BANK LEVERAGE RATIOS, RISK AND COMPETITION – AN INVESTIGATION USING INDIVIDUAL BANK DATA

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Introduction

- Leverage ratios were widely ignored before the subprime crisis but were in fact shown to be warnings of risk for many banks, whose risk adjusted ratios were favourable. Excessively optimistic ratings given to structured products, and also to excessive optimism built into credit risk models underlay this pattern
- The leverage ratio in Basel III was accordingly introduced to complement the risk adjusted capital ratio (RAR). It can prevent excessive leverage building up both for individual institutions and for the system as a whole.
- In this paper, we undertake empirical research that sheds light on the leverage ratio as a regulatory tool. We assess its effectiveness relative to the risk adjusted capital ratio (RAR) and the corresponding risk adjusted Tier 1 ratio in predicting bank risk given competition for up to 8216 banks in Europe and 1270 in the US, using the Fitch-Connect database of banks' financial statements

- The Europe/US comparison is of particular interest given US banks have long been subject to a leverage ratio constraint, as well as risk adjusted measures, whereas for Europe leverage only came to the fore as a regulatory tool from roughly 2010 onwards.
- We bring together the empirical literatures on competition and risk and capital and risk that have been separate for the most part in the past.
- We consider our inclusion of competition as a control variable to be a major contribution that adds to the relevance of our study as most studies of capital and risk ignore competition as a control variable.
- Our results cast light inter alia on the relevance of the "skin in the game" versus the "regulatory hypothesis" in explaining the relation of capital to risk separately for the US and Europe, as well as indicating the importance of allowing for banking competition as an indicator for macro- and microprudential policies.

Literature review

- **<u>Theoretical work</u>**: Early interest of economists in bank leverage (Minsky 1982), Holmstrom and Tirole (1987), Diamond and Rajan (2000) but not in use in regulation.
- Kiema and Jokivuolle (2014), suggest leverage ratio should induce banks to hold similar diversified portfolios, which may increase the overall balance of risk in the banking sector, because of the greater effect of model risk. Barth et al (2018) suggest when a leverage ratio constraint binds, and capital is costly, then banks skilled in credit assessment may be unable to absorb the supply of deposits; instead, there will be new entry of less capable banks.
- Bruno et al (2014) show an optimal level of leverage exists which minimises financial fragility and which varies with the business cycle, (consistent with Adrian and Shin (2010)), so recommend an adjustable leverage ratio over the cycle. Dermine (2015) shows leverage ratios are helpful in preventing bank runs when there is imperfect information on the value of a bank's assets as it gives a floor under the RAR.

- Grill et al (2015)show a leverage ratio requirement incentivises banks bound by the constraint to slightly increase risk-taking, but this is more than outweighed by the increase in loss-absorbing capacity from higher capital, thus increasing bank stability.
- Pfeifer et al (2015) show constraining effect of the leverage ratio on exposures is diminished unless it rises in line with the RAR when the latter is increased for macroprudential purposes.
- **Empirical work:** Barrell et al (2009) looking at optimal capital show dynamics of bank capital buffers can affect lending and pricing of loans. Barrell et al (2010) indicates the aggregate leverage ratio is a key predictor of banking crises. Karim et al (2013) show the additional importance of Off Balance Sheet exposures.
- Davis and Karim, (2018) complementing an extensive literature, suggest bank competition has a clear link to risk that has been widely disregarded among policymakers (notably, a short term change in competition indicates higher risk taking although the long term effect varies with the indicator). This is one starting point for our work below.
- Schaeck and Cihak (2012) look at the inverse effect of competition on capital and find higher competition gives rise to higher capital ratios.

