

Preliminary - comments welcome

MACROPRUDENTIAL POLICY, BANK COMPETITION AND BANK RISK IN EAST ASIA

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Abstract

- Whereas macroprudential policies have become an essential complement to monetary policy globally since the Sub Prime crisis, a number of East Asian countries adopted macroprudential policies already in 1990s and hence it is particularly fruitful to study their experience. Meanwhile, studies of the effect of macroprudential policy on bank risk tend to disregard the potential complementary role of competition.
- Accordingly, we assess the relation of macroprudential policy and competition to bank risk jointly from a sample of 1373 banks from 13 East Asian countries, using the latest IMF dataset of macroprudential policy from 1990 to 2018.
- Among our results, we have found that macroprudential policies did have an effect on bank risk in East Asian countries, controlling for competition, and whereas there is commonly a beneficial effect on risk at a bank level, there are a number of cases where policies were deleterious (increasing risk). Meanwhile there are a number of interactions between competition and macroprudential measures, generally showing a lesser response in terms of risk reduction for banks in a less competitive position.

Introduction

- Macroprudential policies have become an essential complement to monetary policy since the Sub Prime crisis
- East Asian countries were among the first to adopt macroprudential policies. The mean amount of macroprudential tightening over 1990-2006 was 0.48 for Asian banks and 0.18 elsewhere.
- Research on the effects of macroprudential policy has tended to focus on the impact on bank credit and house prices, mainly at a macro level.
- Till recently, few papers on macroprudential policy effects have used micro data, largely limited to lending growth measures. Most recently a few papers have seen the logic that by changing parameters of banks' management decisions, it is likely that macroprudential policy has an impact on individual bank risk or systemic risk. But they typically do not assess the complementary role of competition
- This is to our knowledge the first paper to focus on the relation of macroprudential policy to bank risk and competition, using the latest IMF dataset from 1990 to 2018.

Literature

- Our work brings together two areas that are to date largely separate, namely the determination of risk at a bank level (including bank competition and capital as independent variables) and the effects of macroprudential policy.
- Although there has been extensive work on bank risk, the number of empirical papers with both competition and capital as independent variables is more limited.
- Tabak et al (2012) using a sample of banks in Latin American countries over 2003-8 and the Z-score as a dependent variable, found a U shaped relation of competition to risk - high and low competition benefit stability while average competition gives rise to instability. Larger banks tend to benefit more in terms of stability from competition. Capital benefits stability of all banks in less competitive markets but only large banks in markets with average and high competition.

- Kick and Prieto (2015) looked at the determinants of bank distress within Germany over 1994-2010, with a focus on the effect of competition at a bank, county and state level. They found that at a bank level, market power enhances stability, but at a market level the relation of competition to risk was negative. Capital is one of the control variables but is not a focus of the analysis.
- de-Ramon et al (2018) find that higher competition in the UK leads to lower leverage ratios, although the effect on stability may be offset by higher profitability.
- Davis et al (2020c) show in a panel VAR using macro data across over 100 countries that more intense competition, as measured by the Lerner index at a country level, tends to increase banking sector risk, as well as leading to a reduction in bank capital, leaving banks less robust.
- Most work on effects of macroprudential policy has used macro data to trace effects on house prices and credit. Key papers include Cerutti et al (2017), Kuttner and Shim (2016), Carreras et al (2018) and Akinci and Olmstead-Rumsey (2018)

- In a recent macro study, Alam et al (2019) confirm that loan-targeted instruments have a significant impact on household credit, and a milder, dampening effect on consumption.
- As regards micro studies, Claessens et al (2013) looked at the effectiveness of macroprudential policy in reducing bank asset growth. for 48 countries. Policies aimed at borrowers were found to be effective in (indirectly) reducing the build-up of banking system vulnerability. Measures aimed at banks' assets and liabilities are also very effective, but countercyclical buffers as a group showed less promise.
- Davis et al (2020a and b) looked respectively at the effects of macroprudential measures on bank profitability and its main subcomponent, the interest rate margin. A number of measures of macroprudential policy had a negative and significant effect on banks' profitability. Effect of macroprudential policy on banks' profitability varied according to country development and bank type. Effects on the interest rate margin are found firstly when they are introduced, secondly in levels and thirdly when leveraged in combination with the level of the interest rate.

