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BANK COMPETITION AND RISK-TAKING IN THE EUROPEAN UNION: EVIDENCE OF A NON-LINEAR RELATIONSHIP

ABSTRACT: *This paper assesses the impact of bank specialisation and business models on the relationship between competition and risk. We tested the non-linear relationship between bank competition and risk on an extensive sample of 5,119 European banks active during 2000–2018, using system GMM. The results confirmed the nonlinear relationship between competition and risk-taking. Cooperatives are better protected against liquidity risks and are more stable. Well-diversified banking entities take more risks than their counterparts, whereas larger institutions have a lower risk appetite and a higher exposure to liquidity shocks. Future regulations should consider different risk strategies to make them more efficient and to generate the expected outcomes. The most recent regulatory developments have reduced the risk appetite of large financial institutions. Lastly, it is critical that regulators monitor M&A activity and ensure the optimal competition level.*

KEY WORDS: *banking competition; bank stability; risk management; financial policy; business model*

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1. INTRODUCTION

The most recent financial crisis led to stricter regulation of European banking. Banks had to comply with additional capital and liquidity requirements and these changes implied new costs for the financial institutions (FIs) that translated mainly into lower overall profitability. This left banks with the choice of either adjusting their operations or exiting the market. Top management are increasingly aware of their responsibility and legal liability and know that competent and prudent governance convinces regulators to refrain from imposing additional constraints on entrepreneurial activity. The increasing number of mergers and acquisitions (M&A) in response to the cost burdens caused by new regulations, the need to bail-out banks, low levels of profitability or excess of capacity meant that bank competition dropped after 2008. At the same time, the measures introduced by supervisory authorities should have diminished the risk appetite of FIs.

However, prior to 2008, European regulators encouraged financial institutions to compete more and deliver high quality products and services to their clients. At the same time, permanent efforts were made to integrate banking systems and create one single market for financial activities.

Bank risk-taking and its determinants has been widely discussed recently. Two main issues have been extensively investigated in the empirical literature. The first concerns the link between competition and bank risk-taking. However, as suggested by the meta-analysis of Zigraiova & Havranek (2016), results are relatively mixed and do not give a clear-cut answer as to how bank competition affects bank risk-taking and thus financial stability. While some papers find that bank competition is not beneficial to overall financial stability (see, e.g., Marcus, 1984; Chan et al., 1986; Keeley, 1990; Hellmann et al., 2000; Matutes & Vives, 2000; Allen & Gale, 2004 and Wagner, 2010), other researchers reach opposite results (see, e.g., Boyd & De Nicoló, 2005). In line with the theoretical predictions of Martinez-Miera & Repullo (2010), some recent empirical studies suggest that this relationship can be non-linear.

The second important issue investigated in the banking literature concerns the link between business model, ownership structures, and bank risk-taking. Indeed, standard property rights (Alchian & Demsetz, 1972) and agency (Jensen &

Meckling, 1976) theories suggest that the form of ownership is a key determinant of firms' risk-taking. In addition, papers like Hesse & Cihák (2007), Ayadi et al. (2010), Martinez-Miera & Repullo (2010), Presbitero & Zazzaro (2011), Liu et al. (2013), and Fiordelisi & Mare (2014) have shown that banking markets with a higher share of cooperative unions are less exposed to financial distress when the level of competition rises. Moreover, the benefits of income diversification depend on the size of the financial institution. For instance, Köhler (2015) finds that cooperative banks enjoy diversification benefits the most, as through their investment in non-interest activities they have lower risk exposure.

Against this background, our paper contributes to the existing literature by testing competition–risk nexus conditioned by the business model (i.e., structure of assets, funds, and revenues) and bank specialisation (i.e., commercial, cooperative, savings) to check whether financial institutions respond differently to competition according to how they operate and organise their activities.

To the best of our knowledge, no study exists in the literature that deals with this topic. A lot of research (e.g., Hesse & Cihák 2007; Altunbas et al. 2012; Fiordelisi & Mare 2014; Chiaramonte et al. 2015; Köhler 2015; Clark et al. 2018) only investigates the impact of business models on risk appetite or the influence of certain forms of bank specialisation on financial stability. The bulk of the literature primarily deals with the competition–stability controversy in commercial banking (Berger et al., 2009; Beck et al., 2013; Lapteacru, 2017), and only a few papers consider cooperatives (Clark et al., 2018). Moreover, we investigate the possible nonlinear relationship using the U-test. Lastly, the extended sample and timeframe allow for investigation of various macroeconomic and financial conditions, such as boom, financial crisis, and recession.

The remainder of the study is structured as follows. Section 2 briefly reviews the existing literature. In Section 3 we present the data used and methodology applied. The results are reported and discussed in Section 4, along with several robustness checks. Section 5 concludes.

2. LITERATURE REVIEW

The impact of bank competition on financial stability remains a topic of interest for researchers, policymakers, and regulatory authorities. Several theoretical and empirical studies find that competition is beneficial for overall financial stability (Boyd & De Nicoló, 2005; Schaeck et al., 2009), whereas earlier literature claims the opposite (Allen & Gale, 2004; Keeley, 1990). Martinez-Miera & Repullo (2010) reconcile these conflicting views and identify a risk-shifting effect that enhances stability due to lower default rates on loans as a result of decreasing interest rates, and a margin effect that reduces buffers against loan losses and promotes instability. The two competing forces result in a U-shaped relationship between competition and stability.