- Ondo-Ndong and Rigot (2011) test for the effectiveness of a global aggregated leverage ratio (including investment banks) and find it a helpful empirical indicator of overall financial stress.
- Yang (2016) looked at leverage and risk weighted capital as predictors in US bank failures, finding leverage was important for both large and small banks but that risk adjusted capital was not significant for large banks. Contrasts to Haldane and Madouros (2012) who found the RAR a superior failure predictor to the leverage ratio.
- Hambusch and Shaffer (2012) sought to forecast bank leverage as an alternative tool for assessing the likelihood of failure. Results support the use of leverage as an indicator for such likelihood.
- Brei and Gambacorta (2014) tested for procyclicality of capital ratios and found the leverage ratio is significantly more countercyclical than the RAR: it is a tighter constraint for banks in booms and a looser constraint in recessions.

- Diverse results of **empirical studies of the relation of capital and risk** – the other basis of our own work - justify differing hypotheses on the relation of capital to risk.
- According to **"skin in the game"**, it would be expected that a higher capital ratio would be consistent with lower risk as bank managers become prudent and wiser in their investment choices (Bitar et al 2018). Banks hold higher capital to resist earnings shocks and to be able to repay deposits as requested, so obliging banks to hold more capital via regulation improves screening and monitoring and reduces the risk of bailouts (Demirguc Kunt et al 2013).
- Such negative relations are found inter alia in Lee and Hseih (2013), Tan and Floros (2013) and Anginer and Demirguc Kunt (2014)
- A corollary of "skin in the game" is that a low capital ratio may give incentives to take risks and "gamble for resurrection" especially when there is generous and mispriced deposit insurance. It applies strongly to large banks that may consider themselves too big to fail.

- As a response, regulators may require banks to hold more capital to reduce moral hazard and ensure capital is commensurate with risks. Hence the **“regulatory hypothesis”** would suggest that regulators require higher capital in response to higher risk, and so a positive relation of capital to risk would be expected (Iannotta et al (2007), Bitar et al (2018)).
- Alternatively, such a positive relation could be explained by agency issues in banks with high capital, such that there may be an **“outsider equity effect”** with managers taking risks or being less active in screening at the expense of shareholders.
- A third possibility is a zero effect; **ineffectiveness of risk adjusted measures** may relate to untruthful assessment of bank real risk exposure.
- We comment that leverage ratios are intrinsically related to risk, since they show the overall debt/equity ratio of the bank; on the other hand, if risk adjustment is done properly, then risk adjusted measures will have a weaker relation to risk, depending on whether the authorities choose to enforce higher risk adjusted ratios for risky banks (or managers choose such higher ratios independently).

Methodology

- We have data on 8216 banks in the EU and 1270 in the US, over 1998-2016, using the Fitch-Connect database of banks’ financial statements
- We include universal commercial banks, retail and consumer banks and banks per se, but not investment banks or bank holding companies.

Competition estimation: H statistic and Lerner index

- **The H statistic** involves estimation of revenue function for each country. It can be argued to be a superior measure of the degree of competition because it is derived from profit maximising equilibrium conditions (Claessens and Laeven 2004).
- $LogR_{it} = \Sigma J_{(j=1)}\ \alpha_j Log\ w_{jit} + \Sigma N_{(n=1)} \gamma_n Log\ X_{nit} + \varepsilon_{it}$

- wit is a three-dimensional vector of factor prices the log of the ratio of interest expense to total debt funding, IED; the log of the ratio of personnel expenses to total assets, PTA; and the log of the ratio of other costs as a proportion of fixed assets, OCF.
- Then H = Σαj H = 1 perfect competition, H 0 to 1 imperfect competition, H below 0 monopoly
- X_{it} is a vector of exogenous and bank-specific variables that may shift the cost and revenue schedule (business mix). N = 4: the log of loans as a proportion of assets, (LAR), showing credit risk; the log of the ratio of other non-earning assets to total assets (OTA), reflecting asset composition; the log of customer deposits as a proportion of deposits plus money market liabilities (CDT), showing liquidity risk; and the log of equity to total assets (LEVERAGE), showing leverage and hence risk preferences.

