownership concentration using a binary variable d(Concentration1) and [d(Concentration2)] which take a value of one if Concentration1 (Concentration2) is greater than the median value, and zero otherwise.

In line with the aim of our analysis, beyond ownership concentration we also consider the type of the largest controlling shareholder of each bank. We hence classify banks' conntrolling shareholders into five categories: banks (Bank); institutional investors including insurance companies, mutual and pension funds, and financial companies (Institutional); industrial companies (Industry); individuals or family investors (Family); and states or public authorities (State). Based on these categories, we define a set of dummy variables [*d(Type)*] to capture the category of the bank's largest shareholder: *d(Bank)*, *d(Institutional)*, *d(Industry)*, *d(Family)*, and *d(State)* which take a value of one if the laregest shareholder is of that category, and zero otherwise.

2.2.3. Control variables

We include in our estimations a set of bank level and country level control variables (X) that are expected to affect banks' systemic risk.

We include in our regressions the natural logarithm of bank total assets (LnTA) and the ratio of equity to total assets (EQTA) to respectively account for bank size and capitalization. While banks with higher capital ratios are expected to be less exposed to systemic risk (Acharya and Thakor, 2011; Brunnermeier et al., 2012; Mayordomo et al., 2014; Jamshed et al., 2015), the impact of bank size on systemic risk is uncertain. Due to their wide connections with other institutions, larger banks could be more exposed to systemic shocks than small ones (Laeven et al., 2016). But larger banks could also be less systemically important because they have greater ability to diversify their activities and, as a consequence, their individual risks should be less correlated. For instance, Mayordomo et al. (2014) find no significant relation between banks' size and systemic risk. To account for non-linearity in the effect of bank size on systemic risk exposure, we also include the square term of LnTA (Anginer et al., 2014).

To account for differences in the level of bank profitability, we introduce in our model the ratio of net income to total assets (ROA) which we expect to negatively affect banks' systemic risk exposure (Anginer et al., 2014; De Jonghe et al., 2015).

We also control for differences in business models by including the ratio of net loans to total assets (LOTA). Greater reliance on non-traditional activities makes banks more complex and therefore more subject to systemic crises (e.g., De Jonghe et al., 2015). But De Jonghe et

al. (2015) show that the effect of non-interest income on systemic risk exposures varies with bank size. The authors find that the non-interest income variable reduces the systemic risk of large banks whereas it increases that of small banks.

We introduce the ratio of loan loss provisions to net loans (LLP) to control for differences in credit risk among banks. Higher values of LLP suggest higher credit risk and potentially greater systemic risk exposure (Anginer et al., 2014).

We also include the market to book ratio defined as the market value of equity divided by the book value of equity (MTB) to account for banks' growth opportunities. Banks with high franchise value take generally less risk (Keeley, 1990) and, as a consequence, MTB is expected to have a negative effect on systemic risk exposure (Anginer et al., 2014).

We also account for differences in ownership types (Barry et al., 2011) by including a set of dummy variables which reflect the type of the largest controlling shareholder as previously defined [d(Bank), d(Institutional); d(Family), d(State), d(Industry) and d(Foundation)] with the category of widely held banks considered as the benchmark group.

Regarding country level variables, we include the growth rate of the real gross domestic product (GDPGrowth) to take into account differences in the macroeconomic and institutional environment within countries. We also include the number of banks [Ln(Number of banks)] in each country to account for the banking system concentration. Banking systems dominated with a few large banks may be less fragile compared to banking systems with many small banks (Anginer et al., 2014).

[Insert Table 3 about here]

2.3. Model specification

To test the effect of ownership structure on systemic risk, we estimate the following model including a set of control variables (X) as well as vectors of country (Country), year (Year) and bank specification (Specification) dummies:

$$SRISK_{it} = \alpha_1\, OwnershipConcentration_i + \beta' X + \beta_0 + \sum_{k=2}^{16} \varphi_k Country_i^k + \sum_{t=2005}^{2016} \omega_t\, Year_i^t + \sum_{s=2}^{4} \gamma_s\, Specification_i^s + \varepsilon_{it} \quad (3)$$

where the dependent variable is the systemic risk contribution measured by the ΔCoVaR for bank i at time t. OwnershipConcentration refers to one of the ownership measures described above [Concentration1; Concentration2; d(Concentration1); d(Concentration2)]. X is the vector of bank and country level control variables as defined above.[6]