- Several recent papers also focus on the effect of macroprudential policies on risk for individual banks, but none relate to the link to competition:
- Altunbas et al (2018) assess the impact of macroprudential policy on two measures of bank risk, the change in the expected default frequency and the change in the Z score, for 3177 banks in 61 countries over 1990-2012. They found a significant negative effect on risk for the onset of macroprudential policies, which is greatest in an upturn and for banks that are small, poorly capitalised and with more wholesale funding.
- Gaganis et al (2020) sought to assess how macroprudential policy and corporate governance together might impact on bank risk, and found that macroprudential policy does indeed condition the effect of corporate governance on risk taking. The more macroprudential policies are introduced (specifically those targeted to financial institutions and not borrowers) the greater the impact of corporate governance on risk taking. They argued macroprudential policies constrain risk taking incentives.
- Meulemann and Vandervennet (2020) investigating the impact of macroprudential policies on systemic risk for EU banks from 2000-2017, found that whereas macroprudential policies do reduce the component of systemic risk related to individual bank risk, the component related to risks arising from systemic linkages was aggravated by some policies and for some types of bank, and this was seen as linked to risk shifting behaviour.

Methodology

- We choose four risk indicators as dependent variables, although we focus mainly on the Z Score. We note that existing work typically uses the Z-Score only, together with market-based data which would limit the sample to listed banks
 - **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 $Z\text{-Score} = (\text{ROA} + (\text{Capital}/\text{Assets})) / \text{SD}(\text{ROA})$. 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 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 two loan quality measures that follow it can be seen as an advance indicator of potential risk.
 - **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 (although with the introduction of IFRS in Europe the latter should have been less evident for European banks over the period since 2005).
 - **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.

- Our model follows the modelling approach of the key competition-risk study by Beck et al (2013), as also employed in Davis and Karim (2018) and Davis et al (2020c). The vector of independent variables characterizes aspects of a banking sector's weighted average business model that contribute to financial stability.
- In particular, we include as control variables proxies for the funding structure linked to liquidity risk (customer deposits to total deposits), asset structure and resultant credit risk (loans to assets ratio and provisions to loans ratio) and revenue mix which also captures market risk exposure as well as scope for diversification (share of non-interest income in total income). With our additional of aggregate leverage ratios and banking sector competition, these are key measures that are relevant for macroprudential surveillance.
- Banking competition is measured by the Lerner Index, derived by estimation of a translog cost function. The Lerner index is a measure of the price-cost margin; it is a proxy for current and future profits stemming from pricing power, and it varies at the level of the individual bank. Under perfect competition the index is zero as the output price (marginal revenue) equals marginal cost, and "normal" economic profits are zero. The Lerner index is positive as a firm's market power increases and price rises above marginal cost in a quantity-setting oligopoly model, with the limiting case being monopoly.

- Further control is provided by the addition of key macroeconomic variables which influence bank behaviour and performance. These are respectively GDP growth, CPI inflation, the presence of a banking crisis as shown in Laeven and Valencia (2018) and the difference and lagged level of the central bank policy interest rate.
- Our data, covering 1990-2018 for 13 East Asian countries are from three sources.
(1) Annual data for banks balance sheets and profit and loss from Fitch Connect
(2) Macro data from the IFS and WDI (3) The latest IMF dataset for macroprudential policy from IMF (2020) as described by Alam et al (2019)
- We choose data for the 100 largest banks for each country in 1995, 2005 and 2015 (or less if there are less in the database) as in Claessens et al (2013). This avoids the sample being dominated by countries with many banks (in this sample, Japan)
- We then incorporate the macroprudential policy data from the latest IMF dataset covering covers 134 countries from January 1990 to December 2018 (IMF (2020) as described in Alam et al (2019)). This dataset provides information on the introduction and removal of policy measures as 0,1,-1 dummies, as well as permitting aggregation across instruments. Note that this is distinct from the earlier datasets of IMF which kept the dummy at 1 as long as the policies are in operation. We aggregate the monthly data to annual observations
- We also cumulate the monthly measures and then annualise to show the stance as well as the implementation of policy (long and short run effects), akin to the level and the change of the monetary policy rate.