- **The Lerner index** can be seen as proxy for current and future profits stemming from pricing power, and unlike H it varies that the level of the individual bank. To obtain it, we first estimate a translog cost function (appended), with the following input prices:
- W_{1it} is the ratio of interest expenses to the sum of total deposits and money market funding (IES); $W2_{it}$ is measured as personnel expenses divided by total assets (PTA); and W_{3it} is the ratio of other operating expenses to fixed assets (OCF). We have time fixed effects.
- The Lerner index for each bank–year is
- $Lerner_{it} = (P_{it} – MC_{it})/P_{it}$
- where P_{it} is the price of assets and is equal to the ratio of total revenue to total assets and MC_{it} is derived from the restricted translog cost function as described in the Appendix.

Risk estimation

- We choose four risk indicators as dependent variables
  - **The Z-Score** captures the distance from insolvency of a bank. Z-score compares the buffer of a bank (capitalization and returns) with the volatility of those returns. Hence Z-Score = (ROA+(Capital/Assets))/SD(ROA)). It captures the number of standard deviations by which returns would have to fall from the mean to wipe out all the equity of the bank. We log the Z score as the level is highly skewed, while the log is normally distributed.
  - **The Provisions/loans ratio** is a measure of loan quality, being an indicator of a precautionary reserves policy and also an anticipation of high non performing revenue. It takes the past and future performance of the loan portfolio into account.
  - **The NPL/loans ratio** is often used as a proxy for asset quality and may show problems with asset quality in the loan portfolio across the banking sector as a whole. Note however, that impaired loans are in some senses a lagging indicator of bank risk, as it rises when loans actually become delinquent.
  - **The growth rate of loans** as measured by the log-difference of loans. This measure aims to capture the risk that banks seeking to grow their loan books rapidly will take on poor quality loans in a form of adverse selection. In contrast to the impaired loan ratio it can be seen as an advance indicator of potential risk.

- **Control variables (capital)**
  - the leverage ratio of equity to assets,
  - the total regulatory capital/risk adjusted assets
  - the Tier 1 regulatory capital ratio (with equity only in the numerator)
- **Control variables (competition)**
  - H and LERNER are entered as a first difference, second and third lag to enable short and long run effects to be distinguished.
  - The first difference of LERNER is instrumented by first and second lags of itself to reduce simultaneity (since the margin is related to the return on assets that enters the Z-score).
- **Other control variables** similar to Beck et al (2013) and Davis and Karim (2018)
  - NONINTSH (share of noninterest income in the total)
  - CDT (ratio of customer deposits to total short term funding),
  - PII (provisions to net interest income ratio) except for provisions equation
  - LAR (loans as a proportion of assets)
  - log of total assets and its first difference.
- **Estimation:** We use panel OLS, estimated again using the within estimator and pooled FGLS, with year fixed effects and White's cross-sectional standard errors and covariance (corrected for degrees of freedom) as in Davis and Karim (2018). Other than competition, all variables are entered as 1-year lags to assess indicator properties and reduce the risk of simultaneity. Variables winsorised at 99% except H for Europe (95%)

Statistical properties of capital ratios and competition measures

	US			Europe		
	LEV	TOT	TIER	LEV	TOT	TIER
Mean	0.117	0.172	0.159	0.12	0.186	0.164
Median	0.0959	0.137	0.123	0.0797	0.162	0.140
Maximum	0.777	1.067	1.071	0.901	0.773	0.706
Minimum	0.0217	0.081	0.066	0.00619	0.0762	0.054
Std. Dev.	0.0958	0.128	0.13	0.147	0.101	0.0978
Observations	14704	13585	13487	86080	39431	30518

Notes, LEV is the leverage ratio, TOT is the total regulatory capital ratio risk adjusted, and Tier 1 is the corresponding Tier 1 ratio.