The coefficient α_1 measures the effect of greater ownership concentration on banks' systemic risk contribution. Controlling owners –especially of the same category– may have homogeneous behavior and objectives in terms of risk-taking. Banks under the control of those shareholders may therefore behave similarly and take correlated risks, increasing their systemic contribution. Consistent with this risk culture view, we expect the coefficient α_1 to be negative and statistically significant indicating that higher ownership concentration is associated with greater systemic risk contribution.

3. Sample characteristics and univariate analysis

We first present the ownership characteristics of the sample banks. Then, using univariate mean tests we look into banks' characteristics and systemic exposure depending on their ownership concentration.

3.1. Ownership characteristics of the sample banks

We present in Table 4 information on ownership type and percentage held by each shareholder category.

Considering the control threshold of 10%, our sample includes controlled banks (around 70% of the observations) and widely-held banks (30% of the observations). The number of direct controlling shareholders for each bank ranges from one to five. The data also show that industrial companies, other banking institutions and institutional investors are the predominant largest controlling shareolders of banks in our sample. Family and state owners are also present as largest controlling shareholders but at a lower extent compared to other categories. Banks in our sample are very rarely controlled by foundations.

3.2. Ownership structure and banks' characteristics: univariate analysis

We analyze the characteristics of the sample banks depending on their ownership concentration. To achieve this, we divide the sample banks into two groups based on the median value of ownership concentration measures: concentrated banks are banks for which

[6] Table A.1 in Appendix A shows the correlation coefficients among the main independent variables used in our regressions. On the whole, the correlation coefficients are low except for bank size as measured by the natural logarithm of total assets (LnTA) and the ratio of equity to total assets (EQTA). We introduce separately LnTA and EQTA in the regressions and the results are not affected by high correlation.

the ownership concentration is above the median value and less concentrated (dispersed) banks are banks for which the ownership concentration measure is below the median value.

Table 5 compares the key financial characteristics and systemic risk contribution of concentrated and dispersed banks.

In terms of general financial characteristics (Panel A of Table 5), the results do not display significant differences across concentrated and dispersed banks. Specifically, the data show that banks with high ownership concentration are smaller but have greater growth opportunities compared to banks with dispersed ownership.

Regarding systemic risk contribution (Panel B of Table 5), the table mainly shows that concentrated banks are associated with higher values of ΔCoVaR (in absolute values) suggesting that ownership concentration increases banks' systemic risk contribution. This result is consistent with the risk culture view suggesting that controlling owners –especially if they are of the same category– may encourage their banks to take similar risky activities increasing the correlation of their risk-taking behavior and making them simultaneously vulnerable to shocks.

To better emphasize the characteristics of the sample banks, we further analyze the data across sound times and distress times (2008-2009). Not surprisingly, the data (Table 6) show that systemic exposure of our banks has increased during the financial crisis of 2008-2009. The results also show that banks are smaller (lower LnTA), less profitable (lower ROA) and have lower growth opportunities during the financial crisis of 2008-2009. Moreover, the table indicates that banks have increased their provisions (higher LLP) during the financial crisis.

To analyze the pattern of our systemic risk measure (ΔCoVaR), we report in Table 7 the average systemic contribution by country. The table shows that systemic risk contribution is higher for banks located in countries like Greece and Ireland.

4. Econometric results

We first examine the effect of ownership concentration on European banks' systemic risk contribution. We then go deeper by analyzing whether and how the type of shareholders may affect such a relationship.

We perform several tests to choose the appropriate method to estimate the coefficients of Eq. (3). The Fischer test points to the presence of individual effects and the Hausman test indicates that random individual effects are more suitable for our dataset. As a consequence,

we estimate the coefficients of the model presented in Eq. (3) using the random effects panel techniques.

4.1. Ownership concentration and bank systemic risk exposure

Table 8 reports the estimation results. Columns 1-2 of this table report the results using a continuous variable for ownership concentration (Concentration1 and Concentration2) and columns 3-4 present the estimation results using a binary variable to capture ownership concentration [d(Concentration1) and d(Concentration2)].