2.1. Competition–fragility

Fiercer bank competition generates higher financial instability and more fragile entities as FIs take up riskier projects with substantial and quick profits. These strategies expose financial institutions to higher risks and may lead to bankruptcy.

In deposit markets, increasing competition results in riskier bank decisions as franchise value declines (Marcus, 1984). Similarly, loan quality decreases with growth in the number of banks (Broecker, 1990) because more competition means lower informational advantage and higher risk exposure (Bofondi and Gobbi, 2004), while market power lessens bank default profitability (Jiménez et al., 2006). US financial liberalisation stimulates risk-taking and reduces charter value and total profits (Keeley, 1990; Edwards & Mishkin, 1995; Hellmann et al., 2000). The strongest US institutions should be solvent and hold risky assets (Demsetz et al., 1997). Boyd & De Nicolo (2005) argue that market concentration positively impacts banking fragility.

The concentration in the EU25 banking market has a significant negative effect on financial soundness, primarily due to the higher returns volatility of large FIs in concentrated markets. Moreover, East European banks are exposed to lower competition, have fewer diversification options, and a greater proportion belong to the government, and therefore they are considered more fragile (Uhde & Heimeshoff, 2009).

2.2. Competition–stability

The probability of default increases in a more concentrated banking sector, since the bankruptcy of a big FI creates systemic risk and higher loan interest rates generate credit risk due to moral hazard, adverse selection, and a higher non-performing-loans ratio (Stiglitz and Weiss, 1981; De Nicoló et al., 2006). In addition, market concentration decreases loan rationalisation, higher credits, and the probability of default (Caminal & Matutes, 2002), while fiercer competition does not boost risk in South-Eastern Asia (Liu et al., 2013).

Regarding European banks, more concentrated banking sectors reduce financial stability (Uhde & Heimeshoff, 2009). Competition significantly improves stability via the efficiency channel and lowers the systemic risk, measured by the aggregated value of non-performing loans. Fiercer competition improves overall bank capital and profitability, except in the case of fragile financial institutions (Schaeck & Cihák, 2014). No clear positive relationship between regulatory framework and competition level has been revealed in CEE countries. Once credit risk is taken into account, enhanced banking regulations and entry requirements have a negative effect on market power (Agoraki et al., 2011).

2.3. Competition–fragility and competition–stability

In their research on a 1999–2005 sample of 23 European and Middle Eastern states, Berger et al. (2009) claim that competition–stability and competition–fragility coexist: higher competition generates increasing non-performing loan (NPL) rates, whereas higher market power decreases insolvency risks.

2.4. Business model and bank specialisation

Several papers analyse the impact of bank type or ownership on risk-taking behaviour and competition–risk nexus.

Cooperative banks are, on average, more stable due to the ease of access to information on clients' creditworthiness, their lower returns' volatility (implicit lower profitability), and the mutual support mechanism that characterises their business model. However, cooperative banks are less likely to be bailed out in case of default since they are small and their default does not lead to panic in financial markets. When cooperative banks have a larger market share, commercial banks become less stable since they have less access to the retail market and so finance

their activities using less stable revenues (Hesse & Cihak, 2007; Groeneveld & de Vries, 2009; Liu et al., 2013). Another study confirms that the more diversified banks are the more stable they are, especially in the case of savings and cooperative banks in EU15 countries (Köhler, 2015).

Iannota et al. (2007) identify different financial intermediation models in 15 European countries based on asset and funding structure. According to them, mutual banks have better loan quality and are less exposed to asset risk than public and private banks. In line with this, García-Marco & Robles-Fernández (2008) show that Spanish commercial banks adopt riskier strategies than savings banks. Cooperative and savings banks are more stable than their private counterparts in Germany due to consumer surplus maximisation, diverse shareholdings, a focus on capital endowment protection, and lower profit volatility (Beck et al., 2009).

Fiordelisi & Mare (2014) go a step further and find a positive relationship between competition and stability, meaning that cooperative banks are riskier in less competitive environments in Western Europe. Therefore, the competition–stability hypothesis holds in both the short and long run. Likewise, Clark et al. (2018) conclude that competition between cooperative banks in Western Europe reduces individual stability, though the relationship is hump-shaped because of market power in the loans market.

Several researchers have carried out in-depth analyses of financial reports to investigate further the link between specialisation, diversification, and risk-taking appetite. Non-interest-generating activities belong to two categories: trading activities and commission and fee activities. As fee-based activities in European countries are riskier than trading activities, non-traditional activities contribute to a more fragile banking system (Lepetit et al., 2008). On the other hand, high interest margins and loan-to-asset ratios stimulate the stability of the EU15 banking sector (Jonghe et al., 2010).