	US		Europe	
	H statistic	Lerner index	H statistic	Lerner index
Mean	-0.25	0.239	0.121	0.211
Median	-0.465	0.246	0.313	0.214
Maximum	0.758	0.551	1.47	0.567
Minimum	-1.188	-0.376	-2.169	-0.397
Std. Dev.	0.549	0.141	0.973	0.135
Observations	24130	13491	149354	72381

Equations for Z score/H statistic

Z SCORE	**US**		**Europe**	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic
C	3.47	9.1	3.5	17.6
DH_Q95 (Europe) Q99 (US)	0.052	0.4	0.0029	0.1
H99_ Q95 (-2) (Europe) Q99 (US)	-0.22	-1.6	0.088	3.6
H99_ Q95 (-3) (Europe) Q99 (US)	-0.12	-1.1	0.077	2.4
CDT_Q99(-1)	0.35	2.3	0.47	6.9
LAR_Q99(-1)	-0.35	-3.6	0.54	16.1
NIR_Q99(-1)	-0.38	-2.2	-0.98	-12.6
PII_Q99(-1)	-0.022	-13.4	-0.0083	-15.6
LOG(TOTALASSETS_Q99(-1))	0.022	1.3	0.0096	1.1
D(LOG(TOTALASSETS_Q99(-1)))	-0.13	-2.0	-0.23	-5.6
Periods included	16		16	
Cross-sections included	969		5782	
Observations	10742		53127	
R-squared	0.21		0.169	
Adjusted R-squared	0.209		0.169	
S.E. of regression	1.026		1.073	
Fixed effects	None		Period	

Equations for Z score/Lerner index

	US		Europe	
Variable	Coefficient	t-Statistic	Coefficient	t-Statistic
C	3.6	11.7	3.7	13.1
DLERNERINST_Q99	0.73	2.3	0.33	2.7
LERNER_Q99(-2)	1.75	8.6	0.88	3.8
LERNER_Q99(-3)	0.11	0.8	0.26	1.3
CDT_Q99(-1)	0.24	2.0	0.41	6.8
LAR_Q99(-1)	-0.6	-6.2	0.45	12.9
NIR_Q99(-1)	-0.42	-2.7	-1.0	-16.8
PII_Q99(-1)	-0.02	-19.4	-0.0097	-15.3
LOG(TOTALASSETS_Q99(-1))	0.011	0.9	-0.0026	-0.2
D(LOG(TOTALASSETS_Q99(-1)))	-0.2	-2.5	-0.24	-3.5
Periods included	16		16	
Cross-sections included	943		5337	
Observations	9852		47487	
R-squared	0.297		0.183	
Adjusted R-squared	0.295		0.183	
S.E. of regression	0.957		1.061	
Fixed effects	Period		Period	

Results for capital on risk measures

Measure	US: H statistic			US: Lerner index			Europe: H statistic			Europe: Lerner index		
	LEV	TOT	TIER	LEV	TOT	TIER	LEV	TOT	TIER	LEV	TOT	TIER
Z-Score	1.04 (3.6)			0.74 (2.8)			0.84 (5.1)	0.6 (3.7)	0.53 (3.0)		0.46 (2.9)	0.51 (3.5)
Provisions/loans ratio	1.1 (3.0)	0.4 (2.7)	0.31 (1.9)	1.14 (2.7)			0.99 (2.7)	-0.52 (2.7)		1.32 (2.2)	-1.0 (4.7)	
Impaired loans ratio	-0.016 (2.2)			-0.016 (2.4)			0.11 (6.0)		0.04 (3.8)	0.18 (7.1)		0.04 (4.4)
Loan growth		-0.12 (3.1)	-0.11 (3.0)		-0.09 (2.1)	-0.086 (2.0)	0.046 (1.7)			0.081 (2.2)		

- Note: Results are shown for significant capital ratios only (t values in parenthesis), each regression includes all the additional control variables shown in Tables 3 and 4. Cells shown in grey show a negative relation of capital ratios to risk, cells shown in white show a positive relation of capital ratios to risk

