

THE BANK CAPITAL-COMPETITION- RISK NEXUS – A GLOBAL PERSPECTIVE

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**E Philip Davis, Dilruba Karim and
Dennison Noel**

**Brunel University and NIESR
London**

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Abstract

- Empirical studies of banking sector risk typically look at either the relationship of competition to risk or bank capital adequacy to risk, but rarely integrate the two.
- This raises an issue of potential bias arising from omission of relevant control variables, and is of particular importance in the light of the introduction of a regulatory leverage ratio in Basel III.
- To fill this lacuna, we provide estimates for the relation between capital adequacy, bank competition and other control variables and four measures of aggregate bank risk for different country groups and time periods.
- We use macro data from the World Bank's Global Financial Development Database over 1999-2015 for up to 120 countries globally.

- Our approach enables us to address afresh a number of unresolved empirical issues in the field of financial stability:
 - The relation of bank capital to risk
 - The relative importance of the leverage ratio relative to risk adjusted capital adequacy in financial stability
 - The relation of competition in banking to risk
 - The differences in financial stability patterns between advanced and emerging market economies
 - The relation of competition in banking to capital adequacy
- We contend that our results using macro data are of particular relevance to regulators undertaking macroprudential surveillance because such data gives a greater weight to large systemic institutions than the more commonly-used bank-by-bank data.
- The paper is structured as follows: in Section 2 we provide an overview of the existing literature, Section 3 introduces the data and methodology, Section 4 provides the main results which are summarised in Section 5. Section 6 provides complementary VAR estimates and Section 7 concludes.

Literature

- Our work derives from two distinct strands of the literature. First there are **empirical estimates of the effect of capital on risk**, which generally does not include competition as a control variable. There are two distinct hypotheses.
- According to “skin in the game”, 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). Empirical results supporting this view include Lee and Hsieh (2013), Tan and Floros (2013) and Anginer and Demirguc Kunt (2014).
- Alternative is the “regulatory hypothesis” suggesting that regulators require higher capital in response to higher risk, and so a positive relation of capital to risk would be expected. This is, for example, found by Iannotta et al (2007) and Bitar et al (2018)

- A particular area of interest in the bank capital-risk literature, given the recent introduction of leverage ratios to global regulation in Basel III is **whether leverage ratios or risk adjusted capital ratios are better predictors of bank risk.**
- 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.
- Empirical work on leverage versus the RAR includes Yang (2016) who looked at leverage and risk weighted capital as predictors in 417 US bank failures between 2008 and 2012 using logit, finding leverage was important for both large and small banks but that risk adjusted capital was not significant for large banks.
- This is in line with Haldane and Madouros (2012) who also found the leverage ratio a superior failure predictor to the RAR.

- Bitar et al (2018) found risk based capital measures are unrelated to bank risk, whereas unadjusted measures such as the leverage ratio are significantly positively related to risk as shown by loan loss reserves. They suggest that the ineffectiveness of risk adjusted measures may relate to untruthful assessment of bank real risk exposure.
- 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.
- Davis et al (2019) using data from individual banks in Europe and the US found leverage ratios to be more often significant than risk adjusted capital in determination of bank risk.
- Berger and Bouwman (2013) looked at the effect of the leverage ratio on survival probabilities and market share and found some differences with results for the risk adjusted capital ratio.

- **The competition/risk literature** divided between those works which support “competition-fragility” (more competition leads to higher risk) and “competition-stability” which suggests more competition leads to lower risk. Surveys such as Davis and Karim (2018) and Zigraiova and Havranek (2016) show that empirical results are evenly divided between the two hypotheses.
- “Competition-fragility” suggests institutions in an uncompetitive banking system have incentives to avoid risk, because a banking licence is valuable in such a context, with restricted entry and probably large capital cushions. When deregulation arises, the value of the licence declines as excess returns are competed away by new entrants and by more intense competition between existing players. This gives incentives to increase balance sheet risk to recover the previous level of profitability, since banks effectively shift risks to depositors (or deposit insurers). Some analyses of the GFC (such as FCIC 2011) give a key role to competition as a causal factor.
- According to “competition-stability”, whereas lower lending rates in competitive banking markets increase borrower scope for repayment, higher lending rates in uncompetitive markets lead to adverse selection, with only riskier borrowers seeking funds and moral hazard inducing borrowing firms to take greater risks. Large banks may be harder to supervise.

- There are relatively few **studies of the capital-competition-risk nexus in its entirety**
- Freixas and Ma (2015) look at the relation of bank competition to financial stability with a theoretical model and find the effect depends crucially on a bank's type of funding (retail versus wholesale) and whether leverage is exogenous or endogenous. They suggest that "this opens the road for new empirical analysis on the competition-stability link that should depend upon the type of banks and the state of the economy", a path we also follow.
- de-Ramon et al (2018) find that higher competition in the UK leads to lower leverage ratios, although the effect on stability measured by the Z-Score may be offset by higher profitability.
- Barrell and Karim (2019) found that competition measures such as concentration and the Lerner Index did help to predict banking crises in advanced countries, along with aggregate leverage ratios and property prices. These (along with Berger et al (2009)) are some of the few analyses of capital ratios and risk that take into account competition, which is a paradox given the sizeable literatures on capital and risk, and bank competition and risk cited above.

- Concerning the **advanced versus EME issue**, most studies of financial stability cited in Davis and Karim (2018) and Zigrainova and Havranek (2016) cover individual countries or only one subgroup (advanced or EME).
- The number of studies assessing the differences and similarities between the two groups are relatively sparse. Some recent examples are:
- Fratzscher et al (2016) looks at post crisis supervisory changes' effects on risk comparing advanced and emerging market economies
- Meng and Gonzalez (2017) looks at differences in credit booms between advanced countries, emerging markets and developing countries.
- Finally regarding **competition and capital** besides the de-Ramon et al (2018) paper cited above, Schaeck and Cihak (2012) look at the effect of competition on capital for 2,600 banks from 10 European countries and find higher competition gives rise to higher capital ratios. This may offer an offset to higher risks taken in highly competitive banking systems.