More recently, papers have emerged on the evolution of risk prior to and after the financial crisis according to business model and bank specialisation. Lower diversification of income sources prior to the financial crisis partly explains the ex-post distress of European and American listed banks (Altunbas et al., 2011). The business model is a major source of risk during and after global crises, except

for in Europe (Prabha & Wihlborg, 2014). Similarly, cooperative banks in 26 OECD countries had a more stable business model during the global financial crisis due to their steadier returns. Prior to the crisis these institutions did not significantly impact stability since most banking entities were stable. During times of financial turmoil, having a higher share of cooperatives contributes to the stability of the financial sector (Chiaramonte et al., 2015). Retail-oriented business models are the most resilient and are less exposed to financial distress (Chaffai & Dietsch, 2015; Mergaerts & Vennet, 2016). The resilience to risk also depends on internal governance (Martín-Olivera et al., 2017).

Overall, no available research explicitly assesses the potential reaction of financial institutions to competitive pressures while considering their business model. Thus, our study advances the literature by considering the impact of the type of bank, diversification, and asset and fund structure on financial stability. All these elements are of interest in designing effective competitive and prudential regulation at the European level.

3. METHODOLOGY AND DATA

3.1. Sample

Using financial data provided by FitchConnect, we estimate the competition and risk measures for commercial, cooperative, savings, mortgage, investment, and private banks in the 28 member states of the European Union in 2000–2018.

Several steps were taken to ensure the high quality and relevance of the data. First, we included in our sample only banks with financial statements available for the last three years and positive values for inputs and outputs. We chose a minimum period of three years, since this is the time window used to estimate the Z-score. In addition, we selected FIs with unconsolidated reports, as these statements do not include any reference to business carried out abroad through subsidiaries. On top of this, all the banks were checked to see if they had been involved in an M&A process, and only the merged entity or the acquiring bank remained in the sample.

3.2. Empirical Strategy

We assess the competition–risk nexus using the following model:

$$Risk_{ij,t} = \beta_0 + \beta_1 \cdot Risk_{ij,t-1} + \beta_2 \cdot Competition_{ij} + \beta_3 \cdot Competition_{ij}^2 + \Theta \cdot Bank\,controls_{ij} + \Phi \cdot Macro\,controls_j + Crisis_t + \varepsilon_{ij,t} \quad (1)$$

where *i, j,* and *t* are the bank, country, and time dimensions respectively.

The dependent variable, bank risk, is estimated using a Z-score with a three-year window for ROAA mean and standard deviation (Yeyati & Micco, 2007; Beck et al., 2013; Liu et al., 2013):

$$Z_{it} = \frac{\frac{E_{it}}{A_{it}} + \mu_{ROAA_{it}}}{\sigma_{ROAA_{it}}} \quad (2)$$

where $\frac{E_{it}}{A_{it}}$ = equity to total assets ratio;

$\mu_{ROAA_{it}}$ = mean and standard deviation of $ROAA_{it}$.

We take the natural logarithm of (1+ Z-score), as suggested by Demirgüç-Kunt et al. (2008), Laeven & Levine (2009), and Houston et al. (2010), to lessen the impact of higher values for the Z-score and to enable the estimation of risk measure even when this is negative.

The regressor is competition, measured at the bank level, primarily by the adjusted Lerner index (Fernández de Guevara et al., 2007; Carbó et al., 2009; Weill, 2013; Lapteacru, 2017; Leroy & Lucotte, 2017): since the Lerner index suffers from several flaws and must be altered for efficiency, banks may not be efficient in terms of costs and profits (Koetter et al., 2012):

$$adjusted\ Lerner_i = \frac{\pi_i + tc_i - mc_i \cdot q_i}{\pi_i + tc_i} \quad (3)$$

with the bank profit being π_i, total cost tc_i, marginal cost mc_i and total output q_i.

The adjusted Lerner index ranges between zero and one, higher values showing stronger market power and lower competition. Financial institutions use labour, fixed assets, and customer deposits to finance total assets. We regress the following translog cost function by means of a panel data model with year fixed effects, using the Distribution Free Approach (DFA), along with cost and profit frontier. To obtain the marginal costs, we assume that each bank competes locally and specify the cost function for each country.

$$lnTC = \alpha_0 + \sum_{i=1}^{2}\alpha_1 lnQ_i + \frac{1}{2}\sum_{i=1}^{2}\alpha_1 ln(Q_i)^2 + \frac{1}{2}\sum_{i\neq j}^{2}\alpha_{i,j} lnQ_i lnQ_j + \sum_{i=1}^{2}\sum_{i=1}^{2}\delta_{i,k}\,(lnQ_i lnP_k)$$

$$+\sum_{i=1}^{3}\beta_k lnP_k + \frac{1}{2}\sum_{k=1}^{3}\sum_{m=1}^{3}\beta_{k,m}\,(lnP_k lnP_m) + \theta_1 \ln T + \frac{1}{2}\ln(T)^2 + \vartheta z, \qquad (4)$$

where TC = LKOST + KCOST + FCOST;

$Q_{i,j}$ = the value of the output variable (total assets);

$P_{k,m}$ = three input prices (price of labour, measured as personnel expenditures/total assets; price of other inputs, measured as other operating expenses/total assets; price of funding, measured as total interest expenses/interest-bearing liabilities);

T = time trend;

z = total equity.