Capital on risk in subsamples

Measure	**US: H statistic**			**US: Lerner index**			**Europe: H statistic**			**Europe: Lerner index**		
Z-Score	LEV	TOT	TIER	LEV	TOT	TIER	LEV	TOT	TIER	LEV	TOT	TIER
Full sample (Table 5)	1.04 (3.6)			0.74 (2.8)			0.84 (5.1)	0.6 (3.7)	0.53 (3.0)		0.46 (2.9)	0.51 (3.5)
Low leverage ratio		-2.6 (5.4)	-2.6 (5.4)	2.2 (2.2)	-2.2 (3.1)	-2.1 (2.8)						
High leverage ratio							3.5 (3.6)		-0.86 (2.6)		0.6 (1.8)	
1998-2007	0.5 (2.7)	-0.27 (1.8)	-0.32 (2.0)				1.19 (9.7)	0.63 (3.2)	1.04 (4.8)	0.74 (7.1)	0.47 (2.1)	0.86 (2.7)
2008-2016	2.18 (6.6)	0.43 (2.0)	0.47 (2.1)	1.24 (4.1)			0.69 (2.8)	0.72 (3.9)	0.5 (2.4)		0.6 (3.6)	0.53 (3.2)
Provisions/loans ratio												
Full sample (Table 5)	1.1 (3.0)	0.4 (2.7)	0.31 (1.9)	1.14 (2.7)			0.99 (2.7)	-0.52 (2.7)		1.32 (2.2)	-1.0 (4.7)	
Low leverage ratio						-1.7 (2.7)	4.5 (3.4)	-1.8 (4.2)	-1.1 (2.9)	5.6 (4.0)	-2.3 (4.9)	-1.2 (3.1)
High leverage ratio	0.96 (2.3)			1.4 (2.8)			1.5 (4.6)			2.0 (3.3)	-0.74 (2.5)	
1998-2007	1.1 (2.2)			1.3 (1.9)				-1.1 (4.8)	-1.2 (6.1)			
2008-2016							1.9 (4.7)	-0.5 (2.1)	0.59 (2.1)	2.8 (3.8)	-1.2 (4.5)	

Country assessment of capital effects (Dependent: log Z Score)

Z-Score	H statistic			Lerner index		
	LEV	TOT	TIER	LEV	TOT	TIER
UK full sample			1.64 (2.8)	1.03 (1.7)		2.78 (2.9)
France full sample	2.27 (9.4)		1.79 (2.3)	2.94 (7.5)		2.64 (2.8)
Germany full sample	1.13 (5.3)	1.36 (6.8)	1.69 (8.2)	1.09 (4.5)	1.39 (8.0)	1.91 (10.8)
Italy full sample	2.31 (8.1)	1.23 (5.9)	1.46 (7.1)	2.1 (5.2)	1.3 (5.8)	1.6 (6.0)
UK 1998 -2007	-0.93 (2.6)	1.18 (3.0)	4.5 (3.6)	-0.67 (1.8)	1.43 (2.6)	3.0 (2.8)
UK 2008-2016	2.0 (3.3)	2.0 (2.4)	2.8 (3.8)	2.27 (3.6)		3.8 (3.4)