The results show that ownership concentration is associated with higher systemic contribution and this holds in all the regressions regardless of the ownership measure we use: the coefficient α_1 associated to the ownership concentration variable is negative and statistically significant in all the regressions. Our results are then consistent with the risk culture hypothesis and suggest that ownership concentration exposes banks to similar sources of credit or any other risk and results in a herding behavior and greater correlated risk taking, making the banking system more fragile to shocks.

Regarding the control variables, few of them enter significant. More specifically, consistent with prioir studies the results show that highly capitalized banks (higher EQTA) are less exposed to systemic risk. In line with previous studies, the results also indicate that banking systems with a large number of banks [higher Ln(Number of banks)] are more fragile compared to their counterparts. The remaining control variables including those capturing the type of the largest controlling are generally non-significant.

On the whole, our results are consistent with the risk culture hypothesis indicating that owner-controlled banks should be subject to similar risk-taking behavior and, as a consequence, ownership concentration leads to a common individual risk exposure making the banking sector vulnerable to systemic shocks.

[Insert Table 8 about here]

4.2. Ownership concentration and bank systemic risk: the impact of the largest shareholder type

In this subsection, we go deeper by analyzing the effect of the largest shareholder category on the link between ownership concentration and systemic risk contribution.

Consistent with the *risk culture hypothesis*, our main results indicate that ownership concentration exposes banks to higher systemic risk, potentially because controlling shareholders encourage banks to take similar and correlated risks, making them more fragile.

However, risk-taking incentives and culture may vary across different shareholder categories. For instance, diversified owners like banking institutions and other institutional investors may have stronger incentives to undertake risky strategies and to encourage risk-shifting behavior. Moreover, because they have expertise and experience in several activity areas, such shareholders should also encourage their banks to invest in different areas and to choose very diversified asset portfolios. Such a behavior may allow for risk diversification at the individual level but for greater risk correlation at the aggregate level. State-owned banks could also have higher systemic risk exposure because they should be subject to risk-shifting behavior. Black et al.(2016) explain how state ownership can be perceived as a government support and how it leads to increases in systemic risk. In contrast, atomistic shareholders like families or manager controlled banks may be less willing to undertake risky strategies to preserve their human capital skills and private benefits of control. Also, family controlled banks may choose less diversified portfolios and invest in few areas where they have enough expertise. Such a behavior may lead banks to take concentrated risks at the individual level but less correlated risks at the aggregate level.

Given these arguments, we expect banks controlled by other banking institutions or any institutional investor as well as state-owned banks to contribute more to systemic risk compared to their counterparts. To test this hypothesis, we estimate this augmented version of Eq.(3) where we introduce interactions among the ownership concentration variable and the dummy capturing the category of the largest controlling shareholder:

$$SRISK_{i,t} = (\alpha_1 + \alpha_2 OwnershipType)\ OwnershipConcentration_i + \beta' X + \beta_0 + \sum_{k=2}^{16} \varphi_k Country_i^k + \sum_{t=2005}^{2016} \omega_t\ Year_i^t + \sum_{s=2}^{4} \gamma_s\ Specification_i^s + \varepsilon_{it} \quad (4)$$

Where OwnershipType is a row vector including a set of dummy variables capturing the category of the largest controlling owner of each bank: d(Bank); d(Institutional); d(Family); d(State); and d(Industry).

The estimation results are provided in Table 9. Consistent with our predictions, the results show that the effect of ownership concentration on systemic contribution is enhanced when the contolling shareholder is another banking institution, an institutional investor or a state: the coefficient α_2 associated to the interaction term is negative and statistically significant, suggesting that these categories of shareholders strengthen the banks' systemic contribution, potentially because of the risk-shifting behavior as explained before (wald tests are displayed on the bottom of Table 9).

[Insert Table 9 about here]

5. Robustness checks

In this section, we perform various regressions to check the robustness of the results obtained in subsections 4.1 and 4.2. To save space we do not report the robustness results which are available on request.