Methodology

- We undertake an econometric investigation of the relationship of the leverage ratio to risk relative to a risk adjusted measure, with competition as an independent variable as well as standard control variables.
- We estimate generally from 1999-2015, using macro data from the World Bank's Global Financial Development Database.
- Using logit and panel GMM approaches, we test a global sample and also test for high income countries and emerging market and developing economies separately, as well as before and after the financial crisis.
- Thereafter, we present results of simple VARs for the interrelation of competition, risk and capital that casts further light on the interrelationship of these key variables in financial stability analysis.

- Four dependent variables of macroprudential relevance were drawn from the World Bank Global Financial Development Database (GFDD) (Cihak et al (2012), World Bank (2017)) as in Davis (2017).
- First, there is the **incidence of financial crises** per se, as drawn from Laeven and Valencia (2012). It is 1 for each period a crisis lasted, and 0 otherwise.
- Second, we use the **NPL/loans ratio** which may show problems with asset quality in the loan portfolio across the banking sector as a whole.
- Third, **the Z-Score** captures the probability of default of a country's commercial banking system. Z-score compares the buffer of a country's commercial banking system (capitalization and return on assets (ROA)) with the volatility (standard deviation) of those returns. Hence $Z\text{-Score} = (\text{ROA} + (\text{Capital}/\text{Assets}))/\text{SD}(\text{ROA})$. As noted by Lui et al (2013), it is appropriate to log the Z score as the level is highly skewed, while the log is normally distributed, so we enter the variable as $\log(Z\text{-Score})$.
- Fourth, the **Provisions/Loans ratio** is an indicator of how well protected a banking sector is against future losses. It 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 (Lee and Hsieh 2013).

- Then, we use the leverage ratio and the regulatory capital/risk adjusted assets measures to test for the link of capital ratios to risk. Our key additional variable is competition, which we measure by the Lerner index for bank competition
- The Lerner Index is a measure of market power in the banking market. It compares output pricing and marginal costs (that is, mark-up). An increase in the Lerner index indicates a decline in the competitive conduct of financial intermediaries, as reflected in wider margins.

- Other control variables (lagged) were similar to Beck et al (2013), Davis and Karim (2018) and de-Ramon et al (2018):
 - NONINTSH (share of noninterest income), showing income diversification;
 - CREDASSET (ratio of bank loans of deposit money banks to assets for deposit money banks), which may link to credit risk
 - DEPASSET (ratio of deposits of deposit money banks to total assets of deposit money banks), which shows the dependence of banks on deposits for their funding.
- For the crisis estimation we use the traditional logit as in Barrell et al (2010) and Karim et al (2013).
- For the other risk variables, we use difference GMM as in Arellano and Bond (1991), with a lagged dependent variable and cross section difference fixed effects and using White's method to reduce the impact of heteroskedasticity. All variables are entered as 1-year lags to assess indicator properties and reduce the risk of simultaneity.

Statistical measures for dependent variables

	Crisis	NPL/loans (%)	Log Zscore	Provisions/Loans (%)
Mean	0.043	7.23	2.3	4.43
Median	0.00	4.42	2.36	2.96
Maximum	1.00	74.1	4.54	36.00
Minimum	0.00	0.01	-4.1	0.00
Std. Dev.	0.2	7.52	0.74	4.39
Skewness	4.51	2.26	-1.25	2.21
Kurtosis	21.38	10.92	8.54	10.32
Jarque-Bera	187212.1	6513.33	5381.13	5178.33
Probability	0.00	0.00	0.00	0.00
Sum	459.00	13591.11	8046.9	7542.88
Sum Sq. Dev.	439.33	106330.3	1933.12	32750.26
Observations	10712	1880	3493	1701

Statistical measures for independent variables

	Lerner index	Bank leverage (%)	Regulatory capital/risk adjusted assets (%)	Deposit/asset ratio	Noninterest income/total income	Credit/asset ratio
Mean	0.23	9.72	16.4	1.00	36.85	0.79
Median	0.26	9.1	15.4	0.92	35.4	0.83
Maximum	1.08	30.60	48.6	18.45	93.18	1.00
Minimum	-44.63	1.49	1.75	0.035	1.43	0.047
Std. Dev.	0.95	4.00	5.35	0.58	16.43	0.18
Skewness	-43.06	0.996	1.59	7.98	0.43	-1.39
Kurtosis	2009.61	4.53	7.00	167.75	3.28	5.06
Jarque-Bera	4.15E+08	480.71	2065.30	7416473.	119.2665	3257.832
Probability	0.00	0.00	0.00	0.00	0.00	0.00
Sum	574.54	17851.03	31103.00	6497.24	127708.2	5176.6
Sum Sq. Dev.	2233.59	29373.05	54215.23	2148.49	935327.8	211.66
Observations	2468	1836	1896	6497	3466	6558

Unit root tests

Variable	Im-Pesaran-Shin panel unit root test (probability)
NPL/loans	-42.1 (0.0)
Log Zscore	-15.4 (0.0)
Provisions/Loans	-2.9 (0.0)
Lerner Index	-8.5 (0.0)
Bank leverage	-2.0 (0.02)
Regulatory capital/risk adjusted assets	-2.3 (0.0)
Deposit/asset ratio	-8.9 (0.0)
Noninterest income/total income	-4.8 (0.0)
Credit/asset ratio	-8.3 (0.0)

