The Leverage Ratio, Risk-Taking and Bank Stability

Assessing the trade-off between risk-taking and loss absorption

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Motivation

- From 2018 onwards, a non-risk based leverage ratio (LR) is to be introduced alongside the risk-based capital framework.

$$\text{LR} = \frac{\text{Tier 1 Capital}}{\text{Total Assets}} \qquad \text{Basel III LR} = \frac{\text{Tier 1 Capital}}{\text{Exposure measure}}$$

- The Basel committee is currently testing a minimum requirement of 3%, but some countries have gone or are considering going further:
- US: 3% + 2% buffer for their 8 largest banks
- UK: 3% + SIB buffer + countercyclical buffer
- The Netherlands: 4%

Why a leverage ratio?

- Simple complementary measure alongside risk-based capital framework to guard against excessive leverage
    - Excessive leverage has been identified as a key factor in the run up to the financial crisis
- Does not suffer from model risk, and it may be less susceptible to gaming
- Protection against shocks (e.g. aggregate shocks and tail risks) that may not be covered by the risk-based framework

Motivation

- On the other hand, the risk-insensitivity of a leverage ratio may create perverse incentives regarding risk-taking
- This has led to concern that a move away from a solely risk-based framework will lead to increased bank risk-taking.
- At the same time, imposing a floor on leverage ratios should increase loss-absorbing capacity.
- There is a potential trade-off
  - We seek to analyse this trade-off through a theoretical and empirical analysis
  - Does it exist?
  - Which effect dominates?

Preview of the results

- Theory
  - Imposing a leverage ratio incentivises banks bound by it to modestly increase risk-taking
  - This increase in risk-taking is outweighed by an increase in loss-absorbing capacity which should lead to a lower probability of failure and expected losses
- Empirics
  - Estimates suggest an increase in risk-taking from banks bound by the leverage ratio to be in the region of a 1.5-2.5 p.p increase in risk-weighted assets to total assets ratio
  - Results suggest that for a 3% leverage ratio, banks could increase risk-weighted assets by 6 p.p and distress probabilities would still significantly decline.

Overview

1. Previous Literature
2. Theoretical Model
3. Empirical Analysis
4. Conclusions

Previous Literature

- Theory
  - Gaming: Blum (2008); Rugemintwari (2011); Spinassou (2012)
  - Model risk: Kiema & Jokivoulle (2014)
  - Bank runs: Dermine (2015)
- Empirics
  - Canada: Bordeleau, Crawford & Graham (2009)
  - Switzerland: Kellerman & Schlag (2012)
  - US: Koudstaal & van Wijnbergen (2012)
  - Early warning models: Estrella, Park & Peristiani (2000); Betz, Oprica, Peltonen & Sarlin (2014); Lang, Peltonen & Sarlin (2015)

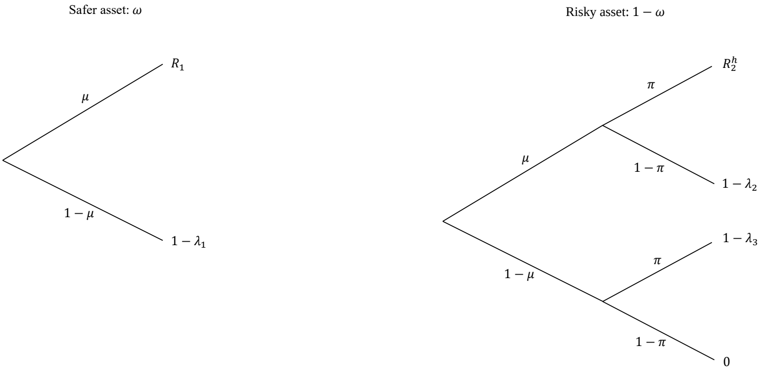
Model

- We build on Dell'Ariccia, Laeven & Marquez (2014, JET)
- There exist three agents: banks, depositors and investors
- All agents are risk neutral
- Both depositors and investors have outside options:
  - Investors have an opportunity cost equal to ρ per unit of capital. Hence, they demand an expected return on equity of at least ρ.
  - Depositors have access to a storage technology which yields 1.
- There exists full deposit insurance