Until now, the annual ΔCoVaR we use is measured as the mean value of weekly ΔCoVaRs. To check whether the use of mean value has not biased our results, we compute the annual ΔCoVaR as the median value of weekly ΔCoVaRs. Our results remain unchanged.

Our sample period includes sound and distress times. To ensure that our results are not affected by the financial crisis of 2008-2009, we run regressions separately on subsamples of normal times and distress times. Our results remain unchanged.

Until now, our systemic risk measure is computed at the 99% confidence level. To check whether our results identically hold regardless of the confidence level we consider, we also run regressions using a ΔCoVaR computed at the 95% level. The results are qualitatively the same.

Finally, we change the control threshold and compute again ownership variables with a control level of 20% instead of 10%. This new control threshold increases the proportion of banks considered as widely held and decreases the proportion of family- and state-owned banks in our sample. Nevertheless, our main results are unchanged.

6. Conclusion

The aim of this study is to empirically test the impact of ownership structure on banks' systemic risk. More specifically, we investigate whether bansk' systemic contribution depends on their ownership concentration and test how this effect may vary across different shareholder categories. For this purpose, we construct a dataset on ownership concentration and accounting and market data of 79 banks based in 16 European countries during the 2004-2016 period. We estimate systemic risk using the ΔCoVaR which measures the contribution of each bank to the overall risk. Then we define ownership structure indicators that capture the controlling shareholder ownership percentages and types. Finally we establish a link between systemic risk and ownership structure by runnig panel regressions.

Our results show that ownership concentration is associated with greater systemic contribution, potentially because the presence of controlling shareholders leads banks to take highly correlated risks making them more vulnerable. A deeper analysis shows that such a

relationship is even stronger for banks where institutional investors and states are the largest controlling owners.

On the whole, our findings contribute to the post-crisis debate on systemic fragility. Our paper supports the regulatory perspective arguing that the contribution of an individual financial institution to the system's risk may be more relevant than the individual risk of that institution. Our results also address the concerns of the Basel Committee on Banking Supervision (BIS, 2010) highlighting the importance of sound corporate governance schemes in the banking industry and requiring the disclosure of banks' ownership for further monitoring.

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Table 1
Distribution of European banks by country
This table shows the breakdown of the 79 European banks and the number of ovserbations in the final sample for each country.

Country	Number of sample banks	Number of observations
Austria	4	29
Belgium	2	24
Denmark	14	79
Finland	2	20
France	5	55
Germany	8	38
Greece	1	11
Ireland	1	5
Italy	9	67
Netherlands	3	15
Norway	9	52
Portugal	1	4
Spain	5	47
Sweden	3	12
Switzerland	6	21
United Kingdom	6	49
Total	**79**	**528**

Table 2
Distribution of observations by year
This table shows the number of observations in the final sample for each year from 2004 to 2016.

Year	Number of observations	Percentage of observations
2004	26	4.92
2005	48	9.09
2006	49	9.28
2007	34	6.44
2008	32	6.06
2009	40	7.58
2010	34	6.44
2011	52	9.85
2012	33	6.25
2013	40	7.58
2014	41	7.77
2015	40	7.58
2016	59	11.17
Total	**528**	**100**

Table 3

Variables definition and summary statistics

This table provides the definition and summary statistics for all the variables used in our regressions. The sample consists of 79 European banks corresponding to 528 year observations during the 2004-2016 period.