Baseline regression results for leverage and Lerner (1999-2015)

	Crisis	NPL/loans	Log (Zscore)	Provisions/Loans
Constant	-4.28*** (4.6)	-	-	-
Dependent (-1)	-	0.77*** (45.1)	0.191*** (3.8)	0.579*** (26.3)
Lerner (-1)	-3.07*** (3.8)	3.86** (2.3)	-0.001 (0.4)	-2.83*** (3.2)
Leverage (-1)	-0.108*** (3.5)	0.752*** (9.8)	0.00043** (2.1)	0.276*** (5.2)
Deposits/Assets (-1)	-0.325 (1.5)	-16.6*** (6.4)	-0.0885*** (4.3)	-12.7*** (8.2)
Noninterest income/total income (-1)	0.024*** (3.2)	-0.005 (0.4)	-0.00002 (0.3)	0.02** (2.6)
Credit/assets (-1)	3.68*** (4.0)	26.5*** (6.2)	-0.037 (1.3)	0.486 (0.2)
Regression type	ML - Binary logit	Panel GMM difference regression	Panel GMM difference regression (additional instrumenting of leverage)	Panel GMM difference regression
Effects		Cross section fixed (first difference)	Cross section fixed (first difference)	Cross section fixed (first difference)
Sample (adjusted):	1999-2011	2000-2015	2002-2015	2000-2015
Periods included:	13	16	14	16
Countries included:	112	108	108	107
Observations:	1074 (o/w 118=1)	1206	1046	1063
R-squared	0.1139	-	-	-
S.E. of regression	0.3	4.05	0.024	2.31
Sum of squared residuals	96.19	19670	0.58	5648
Sargan's J (probability)	-	48.9 (0.28)	45.6 (0.29)	42.6 (0.53)
AR(1) (probability)		0.02	0.015	0.03
AR(2) (probability)		0.37	0.203	0.95
Memo: regulatory capital ratio (-1) instead of leverage (-1)	-0.104*** (3.6)	0.15*** (2.7)	-0.0001 (0.3)	-0.04 (1.3)

Regression results for crisis using alternative measures of capital adequacy

Logit Regression	Variable	Equation with leverage ratio	Equation with regulatory capital/risk adjusted assets
Full sample	Lerner (-1)	-3.07*** (3.8)	-2.87*** (3.6)
	Capital ratio (-1)	-0.108*** (3.5)	-0.104*** (3.6)
Higher income countries	Lerner (-1)	-2.21** (2.4)	-2.27** (2.5)
	Capital ratio (-1)	-0.088* (1.8)	-0.031 (0.7)
Emerging market economies	Lerner (-1)	-4.43*** (3.0)	-3.76** (2.6)
	Capital ratio (-1)	-0.052 (1.0)	-0.12** (2.6)
Pre-crisis (1999-2006)	Lerner (-1)	-3.2*** (2.9)	-2.73*** (2.8)
	Capital ratio (-1)	0.007 (0.2)	-0.085* (1.7)
Post-crisis (2007-2015)	Lerner (-1)	-5.52*** (3.9)	-6.32*** (4.6)
	Capital ratio (-1)	-0.189*** (4.4)	-0.199*** (4.4)
Crisis onset only	Lerner (-1)	-1.129 (1.0)	-0.176 (0.1)
	Capital ratio (-1)	-0.109* (1.7)	-0.245*** (3.4)

Regression results for NPL/loans using alternative measures of capital adequacy

Panel GMM-Difference Regressions (cross section fixed effects)	Variable	Equation with leverage ratio	Equation with regulatory capital/risk adjusted assets
Full sample	Lerner (-1)	3.86** (2.3)	2.93** (2.0)
	Capital ratio (-1)	0.752*** (9.8)	0.15*** (2.7)
Higher-income countries	Lerner (-1)	1.58*** (6.7)	0.118 (0.9)
	Capital ratio (-1)	0.233*** (15.8)	0.149*** (44.3)
Emerging Market Economies	Lerner (-1)	-3.25*** (3.6)	0.36 (0.6)
	Capital ratio (-1)	0.48*** (17.7)	0.061*** (3.3)
Pre-crisis (up to 2007)	Lerner (-1)	-6.96** (2.0)	-6.08*** (2.7)
	Capital ratio (-1)	0.672*** (3.2)	0.05 (0.4)
Post-crisis (2008 onwards)	Lerner (-1)	4.68* (1.9)	3.81* (1.9)
	Capital ratio (-1)	0.68*** (4.7)	0.287*** (4.3)

Regression results for log (Z Score) using alternative measures of capital adequacy

Panel GMM-Difference Regressions (cross section fixed effects)	Variable	Equation with leverage ratio (instrumented)	Equation with regulatory capital/risk adjusted assets
Full sample	Lerner (-1)	-0.001 (0.4)	0.0004 (0.3)
	Capital ratio (-1)	0.00044** (2.1)	-0.0001 (0.3)
Higher-income countries	Lerner (-1)	-0.01*** (9.1)	-0.004 (1.0)
	Capital ratio (-1)	0.0008*** (5.2)	0.00066*** (3.9)
Emerging Market Economies	Lerner (-1)	0.0025** (2.3)	0.0009* (2.0)
	Capital ratio (-1)	0.00052*** (5.7)	-0.00017 (0.5)
Pre-crisis (up to 2007)	Lerner (-1)	-0.008 (0.8)	0.044** (2.2)
	Capital ratio (-1)	0.0005 (0.7)	-0.00019 (0.3)
Post-crisis (2008 onwards)	Lerner (-1)	0.0078 (0.9)	0.009 (1.1)
	Capital ratio (-1)	0.0008** (1.9)	0.00078 (1.6)