We include two alternative measures as robustness checks, the Boone indicator, computed for each bank, and liquidity risk (i.e., the share of liquid assets in deposits and short-term funding). Clerides et al. (2015) estimate the Boone (2008) index for each FI using the equation below:

$$profit\ elasticity_i = \frac{q_i \cdot mc_i}{q_i \cdot mc_i - tc_i\left(1 - adjusted\ Lerner_i\right)} \qquad (5)$$

where q_i refers to bank output (i.e., total assets), mc_i represents the marginal cost, tc_i the total costs, and $adjusted\ Lerner_i$ is the index previously estimated.

The latter risk index is relevant and adds value to our research, since the most recent financial crisis has proven the importance of bank liquidity.

Following Berger et al. (2009), Martinez-Miera & Repullo (2010), Liu et al. (2013), and Clark et al. (2018), we introduce the squared term of competition to account for the U-shaped relationship and test it using the U-test. We employ several bank-level control variables commonly used in the literature (*Bank controls*$_{ij,t-1}$) to account for disparities in bank characteristics (Liu et al., 2013; Clark et al., 2018): (1) size as the logarithm of total assets, (2) diversification expressed by total non-interest operating income to gross revenues, and (3) efficiency measured by the cost-to-income ratio. *Macro controls*$_{j,t-1}$ include factors like GDP growth (%) and inflation (CPI) to control for heterogeneity across banking systems and macroeconomic conditions. The model also includes a dummy that accounts for the 2008–2010 crisis (Crisis$_t$). $\varepsilon_{ij,t}$ represents the error term. Table 1 in the Appendix shows the definition of all the variables previously mentioned, while Table 3 in the Appendix reflects important differences in the economic development and behaviour displayed by the analysed banks in time.

In the second specification we interacted the competition measure with the variables for bank specialisation and the business model, which shows the structure and diversification of assets and funding.

Given the potential endogeneity problems between bank competition and risk, we follow Beck et al. (2013) and Chiaramonte et al. (2015) and estimate the model with system GMM. Dependent variables are instrumented using lags 2–4, while the other variables are instrumented by themselves.

4. RESULTS

The results of the inverse U-test confirm the presence of a strong and significant inverse U-shaped relationship between competition and risk-taking (Table 4 in the Appendix). The turning point of 0.51 shows that beyond this value, market power enhances financial fragility. These outcomes support the paradigm proposed by Martinez-Miera & Repullo (2010). The risk-shifting effect dominates in concentrated markets, with high values for the adjusted Lerner index. By contrast, when banks compete more fiercely the margin effect prevails, lowering loan repayments and reducing the buffer that covers potential loan losses. The

business cycle and the size of the FIs encourage bank stability, as expected. When economic conditions are good, banks loosen their lending requirements, whereas worse outlooks lead them to take more cautious risk strategies. At the same time, larger financial entities profit from economies of scale and market power (Saunders et al., 1990; Boyd & Runkle, 1993; Laeven & Levine, 2009; Demirgüç-Kunt & Huizinga, 2010; Brown & Dinç, 2011; Fu et al., 2014). Inflation, efficiency, and diversification contribute to making the financial system less stable. Banks are riskier and have a higher probability of default when they increase the share of non-interest income (Demsetz & Strahan, 1997; Stiroh, 2004; Laeven & Levine, 2009; Demirgüç-Kunt & Huizinga, 2010; Liu & Wilson, 2013; Liu et al., 2013). A high inflation rate translates into information asymmetry, price volatility, and a reduced ability to make the right decisions (Demirguc-Kunt & Detragiache, 1998; Lown & Morgan, 2006; Buch et al., 2014). Inefficient banks are riskier than their counterparts since they try to compensate for their low efficiency level by having more relaxed lending requirements and less restrictive credit monitoring (De Nicoló & Jalal, 2006; Agoraki et al., 2011).

Table 5 in the Appendix reports the results of the regression, taking into account the impact of bank specialisation on the competition–risk nexus. The outcomes of the Lind & Mehlum (2010) test reflect the strong and significant inverse U-shaped nexus. Cooperatives are risk-adverse, whereas for their counterparts that display the same behaviour it is not statistically significant (Hesse & Cihák et al., 2007; Groeneveld & de Vries, 2009; Beck et al., 2013; Liu et al., 2013; Liu & Wilson, 2013).

Given the influence of the business model on the relationship between competition and risk, well-diversified banks tend to face financial distress, while a solid funding structure guarantees that a financial institution is more stable (Table 6). These outcomes are similar to those of DeYoung & Roland (2001), Stiroh (2004), Acharya et al., (2006), Stiroh & Rumble (2006), and Demirgüç-Kunt & Huizinga (2010). Bank lending behaviour stimulates overall stability, since the financial institutions included in the sample constantly invest in soft information and monitor relationships with their clients to reduce the default risk (Liu et al., 2013). Whenever banks are exposed to increasing competition, assets and funding structures and diversification have a negative effect. This impact remains significant only for diversification.