Competition measures with capital

Measure	Lag of comp-etition	US: H statistic			US: Lerner index			Europe: H statistic			Europe: Lerner index		
		LEV	TOT	TIER	LEV	TOT	TIER	LEV	TOT	TIER	LEV	TOT	TIER
Z-Score	DIF				0.73 (2.3)	0.73 (2.3)	0.73 (2.3)				0.33 (2.7)	0.36 (2.3)	0.38 (2.4)
	t-2		-0.23 (1.7)		1.69 (7.8)	1.72 (7.9)	1.72 (8.0)	0.092 (3.5)			0.86 (3.8)	0.81 (4.4)	1.09 (3.9)
	t-3							0.082 (2.5)				0.39 (1.7)	
Impaired loans ratio	DIF				-0.016 (6.4)	-0.016 (6.5)	-0.016 (6.5)						
	t-2				-0.027 (7.5)	-0.027 (7.6)	-0.027 (7.6)	-0.013 (5.1)	-0.012 (4.6)	-0.011 (3.5)			
	t-3							-0.009 (3.8)	-0.009 (3.8)	-0.01 (2.6)			
Provisions ratio	DIF				-0.4 (2.6)	-0.4 (2.7)	-0.43 (2.9)				0.34 (2.4)		
	t-2							-0.1 (2.0)	-0.17 (3.6)	-0.18 (3.2)			
	t-3	0.36 (1.8)	0.36 (1.8)	0.36 (1.8)	0.47 (1.8)	0.44 (1.7)	0.47 (1.8)		-0.19 (3.0)	-0.19 (2.4)	0.59 (2.2)	0.6 (1.6)	
Loan growth	DIF	0.026 (3.0)	0.027 (3.0)	0.027 (2.9)	0.076 (5.1)	0.076 (4.9)	0.076 (4.9)				0.053 (6.5)	0.051 (1.8)	0.033 (2.7)
	t-2				0.098 (2.9)	0.103 (3.0)	0.104 (3.1)			-0.0088 (1.9)	0.037 (1.7)	0.072 (4.7)	0.12 (5.9)
	t-3				-0.074 (2.2)	-0.075 (2.1)	-0.075 (2.3)					-0.027 (2.3)	-0.068 (2.7)

Conclusions

- Using annual data for a sizeable range of banks in Europe and the US over 1998-2016 using the Fitch-Connect database, we have found that capital ratios are consistently significant as predictors of risk, but the relationship varies between positive (the "regulatory hypothesis") and negative ("skin in the game").
- On balance, US banks tend to behave in a manner consistent with "skin in the game" while European banks tend to follow the "regulatory hypothesis", although there are exceptions to these generalisations.
- There is a tendency for the leverage ratio to be more often significant than the risk adjusted measure in a number of the regressions. This observation favours its use in macroprudential policy.
- The incidence of capital on risk varies considerably over time and cross sectionally in Europe vis a vis the US. On the other hand, individual European countries behave similarly to the aggregate.
- Competition is a significant determinant of risk in virtually all regressions, which is positive (competition-fragility) in virtually all cases except H in Europe, and hence more note should be taken of this by regulators.

Deriving marginal costs from translog equation

- $\log(C_{it}) = \alpha + \beta_1\log(TA_{it}) + \beta_2(\log(TA_{it}))_2 + \beta_3\log(W_{1,it}) + \beta_4\log(W_{2,it}) + \beta_5\log(W_{3,it}) + \beta_6\log(TA_{it})\log(W_{1,it}) + \beta_7\log(TA_{it})\log(W_{2,it}) + \beta_8\log(TA_{it})\log(W_{3,it}) + \beta_9(\log(W_{1,it}))_2 + \beta_{10}(\log(W_{2,it}))_2 + \beta_{11}(\log(W_{3,it}))_2 + \beta_{12}\log(W_{1,it})\log(W_{2,it}) + \beta_{13}\log(W_{1,it})\log(W_{3,it}) + \beta_{14}\log(W_{2,it})\log(W_{3,it}) + \Theta\text{Year Dummies} + \varepsilon_{it}$
- C_{it} is total costs and TA_{it} is the quantity of output and is measured as total assets, W are as described above.

- Having estimated this equation, we impose the following restrictions to ensure homogeneity of degree one in input prices:
- $\beta_3 + \beta_4 + \beta_5 = 1$; $\beta_6 + \beta_7 + \beta_8 = 0$; $\beta_9 + \beta_{12} + \beta_{13} = 0$; $\beta_{10} + \beta_{12} + \beta_{14} = 0$; $\beta_{11} + \beta_{13} + \beta_{14} = 0$
- We then use the coefficient estimates from the previous regression to estimate the marginal costs for bank i in calendar year t:
- $MC_{it} = \delta C_{it}/\delta TA_{it} = Cit/TA_{it} \times [\beta_1 + 2\times\beta_2\times\log(TA_{it}) + \beta_6\times\log(W_{1,it}) + \beta_7\times\log(W_{2,it}) + \beta_8\times\log(W_{3,it})]$