Regression results for Provisions/Loans - alternative measures of capital adequacy

Panel GMM-Difference Regressions (cross section fixed effects)	Variable	Equation with leverage ratio	Equation with regulatory capital/risk adjusted assets
Full sample	Lerner (-1)	-2.83*** (3.2)	-1.67*** (2.7)
	Capital ratio (-1)	0.28*** (5.2)	-0.04 (1.3)
Higher-income countries	Lerner (-1)	-1.7*** (8.1)	-1.197*** (5.6)
	Capital ratio (-1)	0.112*** (14.6)	0.019*** (3.4)
Emerging Market Economies	Lerner (-1)	-1.73*** (3.8)	-3.18*** (5.1)
	Capital ratio (-1)	0.23*** (5.6)	-0.018 (1.0)
Pre-crisis (up to 2007)	Lerner (-1)	-7.27*** (4.4)	-6.33*** (2.3)
	Capital ratio (-1)	0.018 (0.1)	-0.18 (1.6)
Post-crisis (2008 onwards)	Lerner (-1)	0.91 (0.6)	1.22 (0.9)
	Capital ratio (-1)	0.214*** (3.1)	0.051 (1.5)

Summary of significance and signs

Country group/time period	Risk indicator	Leverage ratio	Risk adjusted capital ratio	Competition (Lerner)
Global	Crisis	_-***	_-***	_-***
	NPL/loans	+***	+***	+**
	Log Z Score	+**		
	Provisions/loans	+***		_-***
Advanced	Crisis	_*		_-**
	NPL/loans	+***	+***	+***
	Log Z Score	+***	+***	_-***
	Provisions/loans	+***	+***	_-***
Emerging market economies	Crisis		_-**	_-***
	NPL/loans	+***	+***	_-***
	Log Z Score	+***		+**
	Provisions/loans	+***		_-***
Pre-crisis (up to 2007)	Crisis		_*	_-***
	NPL/loans	+***		_-**
	Log Z Score			
	Provisions/loans			_-***
Post-crisis (2008 onwards)	Crisis	_-***	_-***	_-***
	NPL/loans	+***	+***	+*
	Log Z Score	+**		
	Provisions/loans	+***		

Note: *** implies significance at 99%, ** at 95% and * at 90%. Cells for competition shown in white show a negative relation of competition to risk (“competition-stability”), cells for competition shown in light grey show a positive relation of competition to risk (“competition-fragility”). Cells for capital shown in dark grey show a negative relation of capital ratios to risk (“skin in the game”), cells for capital shown in white show a positive relation of capital ratios to risk (“regulatory hypothesis”).

- Regarding the relation of **capital to risk**, controlling for competition, we have mainly but not solely a negative relation so that more capital leads to lower risk – or conversely less capital leads to higher risk (“skin in the game”).
- The **leverage ratio** is clearly relevant for many cases, as is the regulatory capital ratio, thus justifying the regulatory focus on both measures. In terms of individual regressions, leverage is significant in 16/20 cases, and regulatory capital in 10/20.
- From the standpoint of **competition and risk**, the evidence strongly favours the competition-fragility hypothesis. The implication is clearly that regulators need to take more note of competitive conditions in banking markets when assessing the stance of macroprudential policy and the risk of financial instability.
- Finally, we see numerous contrasts between the experience of **advanced countries and EMEs** in the sample. Results imply, EME regulators should pay particularly close attention to competition, while both groups are justified in a focus on leverage as well as the RAR.

Robustness checks

- In order to further check robustness we first included the macroeconomic variables GDP growth, CPI inflation and the rate of unemployment (ILO definition) in each regression. These data came from the World Bank's World Development Indicators database.
- This test would show whether the favourable results obtained are due to omission of such macroeconomic effects. We ran the tests for the full sample.
- Second, we added a lagged crisis variable to the regressions for NPLs, provisions and Z-score
- As shown below the main results are robust to the addition of these variables

Including macro variables

Dependent variable	Independent variables	Equation with leverage ratio	Equation with regulatory capital/risk adjusted assets
Crisis (1)	Lerner (-1)	-3.05*** (3.4)	-2.62*** (3.0)
	Capital ratio (-1)	-0.089** (2.6)	-0.135*** (3.9)
Crisis onset (2)	Lerner (-1)	-0.73 (0.4)	-1.4 (1.3)
	Capital ratio (-1)	-0.222*** (3.0)	-0.11 (1.6)
NPL/loans (3)	Lerner (-1)	0.83 (0.8)	0.015 (0.1)
	Capital ratio (-1)	0.367*** (5.7)	0.03 (0.7)
Log Z Score (4)	Lerner (-1)	-0.006 (1.6)	0.001 (0.6)
	Capital ratio (-1)	0.0004* (1.7)	-0.0003 (0.9)
Provisions/loans (5)	Lerner (-1)	-0.25 (0.3)	0.032 (0.1)
	Capital ratio (-1)	0.15*** (3.0)	-0.043* (1.7)

Including crisis variable

Dependent variable	Independent variables	Equation with leverage ratio	Equation with regulatory capital/risk adjusted assets
NPL/loans	Lerner (-1)	-4.2 (1.6)	-1.11 (0.5)
	Capital ratio (-1)	0.89*** (7.2)	0.18** (2.0)
Log Z Score	Lerner (-1)	0.005 (0.6)	0.022 (1.3)
	Capital ratio (-1)	-0.00001 (0.1)	-0.00017 (0.4)
Provisions/loans	Lerner (-1)	-3.31** (2.5)	-3.66*** (3.2)
	Capital ratio (-1)	0.421*** (4.4)	-0.0006 (0.1)