All the results noted previously are complemented by robustness checks performed using alternative measures of the Boone indicator for competition and liquidity risk for risk. Competition stimulates bank stability and the non-linear relationship is confirmed in all the additional scenarios, including the Boone indicator (Table 7 in the Appendix). Commercial and cooperative banks appear to harm the stability of the banking sector, whereas savings banks are more solid. When the level of competition is on the rise, commercial banks and cooperatives apply riskier strategies to preserve their profitability and market position (Table 8 in the Appendix). Lending patterns and funding structure decrease the banks' risk exposure, while portfolio diversification contributes to a more fragile banking sector. The same results occur when there is greater competition (Table 9 in the Appendix). Based on the results of the U-test, Table 10 in the Appendix shows the quadratic relationship between bank competition and liquidity risk. Cooperative banks encounter the least exposure to liquidity risk, with fiercer competition having a negative impact (Table 11 in the Appendix). Diversification strategies and the funding structure expose financial institutions to additional challenges for their liquidity levels. However, if banks are exposed to greater competition, having a larger share of loans ensures safety (Table 12 in the Appendix).

5. CONCLUSIONS

In this study we investigate the impact of bank specialisation and business models on the competition–risk relationship using a sample of 5,119 commercial, cooperative, savings, mortgage, investment, and private banks from EU28 countries in 2000–2018. The current research finds evidence of a robust non-linear relationship between bank competition and risk, taking into account different variables like the adjusted Lerner index, the Boone indicator, the Z-score, and liquidity risk, and controlling for bank-specific and country-specific factors.

We analyse business models by considering loan share, diversification, and funding structure. Several outcomes are of interest to policymakers. First, depending on their type, financial institutions follow different risk strategies: well-diversified entities take more risks than their counterparts. Size does not harm overall financial stability, suggesting that the most recent regulatory developments have reduced the risk appetite of large financial institutions. Lastly,

above a certain threshold a low level of competition enhances individual risk-taking behaviour and is detrimental to the stability of the banking sector. Therefore, it is critical that regulators monitor M&A activity and ensure the optimal level of competition. In the same vein, the designers of future regulations should consider these evidence in order to support the financial stability.

Further studies on this topic may consider alternative measures of liquidity risk along with indicators for interest rate and credit risk.

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APPENDICES

Table 1: Description of variables

Variable	Definition	Source
Dependent variables (bank level)		
Z-score	Measure of bank soundness that shows the capacity of the financial institutions to absorb losses.	Own calculation [a]
Liquidity risk	Liquid assets to deposits and short-term funding.	Own calculation [a]
Main regressors (bank level)		
Adjusted Lerner index	Scores for market power at bank-level adjusted for cost and profit inefficiency. The variable ranges between 0 and 1. The higher the value is, the lower the competition.	Own calculation [a]
Boone indicator	Scores for the profit efficiency of market power. The more negative the value is, the fiercer the competition.	Own calculation [a]
Bank controls (bank level)		
Size	Log of bank total assets.	Own calculation [a]
Diversification	Total non-interest operating income to gross revenues.	Own calculation [a]
Efficiency	Cost to income ratio.	FitchConnect
Specialisation	Variable successively equal to dummies for commercial, cooperative, and savings banks.	FitchConnect
Business Model	Variable that alternatively refers to asset structure (the share of total loans in total assets), diversification, and funding structure.	Own calculation [a]
Macro controls (country level)		
GDP growth	Annual percentage growth rate of GDP at market prices based on constant local currency. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.	World Development Indicators
Inflation	Inflation measured by the consumer price index, reflecting the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals.	World Development Indicators
Crisis dummy	Dummy variable that takes the value 1 during the GFC (2008–2010) and 0 otherwise	Own calculation [a]

Note: [a] Based on FitchConnect data. Variables have annual frequency.

Table 2: Distribution of banks

Country	Total number of banks
Austria	551
Belgium	67
Bulgaria	25
Croatia	41
Cyprus	25
Czech Republic	36
Denmark	123
Estonia	13
Finland	59
France	344
Germany	1,796
Greece	14
Hungary	166
Ireland	29
Italy	735
Latvia	18
Lithuania	12
Luxembourg	116
Malta	19
Netherlands	42
Poland	175
Portugal	121
Romania	33
Slovakia	21
Slovenia	20
Spain	187
Sweden	117
United Kingdom	214
Total	**5,119**

Table 3: Descriptive statistics

Variable name	Observations	Mean	Standard deviation	p25	p50	p75	Min	Max
Dependent variables								
Z-score	42,146	5.73	3.52	4.58	5.48	6.54	0.00	42.73
Liquidity risk	55,053	0.26	0.31	0.09	0.16	0.30	0.01	2.19
Independent variables								
Competition								
Adjusted Lerner	54,306	0.35	0.15	0.27	0.35	0.43	–0.22	0.80
Boone	54,306	–0.07	0.05	0.07	0.08	0.15	–0.57	–0.02
Business models								
Loan share (asset structure)	54,953	0.58	0.21	0.49	0.61	0.72	0.00	8.95
Funding structure	55,079	0.81	0.17	0.80	0.87	0.90	0.00	5.92
Diversification	55,414	0.22	0.17	0.13	0.18	0.26	0.00	1.00
Specialisation								
Commercial bank	55,414	0.05	0.21	0.00	0.00	0.00	0.00	1.00
Cooperative bank	55,414	0.13	0.34	0.00	0.00	0.00	0.00	1.00
Savings bank	55,414	0.02	0.14	0.00	0.00	0.00	0.00	1.00
Bank controls								
Efficiency	55,411	0.80	4.90	0.60	0.69	0.76	0.00	658.00
Size	55,414	20.51	1.86	19.27	20.34	21.54	11.95	29.00
Macro controls								
GDP growth	55,414	1.45	2.31	0.58	1.70	2.82	–14.81	25.12
Inflation rate	55,414	1.66	1.48	0.99	1.55	2.08	–4.48	45.67
Crisis	55,414	0.16	0.37	0.00	0.00	1.00	0.00	1.00