Variable name	Definition	Source	Mean	Median	Standard deviation	Minimum	Maximum	Number of obvesrvations
ΔCoVAR	Mean of weekley ΔCoVaRs defined as the difference between the VaR of the system when the institution is at the 1% percentile and the VaR of the system when the institution is at its median (50% percentile) (%)	Bloomberg	-1.452	-1.170	1.107	-8.268	1.407	528
ΔCoVAR	Median of weekley ΔCoVaRs defined as the difference between the VaR of the system when the institution is at the 1% percentile and the VaR of the system when the institution is at its median (50% percentile) (%)	Bloomberg	-1.194	-0.975	0.870	-5.809	1.187	528
Concentration1	The percentage of shares held by the largest controlling shareholder (%)	Orbis	23.272	17.590	24.567	0	100	528
Concentration2	The sum of ownership percentages held by all controlling shareholders of each bank (%)	Orbis	29.473	20.830	28.380	0	100	528
d(Concentration1)	Dummy equal to one if Concentration1 is greater than the median value; and zero otherwise	Orbis	0.4750	0	0.3428	0	1	528
d(Concentration2)	Dummy equal to one if Concentration2 is greater than the median value; and zero otherwise	Orbis	0.3484	0	0.4769	0	1	528
d(Bank)	Dummy equal to one if the largest controlling owner is a bank; and zero otherwise	Orbis	0.188	0	0.391	0	1	528
d(Institutional)	Dummy equal to one if the largest controlling owner is a financial company, an insurance company, a mutual or a pension fund; and zero otherwise	Orbis	0.123	0	0.329	0	1	528
d(Family)	Dummy equal to one if the largest controlling owner is an individual or a family; and zero otherwise	Orbis	0.083	0	0.277	0	1	528
d(State)	Dummy equal to one if the largest controlling owner is a state, a government or a public othority; and zero otherwise	Orbis	0.057	0	0.232	0	1	528
d (Industry)	Dummy equal to one if the largest controlling owner is an industrial company; and zero otherwise	Orbis	0.235	0	0.424	0	1	528
d(Foundation)	Dummy equal to one if the largest controlling owner is a foundation or reaserch institute; and zero otherwise	Orbis	0.011	0	0.106	0	1	528
d(Widely Held)	Dummy equal to one if the bank is widely held (i.e., with no controlling owner); and zero otherwise	Orbis	0.303	0	0.46	0	1	528
LnTA	Natural logarithm of total assets (Million of Euros)	Bloomberg	9.816	9.929	3.046	2.966	14.627	528
EQTA	Ratio of total equity to total assets (%)	Bloomberg	9.038	6.767	9.771	0.863	89.675	528

Table 3 *(continued)*

Variable name	Definition	Source	Mean	Median	Standard deviation	Minimum	Maximum	Number of obvesrvations
ROA	Return on assets defined as the ratio of net income to total assets (%)	Bloomberg	0.366	0.507	1.341	-6.93	6.789	528
LOTA	Ratio of net loans to total assets (%)	Bloomberg	59.278	63.041	21.341	0.164	94.517	528
LLP	Loan loss provisions defined as the amount of loan loss provisions divided by net loans (%)	Bloomberg	0.493	0.261	0.732	-0.733	6.072	528
MTB	Market to book defined as the ratio of the market value of equity to the book value of equity (%)	Bloomberg	117.89	86.509	97.029	0.451	675.691	528
GDPGrowth	Growth rate of real GDP (Gross Domestic Product) (%)	Bloomberg	1.176	1.500	2.498	-10.100	26.600	528
Ln(Number of banks)	Natural logarithm of the number of banks (with active and inactive trading status) in each country	Bloomberg	4.952	4.905	0.974	2.890	7.163	528

Table 4

Ownership characteristics of the sample banks

This table reports informations on ownership type for the sample banks. We differentiate banks according to the type of their owners: a bank (Bank); a financial company, an insurance company, a mutual or a pension fund (Institutional); an individual or a family (Family); a state, a government or a public othority (State); an industrial company (Industry); a foundation or reaserch institute (Foundation). Widely Held refers to banks with no controlling shareholder.

Owner type	Percentage of observations	Number of observations	Number of banks	Percentage of ownership
Bank	18.750	99	17	36.403
Institutional	12.310	65	9	25.429
Family	8.330	44	7	28.554
State	5.680	30	7	63.967
Industry	23.480	124	18	26.370
Foundation	1.140	6	1	97.610
Widely Held	30.310	160	20	0

Table 5

Financial characteristics, systemic risk and ownership concentration: univariate analysis

This table compares the financial characteristics of dispersed and controlled banks over the 2004-2016 period. Using a control threshold of 10%, we classify a bank as concentrated (dispersed) if the percentage held by the largest shareholder is greater (lower) than the median value. d(Concentration1) is a dummy equal to one if Concentration1 is greater than its median, and zero otherwise; Concentration1 is the percentage of shares held by the largest controlling shareholder; ΔCoVAR is the mean of the weekly ΔCoVaRs defined as the difference between the VaR of the system when the institution is at the 1% percentile and the VaR of the system when the institution is at its median; LnTA is the natural logarithm of total assets; EQTA is the ratio of total equity to total assets; ROA is the ratio of net income to total assets; LOTA is the ratio of net loans to total assets; LLP is the amount of loan loss provisions divided by net loans; MTB is the ratio of the market value of equity to the book value of equity. ***, ** and * indicate significance respectively at 1%, 5% and 10%.