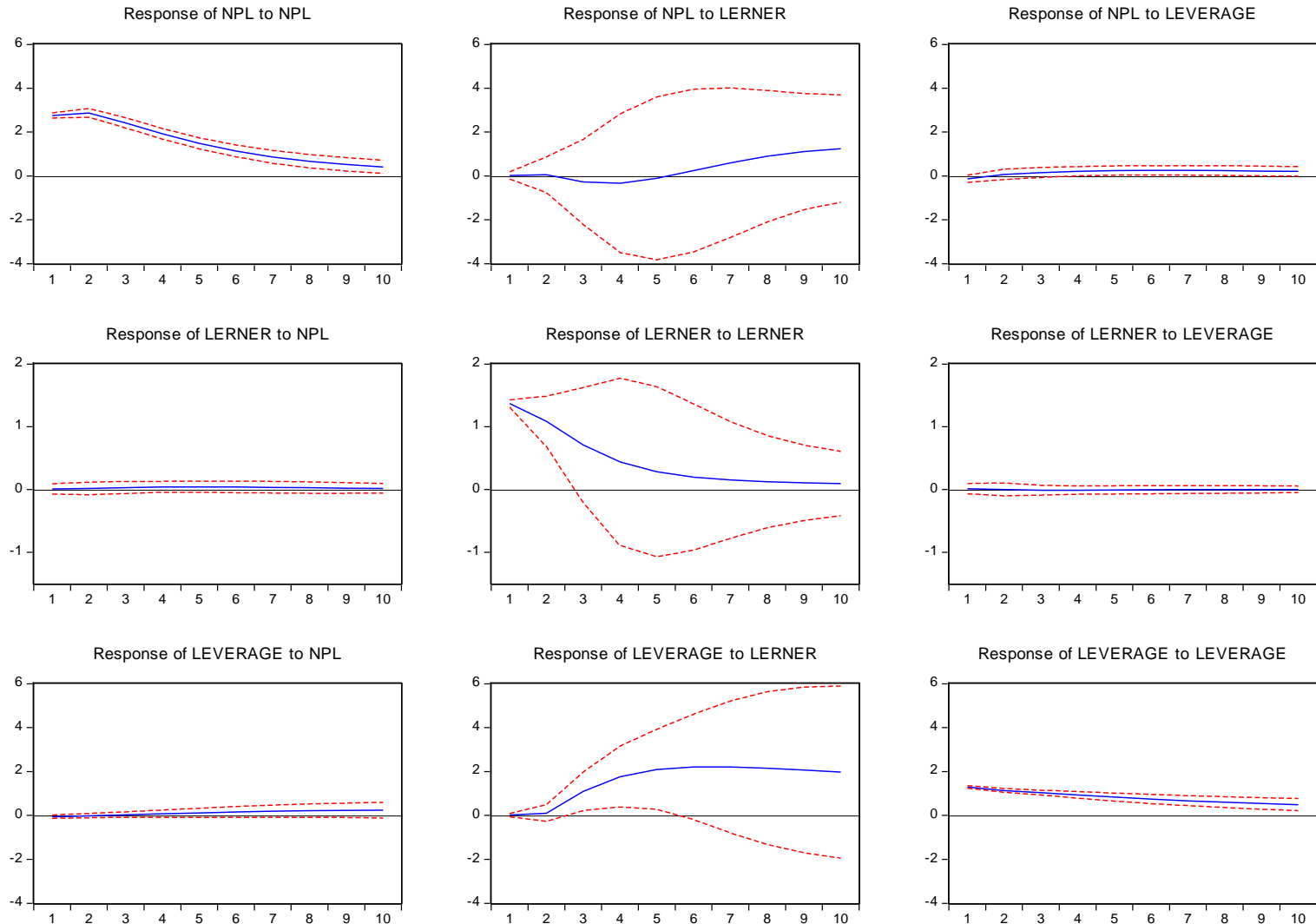
Panel VAR estimation

- To complement our single equation work and investigate further the capital-competition-risk nexus, and in particular the relation of capital to competition, we ran a simple Panel VAR to assess the interrelations of these variables, where risk is measured by the NPL ratio.
- Other control variables used in the principal regressions above (the deposit/asset ratio, the credit/asset ratio and the share of non-interest income) are also included but not detailed below. We took two lags of each variable in the VAR.
- Impulse responses were run using Pesaran's generalised impulses, the variance decompositions with Cholesky ordering competition, capital, the deposit/asset ratio, the credit/asset ratio and the share of non interest income then risk, but also tested with the reverse ordering, giving similar results.

Panel VAR results

- Impulse responses for NPL ratio and leverage

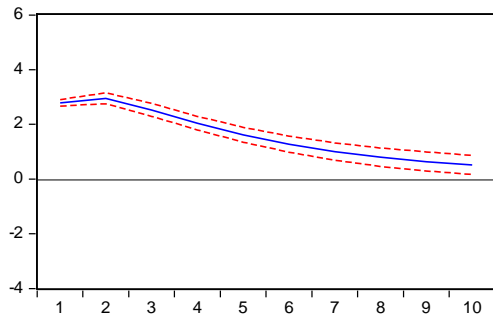
Response to Generalized One S.D. Innovations ± 2 S.E.



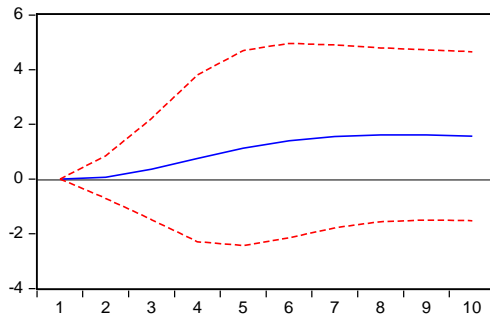
• Impulse responses for NPL ratio and RAR

Response to Cholesky One S.D. Innovations ± 2 S.E.