- Econometrically we use panel OLS, estimated using the within estimator and pooled FGLS, with year fixed effects and lagged dependent variable. We cluster errors at a country level to correct for in-country correlation and as macroprudential policy is a country level variable, and standard errors and covariances are cluster-robust.
- All control variables are entered as 1-year lags to assess indicator properties and reduce the risk of simultaneity, with two exceptions: the Lerner Index and the policy rate are both entered as a current first difference and first lagged level to enable short and long run effects to be distinguished, as also for macroprudential policy.
- The first difference of Lerner is instrumented prior to estimation of the risk equations, as are capital measures prior to estimation of the Z-score equation. All variables except the banking crisis dummy are winsorised at 99%.

Country and bank coverage

Country	ISO Code	IMF category	No. of banks	
			ADV	EME
Australia	AUS	ADV	154	
China	CHN	EME		129
Hong Kong	HKG	ADV	129	
India	IND	EME		127
Indonesia	IDN	EME		166
Japan	JPN	ADV	158	
Korea	KOR	ADV	142	
Malaysia	MYS	EME		97
Mongolia	MNG	EME		13
New Zealand	NZL	ADV	45	
Philippines	PHL	EME		98
Singapore	SGP	ADV	57	
Thailand	THA	EME		58
Total	13		685	688

Variable statistics

(winsorised at 99% except Bank Crisis)

	Mean	Median	Maximum	Minimum	Std. Dev.	Observations	
D LOG LOANS	0.103	0.097	1.447	-1.119	0.274	14958	
POLICY RATE	5.408	5.000	48.238	0.100	4.863	36959	
LERNER INDEX	0.239	0.243	0.645	-0.962	0.189	12185	
CUST DEP SHARE	0.913	0.981	1.000	0.007	0.167	15263	
NONINT RATIO	0.263	0.216	1.268	-0.542	0.256	16351	
LOAN/ASSETS	0.591	0.611	0.999	0.003	0.201	16461	
PROVISIONS/LOANS	1.089	0.550	18.752	-3.150	2.160	13123	
LEVERAGE RATIO	0.121	0.078	0.900	0.002	0.142	16810	
LOG ASSETS	22.016	22.089	27.117	16.054	2.357	17048	
GDP GROWTH	4.727	4.824	11.467	-8.669	3.367	39817	
INFLATION	4.380	3.079	268.151	-0.923	7.256	39778	
BANK CRISIS	0.078	0.000	1.000	0.000	0.268	39817	
NPL RATIO	0.053	0.026	0.633	0.000	0.082	10800	
LOG Z SCORE	3.790	3.869	6.990	-4.221	1.375	13217	