Variable	Concentrated banks [d(Concentration1)=1]	Dispersed banks [d(Concentration1)=0]	T-statistics
Panel A: General financial characteristics			
LnTA	9.296	10.088	-2.8574***
EQTA	9.652	8.718	1.0421
ROA	0.452	0.321	1.0659
LOTA	58.357	59.759	-0.7163
LLP	0.533	0.471	0.9241
MTB	139.491	106.622	3.7398***
Panel B: Systemic risk			
ΔCoVAR	-1.623	-1.363	-2.5706**

Table 6
Characteristics of sample banks during normal and distress times
This table compares the characteristics of banks during normal times (2004-2007; 2010-2016) and distress times (2008-2009). ΔCoVAR is the mean of the weekly ΔCoVaRs defined as the difference between the VaR of the system when the institution is at the 1% percentile and the VaR of the system when the institution is at its median; LnTA is the natural logarithm of total assets; EQTA is the ratio of total equity to total assets; ROA is the ratio of net income to total assets; LOTA is the ratio of net loans to total assets; LLP is the amount of loan loss provisions divided by net loans; MTB is the ratio of the market value of equity to the book value of equity. ***, ** and * indicate significance respectively at 1%, 5% and 10%.

Variable	Normal times	Distress times	T-statistics
ΔCoVAR	-1.359	-2.042	4.9684***
LnTA	9.99	8.718	3.3255***
EQTA	8.895	9.946	-0.8480
ROA	0.409	0.091	1.8779*
LOTA	59.051	60.719	-0.6162
LLP	0.448	0.774	-3.5504***
MTB	122.835	86.571	2.9690***

Table 7
Banks' systemic risk by country
This table presents the average of systemic risk contribution as measured by the ΔCoVaR in each country. ΔCoVAR is the mean of the weekley ΔCoVaRs defined as the difference between the VaR of the system when the institution is at the 1% percentile and the VaR of the system when the institution is at its median.

Country	ΔCoVAR
Austria	-0.8391
Belgium	-1.5734
Denmark	-1.1248
Finland	-1.2433
France	-1.0481
Germany	-1.3313
Greece	-4.3178
Ireland	-3.3337
Italy	-1.6278
Netherlands	-1.7788
Norway	-1.3216
Portugal	-1.2603
Spain	-1.7382
Sweden	-0.7567
Switzerland	-1.8710
United Kingdom	-1.6130

Table 8

Ownership concentration and banks' systemic risk

This table reports the estimation results of the model presented in Eq.(3) for the sample of 79 banks over the 2004-2016 period. The dependent variable is the ΔCoVaR defined as the mean of weekley ΔCoVaRs calculated as the difference between the VaR of the system when the institution is at the 1% percentile and the VaR of the system when the institution is at its median. Our variable of interest is the OwnershipConcentration defined as follow: (1) Concentration1 is the percentage of shares held by the largest controlling shareholder, (2) Concentration2 is the sum of ownership percentages held by all controlling shareholders of each bank, (3) d(Concentration1) is a dummy variable equal to one if the Concentration1 variable is more than its median; and zero otherwise, (4) d(Concentration2) is is a dummy variable equal to one if the Concentration2 variable is more than its median; and zero otherwise. The four models are performed on the sample of 79 banks of 528 observations. LnTA is the natural logarithm of total assets; LnTA2 is the squared term of LnTA; EQTA is the ratio of total equity to total assets; ROA is the ratio of net income to total assets; LOTA is the ratio of net loans to total assets; LLP the amount of loan loss provisions divided by net loans; MTB is the ratio of the market value of equity to the book value of equity; d(Bank)-d(Foundation) is a set of dummy variables representing the type of the largest controlling shareholder (Widely is the benchmark group); GDPGrowth is the real GDP (Gross Domestic Product) growth rate; Ln(Number of banks) is the natural logarithm of the number of banks in each country. Bank specification is a set of dummy variables to account for banks type (commercial banks, diversified or investment banking institutions). P-Values (reported in parentheses) are based on robust standard errors. ***,** and * indicate significance respectively at 1%, 5% and 10%.