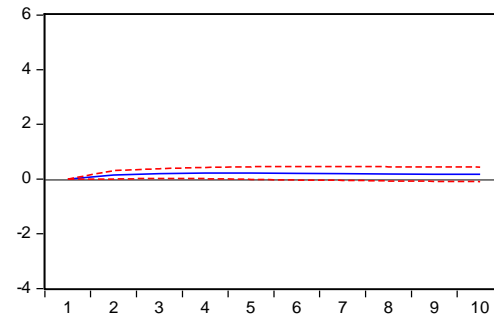
Response of NPL to NPL



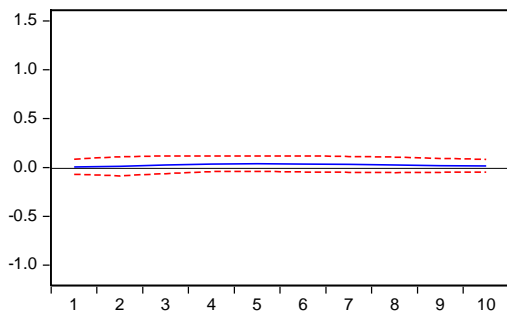
Response of NPL to LERNER



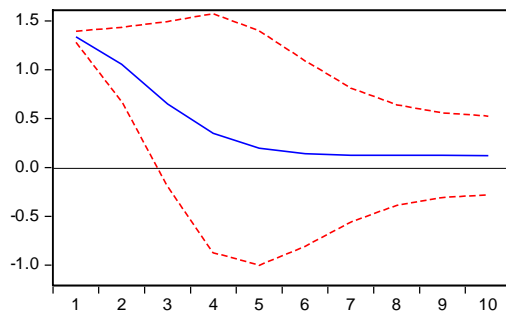
Response of NPL to REGCAP



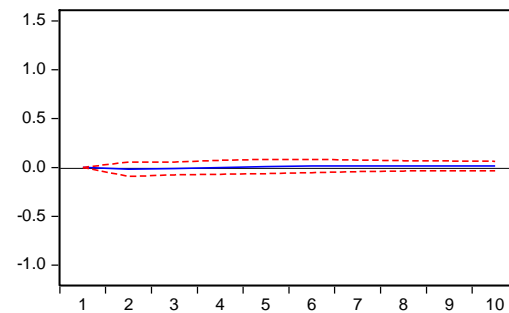
Response of LERNER to NPL



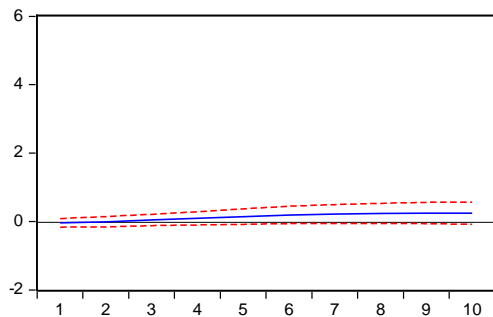
Response of LERNER to LERNER



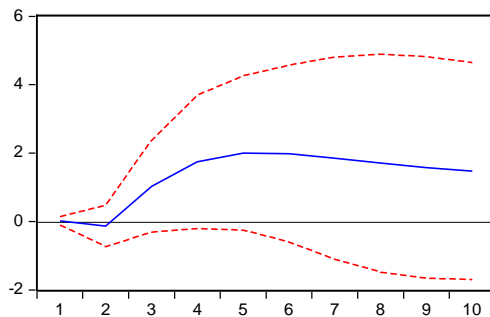
Response of LERNER to REGCAP



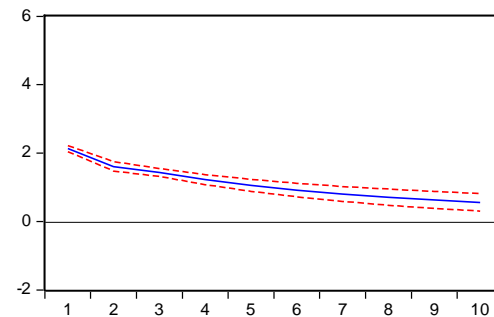
Response of REGCAP to NPL



Response of REGCAP to LERNER



Response of REGCAP to REGCAP



- Variance decomposition for NPL ratio and leverage

NPL:							
Period	S.E.	NPL	LERNER	LEVERAGE	DEPASS	NONINT	CREDASS
1	2.754506	99.16407 (0.55885)	0.003522 (0.15407)	0.238150 (0.26265)	0.474337 (0.41739)	0.114851 (0.25192)	0.005068 (0.12283)
5	5.334897	96.60788 (16.3081)	0.726281 (16.7940)	0.529564 (0.44833)	1.452413 (0.80409)	0.682421 (0.58517)	0.001439 (0.20702)
10	6.032880	83.76580 (24.7046)	11.53423 (26.0386)	1.128157 (1.01509)	1.535362 (0.90385)	1.988757 (1.63180)	0.047700 (0.31196)

LERNER:							
Period	S.E.	NPL	LERNER	LEVERAGE	DEPASS	NONINT	CREDASS
1	1.369333	0.000000 (0.00000)	100.0000 (0.00000)	0.000000 (0.00000)	0.000000 (0.00000)	0.000000 (0.00000)	0.000000 (0.00000)
5	1.962166	0.090566 (0.33583)	99.50917 (0.57424)	0.019936 (0.15108)	0.014884 (0.16579)	0.030973 (0.22159)	0.334467 (0.37026)
10	1.988823	0.176918 (0.59065)	99.28490 (0.99819)	0.020915 (0.26727)	0.079153 (0.23487)	0.040052 (0.44052)	0.398066 (0.51608)