Baseline regression results

	LOG Z SCORE	LOAN GROWTH	PROVISIONS RATIO	NON PERFORMING LOAN RATIO
C	1.037*** (3.8)	0.173* (2.0)	-0.69 (0.9)	0.0366** (2.8)
LAGGED DEPENDENT	0.616*** (28.6)	0.123*** (4.0)	0.36*** (3.8)	0.735*** (21.9)
D POLICY RATE	-0.00702 (0.9)	-0.0003 (0.1)	0.304*** (19.0)	0.00695*** (8.0)
POLICY RATE(-1)	0.00136 (0.1)	-0.00082 (0.5)	0.128*** (5.5)	0.00217*** (4.8)
D LERNER INST	0.593*** (3.3)	0.0162 (1.3)	0.378 (1.1)	-0.0157 (1.0)
LERNER (-1)	0.581** (3.0)	0.0641 (1.7)	0.183 (0.5)	0.000922 (0.1)
CUST DEP SHARE(-1)	0.228* (2.0)	0.0231 (1.1)	-0.284 (1.7)	-0.0194 (1.5)
NONINT RATIO(-1)	-0.156* (1.8)	-0.0134 (0.6)	-0.0432 (0.1)	-0.0024 (0.4)
LOAN/ASSET RATIO(-1)	-0.313* (2.0)	-0.166** (3.0)	0.441 (1.1)	0.00689 (0.5)
PROVISIONS/LOANS(-1)	-0.0649*** (4.1)	-0.00668 (1.8)		0.00141 (0.8)
LEVERAGE RATIO INST(-1)	0.278 (1.1)	-0.103** (2.4)	0.309 (0.8)	-0.0187 (1.1)
D LOG ASSETS	-0.152 (1.2)	0.738*** (11.9)	-0.978** (2.9)	-0.0504*** (3.3)
LOG ASSETS (-1)	0.0286* (2.0)	-0.00363 (1.4)	0.0419 (1.2)	-0.00064 (1.1)
GDP GROWTH(-1)	-0.0135** (2.6)	0.00222 (1.1)	-0.0191 (0.7)	-0.00083 (1.5)
INFLATION (-1)	0.00182 (0.3)	-0.00089 (0.4)	-0.0166 (0.8)	0.000416 (0.5)
BANK CRISIS (-1)	-0.336** (2.5)	0.0314 (1.7)	0.356* (1.9)	-0.0132 (0.8)
PERIODS	26	26	26	26
R2	0.527	0.581	0.400	0.711
OBSERVATIONS	6897	7342	7072	5711
BANKS	886	894	890	770

Comments on the results

- Competition mainly impacts directly on the Z score, where a rise in competition (smaller Lerner index) also raises risk (lower Z score). Risk is also raised according to Z Score by lower customer deposit ratio and smaller total assets, higher non-interest income, a higher loan/asset ratio, higher provisions, faster economic growth and a banking crisis.
- Loan growth rises with higher bank assets, while it is restrained by higher capital ratios and loan/asset ratios. Provisions are higher in the case of a rising or higher policy rate and a banking crisis, while they are negatively related to asset growth. Non performing loans are again linked to tighter monetary policy and lower asset growth
- There are significant lagged dependent variables for each equation.

Macroprudential policies

- CCB Countercyclical buffer
- CONSERVATION conservation buffer
- CAPITAL Capital requirements
- LVR Leverage requirements
- LLP Provisioning requirements
- LCG Credit growth limits
- LOANR Loan restrictions
- LFC Limits on Foreign Currency Loans
- LTV Loan to value limits
- DSTI Debt to income limits
- TAX Levy/Tax on Financial Institutions
- LIQUIDITY Liquidity measures
- LTD Loan to deposit limits
- LFX Limits on FX operations
- RR Reserve requirements
- SIFI SIFI surcharges
- OTHER Other macroprudential measures

Summary measures

- MaPP index” is the sum of dummies for all of 17 categories.
- “Loan-targeted” group consists of the “Demand” and the “Supply-loans” instruments.
- “Demand”: LTV and DSTI.
- “Supply-loans”: provisioning requirements, credit growth limits, loan restrictions, limits to the loan to deposit ratio, and limits to foreign currency loans.
- “Supply-general”: reserve requirements, liquidity requirements, and limits to FX positions.
- “Supply-capital”: leverage, countercyclical buffers, conservation buffers, and capital requirements.