Asset structure

- There are two states of the world $s = \{s_1, s_2\}$
  - States s_1 and s_2 occur with probability μ and $1 - \mu$ respectively
- There exist two assets: a safe asset and a risky asset which performs with probability π
- State s_1 is a good state, whereas in state s_2 there is a correlated system-wide shock
  - Small probability of occurring
  - But hits both the safe and the risky asset
- The friction here directly relates to one of Basel's key reasons for the imposition of an LR - that the risk-weighted framework may not perfectly cover shocks to low risk assets

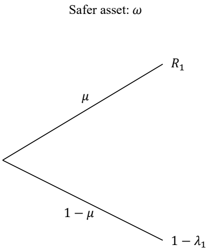
Asset structure

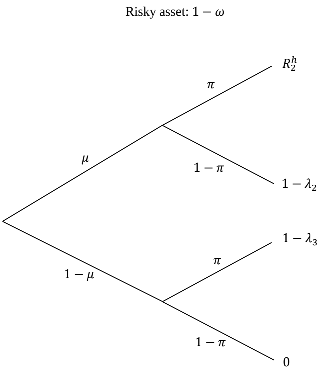


Capital requirements

- Under the Basel risk-based capital structure, on each asset banks are required to hold sufficient capital such that they cover expected and unexpected losses with some probability α, where in the Basel requirements $(1-\alpha) = 0.001$.
- For understanding, suppose the systemic correlated shock is a low probability event such that $(1-\mu) = \alpha$
- As such, the safe asset carries a 0 capital charge under the risk-based framework, and the risky asset carries a capital charge of $k_{risky} = \lambda_2$.

Asset structure

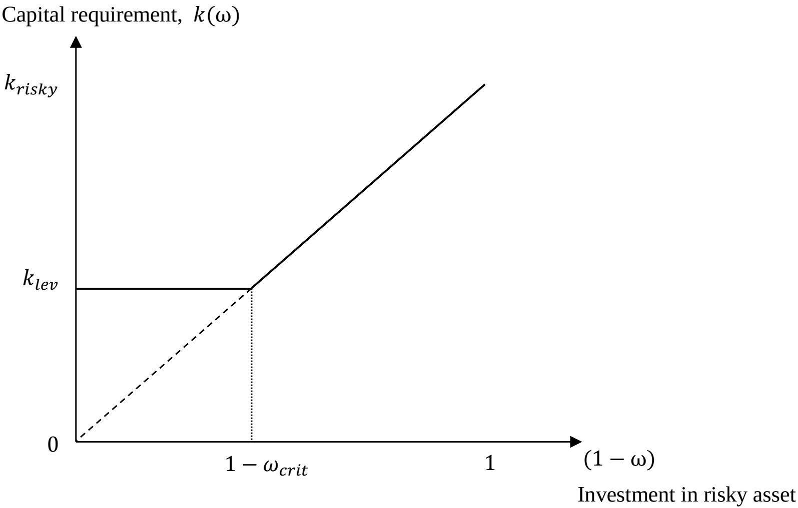




Capital requirements

- The leverage ratio is a non-risk based capital requirement set equal to k_{lev}
- The capital requirement under a combined framework will thus be: $k \geq \max\{k_{lev}, k(\omega)\}$, where $k(\omega) = (1-\omega)k_{risky}$
    - For those banks whose risk-based capital requirements are greater than k_{lev}, the leverage ratio will not bind

Capital requirements



The bank's problem

- Banks wish to maximise their expected profits conditional on survival
- They must determine:
  - Their optimal portfolio $(\omega^*, 1-\omega^*)$ where ω denotes investment in the safe asset
  - Their optimal capital holdings k^* subject to both a risk-based requirement and a leverage ratio
  - How much to pay on deposits i and how much to offer investors as a return on their equity
- We follow Allen and Gale (2000) and assume there exists a cost to investing in the risky asset $c(\omega)$, where $c'(\omega) < 0$

Results

Theorem

If equity is costly, imposing a leverage ratio requirement always incentivises banks to take on more risk.