Table 4: Bank competition and risk

Dependent variable	Z-score
Explanatory variable	(1)
Z-score (lag)	0.327**
	(0.071)
Adjusted Lerner	6.059**
	(0.598)
Adjusted Lerner squared	–5.986**
	(0.699)
Crisis	–0.345**
	(0.046)
GDP growth	–0.005
	(0.007)
Inflation	–0.053**
	(0.014)
Size	0.146**
	(0.016)
Diversification	–0.974**
	(0.133)
Efficiency	–0.019**
	(0.006)
Nr. of observations	36,199
Nr. of banks	4,301
	6.020
Inverse U-shape test	[0.000]
Turning point	0.506
95% CI, Fieller method	[0.472; 0.551]
AR(1)–(p-value)	0.000
AR(2)–(p-value)	0.199
Hansen j statistic (p-value)	0.197

Note: The table reports the estimation results of the following regression $Risk_{ij,t} = \beta_0 + \beta_1 \times Risk_{ij,t-1} + \beta_2 \times Competition_{ij} + \beta_3 \times Competition_{ij}^2 + \Theta \times Bank\ controls_{ij} + \Phi \times Macro\ controls_j + Crisis_t + \varepsilon_{ij,t}$. Estimations are run using system GMM. The U-shape test is based on Lind & Mehlum (2010), with the p-value of the test statistic reported between square brackets. The Hansen test assesses the joint validity of the instruments used. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 5: Bank competition, risk, and specialisation

Dependent variable	Z-score	Z-score	Z-score
Explanatory variable	(2)	(3)	(4)
Z-score (lag)	0.328**	0.329**	0.327**
	(0.071)	(0.071)	(0.071)
Adjusted Lerner	6.070**	6.507**	6.083**
	(0.597)	(0.661)	(0.599)
Adjusted Lerner squared	–5.880**	–6.304**	–5.999**
	(0.690)	(0.745)	(0.697)
Crisis	–0.347**	–0.327**	–0.345**
	(0.046)	(0.046)	(0.046)
GDP growth	–0.005	0.000	–0.005
	(0.007)	(0.007)	(0.007)
Inflation	–0.047**	–0.052**	–0.052**
	(0.013)	(0.014)	(0.014)
Size	0.145**	0.139**	0.146**
	(0.016)	(0.015)	(0.016)
Diversification	–0.911**	–1.031**	–0.983**
	–0.13	–0.136	–0.134
Efficiency	–0.018**	–0.019**	–0.019**
	(0.006)	(0.006)	(0.006)
Commercial bank	0.127		
	(0.111)		
Adjusted Lerner *Commercial bank	–2.207**		
	(0.345)		
Cooperative bank		0.603**	
		(0.113)	
Adjusted Lerner * Cooperative bank		–1.455**	
		(0.449)	
Savings bank			0.246
			(0.160)
Adjusted Lerner *Savings bank			–0.261
			(0.487)
Nr. of observations	36,199	36,199	36,199
Nr. of banks	4,301	4,301	4,301
	5.780	5.960	6.030
Inverse U-shape test	[0.000]	[0.000]	[0.000]
Turning point	0.517	0.516	0.507
95% CI, Fieller method	[0.480; 0.565]	[0.482; 0.561]	[0.473; 0.552]
AR(1)–(p-value)	0.000	0.000	0.000
AR(2)–(p-value)	0.200	0.201	0.199
Hansen j statistic (p-value)	0.209	0.200	0.197

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 6: Bank competition, risk and business model

Dependent variable	Z-score	Z-score	Z-score
Explanatory variable	(5)	(6)	(7)
Z-score (lag)	0.324**	0.327**	0.335**
	(0.071)	(0.071)	(0.070)
Adjusted Lerner	7.549**	7.132**	4.556**
	(0.852)	(0.682)	(0.685)
Adjusted Lerner squared	–6.059**	–5.428**	–3.757**
	(0.701)	(0.670)	(0.530)
Crisis	–0.357**	–0.323**	–0.331**
	(0.047)	(0.046)	(0.045)
GDP growth	–0.002	–0.008	–0.015*
	(0.007)	(0.007)	(0.007)
Inflation	–0.059**	–0.045**	–0.061**
	–0.014	–0.014	–0.014
Size	0.115**	0.122**	0.084**
	(0.014)	(0.014)	(0.012)
Diversification	–1.016**	1.195**	–0.859**
	(0.146)	(0.224)	(0.128)
Efficiency	–0.027**	–0.022**	–0.025**
	(0.007)	(0.006)	(0.008)
Loan share	1.161**		
	(0.292)		
Adjusted Lerner *Loan share	–2.512**		
	(0.748)		
Adjusted Lerner *Diversification		–5.681**	
		(0.656)	
Funding structure			1.939**
			(0.280)
Adjusted Lerner * Funding structure			–0.459
			(0.566)
Nr. of observations	36,056	36,199	36,084
Nr. of banks	4,267	4,301	4,281
Inverse U-shape test	3.390	2.670	2.820
	[0.000]	[0.004]	[0.002]
Turning point	0.623	0.657	0.606
95% CI, Fieller method	[0.546; 0.712]	[0.589; 0.750]	[0.499; 0.720]
AR(1)–(p-value)	0.000	0.000	0.000
AR(2)–(p-value)	0.192	0.198	0.220
Hansen j statistic p-value	0.184	0.210	0.208