	(1) Concentration1	(2) Concentration2	(3) d(Concentration1)	(4) d(Concentration2)
OwnershipConcentration	-0.0111**	-0.0106***	-0.3937**	-0.4740***
	(0.0199)	(0.0080)	(0.0401)	(0.0034)
LnTA	0.1947	0.1682	0.2434	0.2363
	(0.4819)	(0.5256)	(0.4310)	(0.4136)
LnTA2	-0.0098	-0.0084	-0.0117	-0.0114
	(0.5144)	(0.5599)	(0.4819)	(0.4666)
EQTA	0.0214**	0.0232**	0.0239**	0.0238**
	(0.0332)	(0.0171)	(0.0293)	(0.0219)
ROA	0.0006	-0.0010	-0.0061	-0.0074
	(0.9835)	(0.9725)	(0.8431)	(0.8113)
LOTA	-0.0054	-0.0050	-0.0055	-0.0057
	(0.3781)	(0.4041)	(0.3833)	(0.3629)
LLP	-0.0979	-0.0986	-0.1048	-0.1022
	(0.4267)	(0.4248)	(0.3945)	(0.4076)
MTB	0.0009	0.0008	0.0009	0.0008
	(0.5152)	(0.5461)	(0.5233)	(0.5319)
d(Bank)	0.3568	0.3704	0.1661	0.2142
	(0.2244)	(0.1828)	(0.5469)	(0.4144)
d(Institutional)	0.4666	0.5310*	0.5439*	0.5718*
	(0.1315)	(0.0932)	(0.0990)	(0.0693)
d(Family)	0.1947	0.3232	0.1533	0.3869
	(0.5399)	(0.3478)	(0.6067)	(0.1306)
d(State)	0.6512	0.6142	0.3315	0.3951
	(0.1076)	(0.1046)	(0.3853)	(0.2885)
d(Industry)	0.1803	0.3090	0.1341	0.2491
	(0.4134)	(0.1948)	(0.5182)	(0.2603)
d(Foundation)	2.6854***	2.8024***	1.7258**	2.0697***
	(0.0020)	(0.0014)	(0.0144)	(0.0026)
GDPGrowth	0.0391	0.0392	0.0398	0.0398
	(0.2867)	(0.2868)	(0.2773)	(0.2781)
Ln(Number of banks)	-3.1236*	-3.3153**	-3.3089**	-3.1456*
	(0.0839)	(0.0316)	(0.0457)	(0.0561)
Intercept	13.3676	14.4141*	13.9523*	13.2243*
	(0.1304)	(0.0551)	(0.0828)	(0.0981)
Country dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Bank specification	Yes	Yes	Yes	Yes
Number of observations	528	528	528	528
Number of Banks	79	79	79	79
R-Square	0.4680	0.4714	0.4595	0.4649

Table 9

Ownership concentration and bank systemic risk: impact of the largest shareholder category

This table reports the estimation results of the model presented in Eq.(4) for the sample of 79 banks over the 2004-2016 period. The dependent variable is the ΔCoVaR of each bank defined as the mean of weekley ΔCoVaRs calculated as the difference between the VaR of the system when the institution is at the 1% percentile and the VaR of the system when the institution is at its median. OwnershipConcentration is defined as follow: (1) Concentration1 is the percentage of shares held by the largest controlling shareholder, (2) d(Concentration1) is a dummy variable equals to one if the Concentration1 variable is more than its median; and zero otherwise. LnTA is the natural logarithm of total assets; LnTA2 is the squared term of LnTA; EQTA is the ratio of total equity to total assets; ROA is the ratio of net income to total assets; LOTA is the ratio of net loans to total assets; LLP is the amount of loan loss provisions divided by net loans; MTB is the ratio of the market value of equity to the book value of equity; d(Bank)-d(Foundation) is a set of dummy variables representing the type of the largest controlling shareholder (Widely is the benchmark group); GDPGrowth is the real GDP (Gross Domestic Product) growth rate; Ln(Number of banks) is the natural logarithm of the acrive and inactive banks in each country. Bank specification is a dummy variable to control the banks type (commercial, diversified, investment, mortgage, regional). P-Values based on robust standard errors are reported in parentheses. ***, ** and * indicate significance respectively at 1%, 5% and 10%.