LEVERAGE:							
Period	S.E.	NPL	LERNER	LEVERAGE	DEPASS	NONINT	CREDASS
1	1.293667	0.000000 (0.00000)	0.006821 (0.16551)	99.99318 (0.16551)	0.000000 (0.00000)	0.000000 (0.00000)	0.000000 (0.00000)
5	3.778735	0.281358 (0.33566)	61.10617 (19.1603)	38.51700 (18.7954)	0.026215 (0.15008)	0.045718 (0.46560)	0.023542 (0.11214)
10	6.232241	0.740482 (0.88218)	80.26150 (21.2665)	18.73378 (20.1690)	0.020066 (0.23990)	0.086270 (1.40273)	0.157904 (0.43977)

- Variance decomposition for NPL ratio and RAR

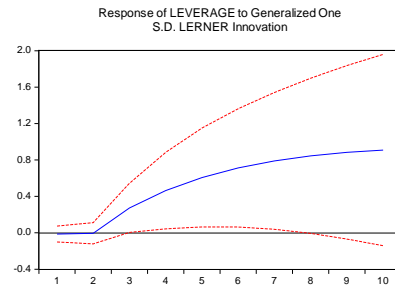
NPL:		NPL	LERNER	REGCAP	DEPASS	NONINT	CREDASS
Period	S.E.						
1	2.782498	99.39065 (0.46565)	0.001894 (0.12578)	0.044198 (0.15920)	0.419951 (0.35798)	0.062925 (0.15795)	0.080384 (0.16937)
5	5.651917	91.61824 (15.4497)	6.326674 (16.1051)	0.299166 (0.48024)	1.343775 (0.90886)	0.269757 (0.48285)	0.142388 (0.31229)
10	6.967745	68.12374 (26.1267)	29.04708 (27.5703)	0.497126 (0.86260)	1.283265 (1.09927)	0.686464 (1.24300)	0.362325 (0.48429)

LERNER:		NPL	LERNER	REGCAP	DEPASS	NONINT	CREDASS
Period	S.E.						
1	1.337417	0.000000 (0.00000)	100.0000 (0.00000)	0.000000 (0.00000)	0.000000 (0.00000)	0.000000 (0.00000)	0.000000 (0.00000)
5	1.872460	0.081078 (0.25562)	99.51752 (0.53814)	0.016652 (0.13651)	0.017184 (0.10316)	0.027679 (0.22145)	0.339890 (0.34162)
10	1.896469	0.159392 (0.49570)	99.26324 (0.97670)	0.043707 (0.23030)	0.088110 (0.17236)	0.042952 (0.41060)	0.402602 (0.55111)

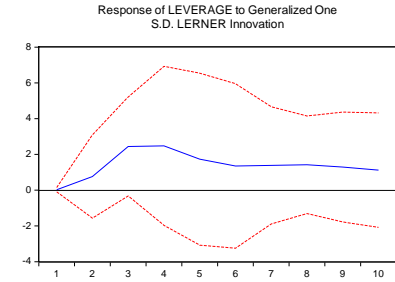
REGCAP:		NPL	LERNER	REGCAP	DEPASS	NONINT	CREDASS
Period	S.E.						
1	2.129910	0.000000 (0.00000)	0.008998 (0.14455)	99.99100 (0.14455)	0.000000 (0.00000)	0.000000 (0.00000)	0.000000 (0.00000)
5	4.466021	0.216587 (0.29456)	40.65494 (22.6521)	58.96699 (22.4158)	0.020849 (0.08182)	0.107745 (0.35023)	0.032896 (0.11978)
10	6.151986	0.805235 (0.85878)	60.82311 (28.3298)	38.08648 (27.8919)	0.025349 (0.15749)	0.058472 (0.71961)	0.201354 (0.28137)

Response of leverage to Lerner (varied samples and specifications)