- Equity is costly, so under a risk-based framework there exists an incentive to lower risk in order to reduce capital requirements
- Under a leverage ratio framework, this trade-off no longer exists. Given banks have to hold this level of capital anyway, they take on more risk
  - The marginal cost of taking risk declines

Results

Theorem

Relative to a solely risk-based capital framework, imposing a leverage ratio requirement:

1. *Leads to a weakly lower probability of failure*
2. *If $\rho \leq \hat{\rho}$, strictly lower expected loss of deposit funds for all $k > \underline{k}$.*
3. *And, if $\rho > \hat{\rho}$, strictly lower expected loss of deposit funds for all $k \in (\underline{k}, \overline{k})$,*

Intuition

- Increasing the minimum capital requirement means banks can absorb greater losses. Furthermore, any losses that do occur bear more on the bank than depositors.
- Banks will take on more risk under a leverage ratio, but not enough to offset its benefit:
  - The 'skin-in-the-game' effect somewhat offsets this incentive to increase risk-taking
  - There is a limit to how much additional risk a bank can take, since if it takes too much, it will move back into the risk-based framework

Empirical Analysis

- The theory suggests two testable hypotheses:
  - A leverage ratio will increase bank risk-taking for those banks for which it is a binding constraint
  - This increase in risk-taking should be outweighed by the beneficial effect on bank stability
- We attempt to test these hypotheses using a panel dataset of European banks

Methodology

- We take a three-levelled approach to our analysis
- First, we estimate the effect of a leverage ratio requirement on risk-taking using a difference-in-difference type analysis
- Second, using the same dataset, we consider the effect of the leverage ratio and risk-taking on bank stability via a logit analysis
- Third, building on the first and second analysis, we perform a counterfactual simulation

Data

- 655 banks from 27 EU countries for the period 2005-2014
- Unbalanced panel due to data gaps and entry/ exit of banks
- The dataset combines information from various sources:

1. Bank distress events
   - Compilation of: State-aid cases, distressed mergers, defaults, bankruptcies
2. Bank financial statements
   - Annual publicly available balance sheet and income statement variables from SNL Financial
3. Banking sector aggregates
   - Aggregate assets and liabilities of MFIs by country from ECB Statistical Data Warehouse (SDW)
4. Macro-financial variables
   - Data on interest rates, GDP, house/stock prices etc. from various sources (through ECB SDW and Haver Analytics)

First level

- Our aim is to see whether imposing a non-risk based leverage ratio increases bank risk-taking
- We employ an innovative strategy borrowing from the programme evaluation literature:
  - We consider the leverage ratio as a treatment and using the kinked structure of capital requirements under a combined risk-based, leverage ratio framework, we carve out treatment and control groups.
  - Banks with leverage ratios below the threshold are treated, while banks with leverage ratios above the threshold are the control group
- Our baseline takes the treatment start date of 2010 and LR threshold of 3% in reference to the initial Basel press releases and QIS reporting.

First level

Formally, we run the following panel regression:

$$y_{i,j,t} = \alpha + \beta T_{i,j,t} + \theta' X_{i,j,t} + \varphi' Y_{j,t} + \mu_i + \lambda_t + \epsilon_{i,j,t}$$

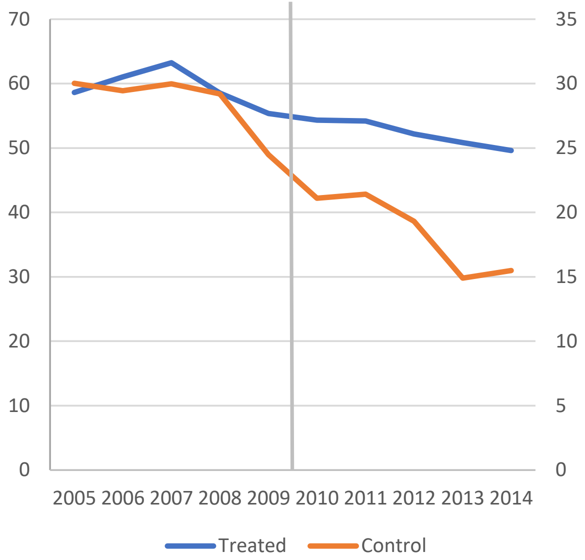
where μ_i and λ_t are bank and time fixed-effects respectively, $X_{i,j,t}$ and $Y_{j,t}$ are vectors of bank-specific and country-specific control variables, and $\epsilon_{i,j,t}$ is an i.i.d error term.