	(1) Concentration1	(2) d(Concentration1)
OwnershipConcentration	0.0196***	2.2000***
	(0.0046)	(0.0045)
OwnershipConcentration *d(Bank)	-0.0335***	-3.1875***
	(0.0022)	(0.0006)
OwnershipConcentration *d(Institutional)	-0.0875***	-3.8437***
	(0.0041)	(0.0001)
OwnershipConcentration *d(Family)	0.0163	-2.2122***
	(0.7618)	(0.0022)
OwnershipConcentration *d(State)	-0.0398***	-2.2741***
	(0.0005)	(0.0051)
OwnershipConcentration *d(Industry)	-0.0166	-2.2432***
	(0.1282)	(0.0098)
LnTA	0.2311	0.3284
	(0.4348)	(0.2684)
LnTA2	-0.0135	-0.0183
	(0.4010)	(0.2588)
EQTA	0.0184	0.0236**
	(0.1136)	(0.0319)
ROA	-0.0033	-0.0024
	(0.9118)	(0.9363)
LOTA	-0.0079	-0.0086
	(0.2541)	(0.1933)
LLP	-0.1101	-0.1008
	(0.3702)	(0.4075)
MTB	0.0010	0.0011
	(0.4539)	(0.4048)
GDPGrowth	0.0392	0.0396
	(0.2790)	(0.2747)
Ln(Number of banks)	-2.3557	-2.5259
	(0.1597)	(0.1071)
Intercept	9.7994	10.1355
	(0.2296)	(0.1849)
Ownership type	Yes	Yes
Country dummies	Yes	Yes
Year dummies	Yes	Yes
Bank specification	Yes	Yes
Number of observations	528	528
Number of banks	79	79
R-Square	0.4844	0.4931
Wald tests: Bank	-0.0139**	-0.9875***
	(0.0348)	(0.0079)
Institutional	-0.0679**	-1.6436***
	(0.0144)	(0.0008)
Family	0.0359	-0.0122
	(0.5148)	(0.9869)
State	-0.0202**	-0.0740
	(0.0547)	(0.8292)
Industry	0.0030***	-0.0431
	(0.6779)	(0.8730)

Appendix A

Table A.1
Correlations table
This table shows the correlations among the explanatory variables used in the regressions. Concentration1 is the percentage of shares held by the largest controlling shareholder; Concentration2 is the sum of ownership percentages held by all controlling shareholders of each bank; LnTA is the natural logarithm of total assets; EQTA is the ratio of total equity to total assets; ROA is the ratio of net income to total assets; LOTA is the ratio of net loans to total assets; LLP is the amount of loan loss provisions divided by net loans; MTB is the ratio of the market value of equity to the book value of equity; GDPGrowth is the real GDP (Gross Domestic Product) growth rate; Ln(Number of banks) is the natural logarithm of the number of banks (with active and inactive trading status) in each country.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Concentration1 (1)	1									
Concentration2 (2)	0.9172	1								
LnTA (3)	-0.0706	-0.1054	1							
EQTA (4)	0.0157	0.0885	-0.4624	1						
ROA (5)	-0.001	-0.0187	-0.0001	-0.0321	1					
LOTA (6)	-0.0616	-0.0949	-0.2143	-0.3076	0.0117	1				
LLP (7)	-0.004	-0.0018	-0.1303	0.0195	-0.4562	0.2226	1			
MTB (8)	0.1798	0.1536	-0.077	0.0498	0.1554	-0.2298	-0.2046	1		
GDPGrowth (9)	0.0604	0.0382	0.0575	-0.026	0.1517	0.0268	-0.3166	0.2225	1	
Ln(Number of banks)	-0.0698	-0.167	0.0082	0.2435	-0.103	-0.3807	-0.072	0.2047	0.0063	1