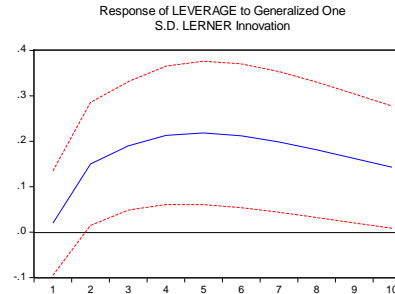
Advanced countries



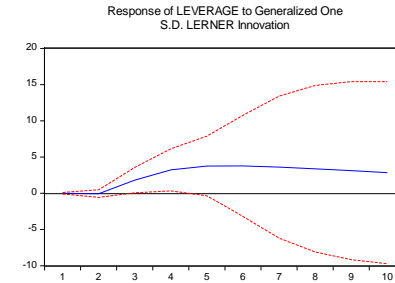
Emerging Market Economies



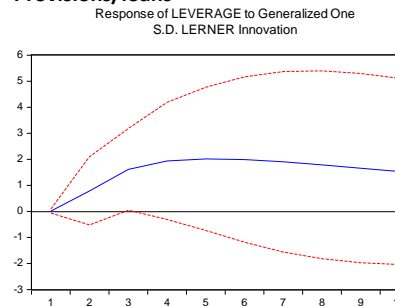
2000-2007



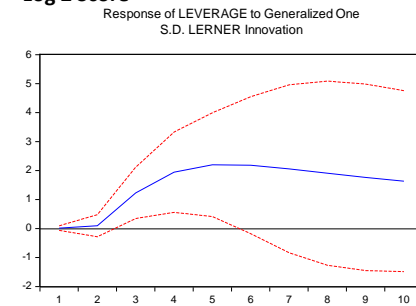
2008-2015



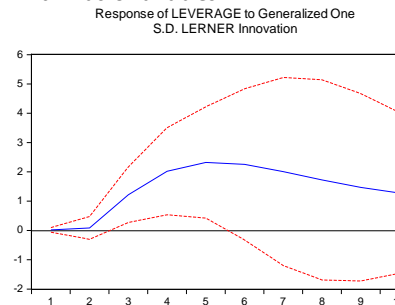
Provisions/loans



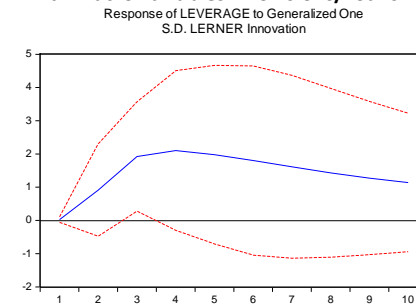
Log Z Score



With macro variables: NPL



With macro variables: Provisions/Loans



Summary of PVAR results

- In impulse responses, **competition drives leverage ratios** significantly, with more competition leading to lower capital ratios and vice versa. There is also a significant **two way relation between leverage and the NPL ratio**, while a shock to Lerner itself does not have a significant direct effect on the NPL ratio. There is no significant impact of competition at 95% on regulatory capital, although there is again an interrelation of regulatory capital and risk.
- In the variance decompositions **competition is autonomous** in both VARs, with over 99% of the variance self-determined even after 10 years. NPLs variance is related to competition albeit not significantly (when leverage is included, 12% after 10 years and 29% with regulatory capital). In contrast, capital (on both measures) is influenced by competition quite significantly (80% with leverage after 10 years and 61% for regulatory capital).
- The **effect of competition on capital in the impulse responses is quite general**, although it is not significant at 95% for emerging market economies. It applies in the cases of advanced countries, pre and post crisis, with the provisions/loans and log Z score measures of risk, and also with the additional macro variables for NPL/loans and for provisions/loans.

Conclusions

- We have highlighted that empirical studies of banking sector risk typically look at either the relationship of competition to risk or bank capital adequacy to risk but rarely integrate the two. This raises an issue of potential bias arising from omission of relevant control variables, and is of particular importance in the light of the introduction of a regulatory leverage ratio in Basel III.
- To address this lacuna, we have undertaken empirical research which assesses the effectiveness of a leverage ratio relative to a measure of the risk adjusted capital ratio in affecting bank risk controlling for competition in the banking sector. We use macro data from the World Bank's Global Financial Development Database over 1999-2015 for up to 120 countries globally.
- Accordingly, our approach is global rather than regional or country specific, enabling results to be derived both globally and dividing countries by stage of economic development. We have obtained new evidence on five unresolved issues in financial stability analysis:

- There is a tendency for both the leverage ratio and the risk adjusted capital ratio to be significant predictors of risk, and for crises and Z score they are supportive of the “skin in the game” hypothesis of a negative relation between capital ratios and risk, whereas for provisions and NPLs they are consistent with the “regulatory hypothesis” of a positive relation of capital adequacy to risk.
- The results for the Lerner Index largely underpin the “competition-fragility” hypothesis rather than “competition stability” and show a widespread impact of competition on risk generally.
- The leverage ratio is much more widely relevant than the risk adjusted capital ratio, underlining its importance as a regulatory tool. The relative ineffectiveness of risk adjusted measures may relate to untruthful or inaccurate assessments of bank real risk exposure.
- There are marked differences between advanced countries and emerging market economies in the capital-risk-competition nexus, with for example a wider impact of competition in emerging market economies (although both types of country need to pay careful attention to the evolution of competition in macroprudential surveillance). Similar pattern to emerging market economies are apparent in many cases for the global sample pre crisis, which arguably are more consistent with normal market functioning than post crisis.
- Competition reduces leverage ratios significantly in a Panel VAR, with impulse responses showing that more competition leads to lower leverage ratios and vice versa. This result is consistent over a range of subsamples and risk variables. In the variance decomposition, we find that competition is autonomous, while the variance of both risk and capital ratios are strongly affected by competition. The Panel VAR results give some indication of the transmission mechanism from competition to risk and financial instability.

- Robustness checks show that the inclusion of key macroeconomic variables and crises do not amend the main results.
- We contend that results such as our own using macroeconomic data may in some ways be superior to those with individual bank data which is more typical of the literature. This is the case not least in that the underlying macro data is a weighted average of individual institutions, thus giving implicitly greater importance to large systemic institutions.
- Further regulatory implications include:
 - the positive relation of bank competition to risk for most risk measures and subsamples, that has often been disregarded by regulators in the past
 - the widespread importance of the leverage ratio, that underlines the appropriateness of its inclusion in Basel III as a complement to risk-adjusted regulatory capital ratios
 - the fact that capital's relation to risk is negative (“skin in the game”) for crises and Z score underlines the importance of overall capital regulation
 - the contrasts in some of the results between advanced countries and emerging markets/developing countries underlines that there is no “one size fits all” for regulation
 - the effect of competition on capital indicates that there are indirect as well as direct effects of competition on risk, again emphasising the importance of the monitoring of competition for macroprudential purposes.

- Further research could include:
 - further breakdown of results between emerging market economies against developing countries
 - could also use coefficients that vary over different horizons for example using the functional coefficients approach as in Herwartz and Xu (2010)
 - since the GFDD is regularly updated, there will in due course be scope to assess robustness including the latest observations.
 - look at the interaction of the risk adjusted capital ratio and the leverage ratio to see if this enhances stability (as it is expected to). This could be undertaken in future once Basel III is properly in place.