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 7: Bank competition and risk, Robustness checks with Boone indicator

Dependent variable	Z-score
Explanatory variable	(8)
Z-score (lag)	0.307**
	(0.071)
Boone	4.818**
	(1.192)
Boone squared	4.448*
	(2.291)
Crisis	–0.279**
	(0.045)
GDP growth	0.011
	(0.007)
Inflation	–0.028*
	(0.013)
Size	0.217**
	(0.022)
Diversification	–0.578**
	(0.129)
Efficiency	0.000
	(0.012)
Nr. of observations	36,271
Nr. of banks	4,285
U-shape test	0.150
	[0.439]
Turning point	–0.542
95% CI, Fieller method	[–Inf; +Inf]
AR(1)–(p-value)	0.000
AR(2)–(p-value)	0.121
Hansen j statistic (p-value)	0.228

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 8: Bank competition, risk and specialisation, Robustness checks with Boone indicator

Dependent variable	Z-score	Z-score	Z-score
Explanatory variable	(9)	(10)	(11)
Z-score (lag)	0.307**	0.306**	0.307**
	(0.071)	(0.071)	(0.071)
Boone	4.363**	4.917**	4.796**
	(1.180)	(1.199)	(1.205)
Boone squared	2.938	4.636*	4.395*
	(2.256)	(2.297)	(2.321)
Crisis	−0.287**	−0.280**	−0.279**
	(0.046)	(0.046)	(0.045)
GDP growth	0.012*	0.011	0.011
	(0.007)	(0.007)	(0.007)
Inflation	−0.028*	−0.028*	−0.028*
	(0.013)	(0.013)	(0.013)
Size	0.216** 0.217**		0.217**
	(0.022)	(0.022)	(0.022)
Diversification	−0.531**	−0.575**	−0.576**
	(0.127)	(0.129)	(0.130)
Efficiency	0.000	0.000	0.000
	(0.012)	(0.012)	(0.012)
Commercial bank	−0.990**		
	(0.131)		
Boone*Commercial bank	−3.739**		
	(0.841)		
Cooperative bank		−0.091	
		(0.163)	
Boone* Cooperative bank		−1.915	
		(3.758)	
Savings bank			0.002
			(0.377)
Boone*Savings bank			0.656
			(4.363)
Nr. of observations	36,271	36,271	36,271
Nr. of banks	4,285	4,285	4,285
U-shape test	–	0.230	0.130
		[0.410]	[0.449]
Turning point	−0.743	−0.530	−0.546
95% CI, Fieller method	[−Inf; +Inf]	[−10.271; −3.770]	[−Inf; +Inf]
AR(1)−(p-value)	0.000	0.000	0.000
AR(2)−(p-value)	0.121	0.121	0.121
Hansen j statistic (p-value)	0.221	0.225	0.228

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 9: Bank competition, risk, and business model; Robustness checks with Boone indicator

Dependent variable	Z-score	Z-score	Z-score
Explanatory variable	(12)	(13)	(14)
Z-score (lag)	0.310**	0.306**	0.325**
	(0.070)	(0.071)	(0.069)
Boone	3.502*	4.859**	–8.115**
	(1.410)	(1.206)	(1.618)
Boone squared	5.450*	3.994*	2.911
	(2.434)	(2.319)	(2.506)
Crisis	–0.265**	–0.280**	–0.269**
	(0.045)	(0.046)	(0.045)
GDP growth	0.013*	0.011	–0.005
	(0.007)	(0.007)	(0.006)
Inflation	–0.02	–0.028*	–0.036**
	(0.012)	(0.013)	(0.012)
Size	0.192**	0.217**	0.090**
	(0.019)	(0.022)	(0.011)
Diversification	–0.426**	–0.615**	–0.625**
	(0.135)	(0.177)	(0.124)
Efficiency	–0.001	0.001	–0.027**
	(0.012)	(0.012)	(0.007)
Loan share	0.835**		
	(0.198)		
Boone*Loan share	3.879**		
	(1.478)		
Boone*Diversification		–0.420	
		(0.941)	
Funding structure			3.292**
			(0.339)
Boone* Funding structure			18.215**
			(2.315)
Nr. of observations	36,142	36,271	36,173
Nr. of banks	4,255	4,285	4,273
U-shape test	1.60 [–0.055]	–	–
Turning point	–0.321	–0.608	1.394
95% CI, Fieller method	[–0.912; –0.812]	[–Inf; +Inf]	[–Inf; +Inf]
AR(1)–(p-value)	0.000	0.000	0.000
AR(2)–(p-value)	0.126	0.121	0.152
Hansen j statistic (p-value)	0.278	0.226	0.335