$T_{i,j,t}$ is the treatment dummy of interest. It is set equal to 1 for a given bank and year if its LR in the previous year was below the (planned) regulatory minimum, but only for years following the first announcement of the Basel III LR. The treatment dummy is set to 0 otherwise.

Variables

- Risk-Taking proxies
  - Dependent variable is Risk-weighted assets/Total Assets
- Leverage ratio
  - We use tier 1/total assets as our measure of the leverage ratio
  - Not exact relative to the Basel definition: we use total assets instead of the exposure measure, which also includes off-balance sheet assets
  - This is due to data limitations, nevertheless tier 1/total assets is the closest we can get. On data we have, correlations exceed 0.9.
- Regressors:
  - We control for standard bank specific characteristics such as size and profitability as well accounting standards used etc.
  - We control for the macro environment with GDP growth, stock market growth, house price index growth and the yield on government bonds.
  - Lastly, we include a dummy variable to indicate whether banks are yet to meet their more stringent risk-weighted requirements

RWA for treated and control



Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Leverage ratio treatment	2.017**	1.596**	2.592**	1.750**	1.445*	2.511**	2.851**	2.812*
Tier 1 capital ratio treatment		-0.676*	1.730***	-0.783*	-0.301	-0.709*	-0.839	-1.682**
Observations	4,689	4,574	2,849	2,836	2748	2111	1,824	1,126
R-squared	0.1709	0.390	0.261	0.407	0.41			
AR1-p						3.63e-7	2.20e-05	0.00130
AR2-p						0.922	0.995	0.455
Hansen-p						0.18	0.164	0.999
Lagged dependent	No	Lag 1	No	Lag 1	Lag 2	Lag 2	Lag 2	Lag 2
Estimation method	FE	FE	FE	FE	FE	GMM	GMM	GMM
Sample	All EU	All EU	All EU	All EU	All EU	All EU	Western Europe	W. Europe excl. GIIPS

Results suggest that a leverage ratio induces around 1.5-2.5 p.p. in additional risk-taking compared to what a bank would do under a risk-based framework.

Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Leverage ratio treatment, 3%	2.647**	2.552***	1.993*	0.990*	1.689***	2.193***		
Leverage ratio treatment 2, 3%							2.273**	
Leverage ratio treatment 3, 3%								3.215**
Tier 1 capital ratio treatment	-0.901*	-0.207	-0.769	-1.53**	-1.257**	-0.951**	-1.243**	-0.914*
Observations	1,550	2,342	1,491	760	1,344	1,950	2,111	1,738
Lagged dependent	Lag 2	Lag 1	Lag 2	Lag 2	Lag 2	Lag 2	Lag 2	Lag 2
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimation method	GMM	FE	GMM	GMM RDD, optimal	GMM RDD, double	GMM RDD, triple	GMM	GMM
Bank sample	Euro Area	All EU $LR \notin (3,5)$	All EU $LR \notin (3,5)$	All EU	All EU	All EU	All EU	All EU

Estimated effect on banks' leverage ratios

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Leverage ratio treatment, 3%	0.610***	0.831***	0.795***	0.439***	0.718***	1.081***		
Leverage ratio treatment 2, 3%							0.534***	
Leverage ratio treatment 3, 3%								0.999***
Tier 1 capital ratio treatment	0.419***	0.400***	0.354***	0.142	0.169	0.473***	0.354***	0.400***
Observations	3,064	2,631	2,393	1,021	1,807	1,826	2,437	2,631
R-squared	0.105	0.102	0.095	0.152	0.137	0.110	0.115	0.102
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimation method	FE	FE	FE	FE RDD, optimal	FE RDD, double	FE	FE	FE
Bank sample	All EU	Western Europe	W. Europe excl. GIIPS	All EU	All EU	All EU $LR \notin (3, 5)$	All EU	All EU

Second level

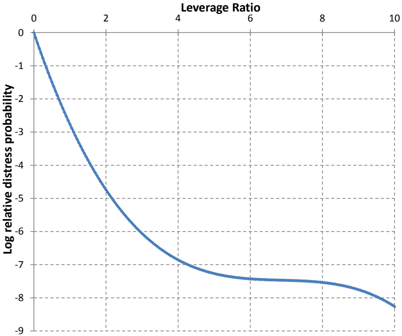
- We now wish to take into consideration how the leverage ratio impacts distress probabilities
- We run two tests:
  - First, based on the same dataset, we estimate an equation for distress probabilities using our distress indicators as the dependent variable
  - Second, we use our estimated logit model to run a counterfactual simulation on distress probabilities