Results for Z score and individual instruments

	Macropprudential variables only		Macropprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*DC	(MP*C)-1
CCB	0.0179 (0.2)	0.105*** (3.5)	0.0382 (0.5)	0.31*** (3.5)	-2.09 (1.7)	-0.729*** (3.3)
CONSERVATION	-0.171** (2.5)	0.069** (2.2)	-0.171* (2.5)	0.0792* (1.9)	-0.306 (1.1)	-0.0466 (0.4)
CAPITAL	-0.0627 (1.2)	0.005 (0.3)	-0.0508 (1.0)	0.0368 (1.1)	1.237** (2.7)	-0.127 (1.8)
LVR	-0.258** (2.8)	-0.0141 (0.2)	-0.269** (2.9)	-0.063 (0.5)	-0.359 (0.5)	0.159 (0.8)
LLP	-0.212*** (6,2)	-0.032 (1.6)	-0.195*** (4.9)	-0.0229 (0.8)	0.514 (1,1)	-0.0355 (0.6)
LCG	-0.117* (2.1)	-0.0233 (0.3)	-0.131** (2.3)	-0.0314 (0.2)	2.152*** (4.6)	0.036 (0.1)
LOANR	-0.00788 (0.3)	0.0178** (2.6)	-0.0185 (0.8)	0.0676*** (5.1)	-0.701* (2.0)	-0.152*** (4.3)
LFC	0.237*** (4.4)	-0.148*** (3.9)	0.261*** (4.8)	-0.14*** (3.1)	0.632** (2.9)	-0.029 (0.5)
LTV	0.0148 (0.5)	-0.0051 (0.3)	0.021 (0.7)	0.0151 (0.5)	-0.352** (3.0)	-0.0623 (1.0)
DSTI	0.0125 (0.3)	-0.0356 (1.0)	0.0108 (0.2)	-0.022 (0.5)	-0.157 (0.7)	-0.044 (0.8)
TAX	0.098*** (3.4)	0.0308* (2.2)	0.1*** (3.4)	0.1*** (3.6)	-0.082 (0.4)	-0.245*** (3.4)
LIQUIDITY	0.0089 (0.3)	-0.0318 (1.6)	0.00838 (0.2)	-0.0115 (0.6)	-0.436 (1.1)	-0.061 (1.7)
LTD	-0.089* (2.2)	-0.282** (2.6)	-0.111** (2.6)	-0.259** (2.2)	-0.925*** (10.6)	-0.0813 (0.8)
LFX	-0.06 (1.4)	-0.087*** (3.7)	-0.057 (1.3)	-0.103* (2.1)	0.528*** (3.3)	0.0612 (0.4)
RR	0.019 (0.8)	0.0061* (2.2)	0.0156 (0.7)	0.0158** (2.3)	-0.234*** (4.1)	-0.03* (1.8)
SIFI	-0.098 (1.4)	-0.078 (1.6)	-0.094 (1.4)	-0.085 (1.0)	-0.336 (1.1)	0.0194 (0.1)
OTHER	-0.0663* (2.0)	0.091*** (3.5)	-0.039 (1.1)	0.18*** (4.5)	0.621 (1.7)	-0.339** (2.2)

Key findings for individual measures

- In the short run, Z score is boosted (risk is lower) when there is tightening of foreign currency lending (LFC) and tax measures (TAX). It is reduced (risk is higher) at the tightening of conservation buffers (CCB), leverage ratios (LVR), provision measures (LLP), loan to deposit (LTD) and other measures (OTH).
- As regards the long run stance of macroprudential policy, risk according to Z score is lower with countercyclical buffers (CCB), conservation buffers (CONSERVATION), loan growth limits (LOANR), tax measures (TAX), reserve requirements (RR) and other measures (OTH). But Z score is lower and risk higher in the long run with foreign currency lending measures (LFC), loan to deposit (LTD) and foreign currency position limits (LFX).
- The same variables are significant with the same sign when we add the leveraged competition measures. However, there are a number of adjustments in the case of a higher or lower level of competition at the bank level. In most cases this implies a lower or more negative effect of the macroprudential measure for banks with a rising or high Lerner index (stronger market position). So macroprudential policy is less effective or more counter productive in respect of risk reduction
- For example the long run effect of macroprudential policy on the Z score is less positive for the countercyclical buffer (CCB), loan growth limits (LOANR), tax measures (TAX), reserve requirements (RR) and other measures (OTH). On the other hand there is no adjustment of the long run effect where the effect of the stance is negative (foreign currency lending measures (LFC), loan to deposit (LTD) and foreign currency position limits (LFX))
- There are also some adjustments when competition is rising and policy is tightened (DMP*DC). In several cases the short run effect is only present when competition is also changing.