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 10: Bank competition and risk, Robustness checks with liquidity risk

Dependent variable	Liquidity risk
Explanatory variable	(15)
Liquidity risk (lag)	0.842**
	(0.042)
Lerner	–0.116**
	(0.030)
Adjusted Lerner squared	0.167**
	(0.045)
Crisis	0.000
	(0.002)
GDP growth	0.002**
	(0.000)
Inflation	0.004**
	(0.002)
Size	0.001**
	(0.000)
Diversification	0.104**
	(0.026)
Efficiency	–0.001
	(0.002)
Nr. of observations	47,932
Nr. of banks	4,891
U-shape test	3.510
	[0.000]
Turning point	0.348
95% CI, Fieller method	[0.312;0.397]
AR(1)–(p-value)	0.000
AR(2)–(p-value)	0.576
Hansen j statistic (p-value)	0.704

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 11: Bank competition, risk, and specialisation; Robustness checks with liquidity risk

Dependent variable	Liquidity risk	Liquidity risk	Liquidity risk
Explanatory variable	(16)	(17)	(18)
Liquidity risk (lag)	0.842**	0.839**	0.842**
	(0.042)	(0.043)	(0.042)
Adjusted Lerner	–0.114**	–0.133**	–0.117**
	(0.030)	(0.036)	(0.030)
Adjusted Lerner squared	0.166**	0.177**	0.168**
	(0.045)	(0.049)	(0.045)
Crisis	0.000	0.000	0.000
	(0.002)	(0.002)	(0.002)
GDP growth	0.002**	0.002**	0.002**
	(0.000)	(0.000)	(0.000)
Inflation	0.004**	0.004**	0.004**
	(0.001)	(0.002)	(0.001)
Size	0.001**	0.001**	0.001**
	(0.000)	(0.000)	(0.000)
Diversification	0.103**	0.108**	0.104**
	(0.026)	(0.027)	(0.026)
Efficiency	–0.001	0.000	–0.001
	(0.002)	(0.002)	(0.002)
Commercial bank	0.010		
	(0.010)		
Adjusted Lerner*Commercial bank	–0.009		
	(0.027)		
Cooperative bank		–0.029**	
		(0.008)	
Adjusted Lerner *Cooperative bank		0.067**	
		(0.023)	
Savings bank			0.000
			(0.010)
Adjusted Lerner*Savings bank			0.014
			(0.025)
Nr. of observations	47,932	47,932	47,932
Nr. of banks	4,891	4,891	4,891
U-shape test	3.550	3.370	3.520
	[0.000]	[0.000]	[0.000]
Turning point	0.345	0.374	0.347
95% CI, Fieller method	[0.307;0.394]	[0.337;0.431]	[0.312;0.399]
AR(1)–(p-value)	0.000	0.000	0.000
AR(2)–(p-value)	0.576	0.588	0.576
Hansen j statistic (p-value)	0.704	0.703	0.704

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 12. Bank competition, risk, and business model; Robustness checks with liquidity risk

Dependent variable	Liquidity risk	Liquidity risk	Liquidity risk
Explanatory variable	(19)	(20)	(21)
Liquidity risk (lag)	0.790**	0.843**	0.826**
	(0.050)	(0.042)	(0.045)
Adjusted Lerner	–0.004	–0.132**	0.292**
	(0.025)	(0.035)	(0.063)
Adjusted Lerner squared	0.139**	0.158**	0.073*
	(0.039)	(0.043)	(0.030)
Crisis	0.000	0.000	–0.002
	(0.002)	(0.002)	(0.002)
GDP growth	0.002**	0.002**	0.003**
	(0.000)	(0.000)	(0.000)
Inflation	0.005**	0.004**	0.003*
	(0.002)	(0.001)	(0.001)
Size	0.005**	0.001**	0.001
	(0.001)	(0.000)	(0.001)
Diversification	0.068**	0.069**	0.092**
	(0.018)	(0.025)	(0.024)
Efficiency	0.000	0.000	–0.001
	(0.002)	(0.002)	(0.002)
Loan share	–0.094**		
	(0.023)		
Adjusted Lerner *Loan share	–0.165**		
	(0.045)		
Adjusted Lerner *Diversification		0.091*	
		(0.054)	
Funding structure			0.007
			(0.017)
Adjusted Lerner* Funding structure			–0.426**
			(0.082)
Nr. of observations	47,755	47,932	47,891
Nr. of banks	4,853	4,891	4,886
U-shape test	1.850	3.12	
	[0.032]	[0.001]	–
Turning point	0.015	0.419	–1.988
95% CI, Fieller method	[–0.250;0.179]	[0.338;0.531]	[–9.632;–0.928]
AR(1)–(p-value)	0.000	0.000	0.000
AR(2)–(p-value)	0.502	0.582	0.621
Hansen j statistic (p-value)	0.782	0.702	0.771

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.