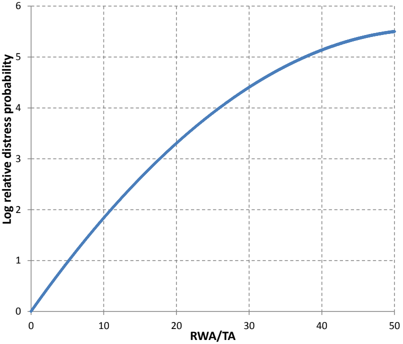
Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Leverage ratio proxy	-0.510***	-0.427***	-1.046***	-3.206***	-2.865***	-3.957***	-5.188**
Leverage ratio proxy, squared			0.054***	0.463***	0.420***	0.580***	0.465
Leverage ratio proxy, cubed				-0.023***	-0.021**	-0.028***	-0.014
RWA / Total assets	0.035***	0.011	0.166***	0.202***	0.188***	0.251***	0.406**
RWA / Total assets, squared			-0.001***	-0.002***	-0.002***	-0.002***	-0.002
Observations	1,661	1,661	1,661	1,661	1,234	1,334	674
Pseudo R2	0.284	0.410	0.430	0.437	0.431	0.408	0.559
AUROC	0.870	0.926	0.929	0.930	0.926	0.918	0.961
Country and time fixed-effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Non-linear effects	No	No	Yes	Yes	Yes	Yes	Yes
Bank sample	All EU	All EU	All EU	All EU	Euro Area	W. Europe	W.E. excl GIIPS

Results

- Results suggest the leverage ratio is a very important indicator for bank distress probabilities.
- For example, consider models 1 and 2. They suggest that a 1 p.p. increase in a bank's LR is associated with around a 35-39% decline in the relative probability of distress to non-distress (the odds ratio).
- This is much larger than the marginal impact from taking on greater risk. Coefficient estimates suggest that increasing a bank's RWA ratio by 1 p.p. is associated with an increase in its relative distress probability of only around 1-3.5%.
- Other models illustrate the result is robust to introducing non-linear effects in the LR and risk-weighted assets ratio, and to different bank samples.


Leverage Ratio
0
2
4
6
8
10
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
Log relative distress probability


6
5
4
3
2
1
0
Log relative distress probability
0
10
20
30
40
50
RWA/TA

Counterfactual simulation

- Using our most complete model (denoted specification 4 above), let us predict distress probabilities using the given data - this will be the base level distress probabilities
- Then, let's increase the leverage ratio for all banks with LRs below the LR minimum (or target) level to that level.
- But at the same time, let's also increase their risk-weighted assets by a given amount X - we try different levels
- Lastly, let's compare predicted distress probabilities to see if there are any significant differences

Counterfactual simulation

LR threshold:	3%	4%	5%	4%	5%	5%
Banks with an LR of:	Less than 3%			Between 3-4%		Between 4-5%
$\Delta(RWA/TA) = 2$	-0.860***	-0.986***	-0.995***	-0.694***	-0.978***	-0.709***
$\Delta(RWA/TA) = 4$	-0.792***	-0.981***	-0.994***	-0.536**	-0.969***	-0.559**
$\Delta(RWA/TA) = 6$	-0.689***	-0.973***	-0.992***	-0.293	-0.956***	-0.327
$\Delta(RWA/TA) = max$	-0.484*	-0.707*	-0.664*	-0.055	-0.462	-0.167

*** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.
Significance is based on bootstrapped standard errors on 10,000 replications.

Conclusions

- Imposing a leverage ratio leads to an inherent trade-off between increased risk-taking and loss absorbing capacity
- We suggest that while a leverage ratio indeed increases incentives to take risk, this is outweighed by greater loss absorbing capacity
- Empirical results suggest increased risk-taking is modest - between 1.5-2.5 p.p. compared to what a bank would have done under a solely risk-based framework
- Further results show that banks can increase risk by much more than this and distress probabilities will still significantly decline
- From a policy perspective, our results support the introduction of a leverage ratio in conjunction with a risk-based framework