Z score and Summary variables

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*DC	(MP*C)-1
MAPP-INDEX	-0.00724 (1.5)	0-.001 (0.4)	-0.0068 (1.4)	0.0075* (1.9)	-0.122 (1.7)	-0.0194** (2.7)
LOAN-TARGETED	-0.0091 (0.5)	-0.004 (0.5)	-0.009 (0.5)	0.00452 (0.4)	-0.25** (2.2)	-0.026 (1.4)
DEMAND	0.013 (0.6)	-0.00762 (0.6)	0.014 (0.7)	0.00485 (0.2)	-0.277** (2.3)	-0.0395 (1.0)
SUPPLY-ALL	-0.0148 (1.6)	0.00122 (0.4)	-0.0154* (1.8)	0.00823 (1.7)	-0.15 (1.4)	-0.021** (2.2)
SUPPLY-LOANS	-0.0527* (1.8)	-0.0065 (0.5)	-0.057* (2.1)	0.0075 (0.4)	-0.416 (1.2)	-0.0415 (1.3)
SUPPLY-GENERAL	0.0114 (0.6)	0.0027 (0.8)	0.008 (0.5)	0.011 (1.5)	-0.244* (2.0)	-0.027 (1.6)
SUPPLY-CAPITAL	-0.103*** (4.7)	0.023 (1.4)	-0.1*** (4.0)	0.031 (1.0)	0.0017 (0.1)	-0.03 (0.4)

Key findings for summary measures

- Tightening of supply-loans and supply-all has a negative effect on the Z score but there are no significant long run effects if the leveraged coefficients are excluded.
- Inclusion of leveraged measures shows a positive effect (risk reducing) of all measures together (MAPP-Index) in the long run, albeit less so when market power is high. There is a negative effect for supply-all which is greater for cases with high market power.

Observations on subsamples and global sample (Appendix tables)

- We looked separately at the countries in our sample that are in the advanced and the EME categories, according to the IMF. We focus on results for the Z Score
- There are some differences in the effects of macroprudential policies on bank risk as measured by the Z score. The risk-reducing effect of macroprudential policy is most apparent in the EMEs
- There remain a considerable number of significant leveraged effects in each subsample, showing the competition effect is not just a consequence of country-development (measures are close - the average Lerner index for the EME banks is 0.24 and advanced countries 0.23)
- The global sample is comparable to Asia in terms of effects of policy. It shows less leveraged effects than Asia. This may result from a more recent introduction of macroprudential but also differences at a regional level.

Alternative risk measures: loan growth

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*DC	(MP*C)-1
CCB	-0.0133 (0.8)	-0.0082 (0.8)	-0.0061 (0.4)	0.0457*** (3.8)	-0.209** (2.3)	-0.188*** (3.3)
CONSERVATION	-0.0222** (2.8)	-0.0058 (0.9)	-0.0224** (2.9)	-0.0087 (0.7)	0.046 (0.7)	0.011 (0.5)
CAPITAL	0.002 (0.4)	0.0027 (1.3)	0.0028 (0.5)	0.0014 (0.3)	0.111** (2.7)	0.0061 (0.3)
LVR	-0.0343* (2.1)	-0.002 (0.3)	-0.0337* (2.1)	-0.01 (0.6)	0.127** (2.6)	0.0259 (0.4)
LLP	-0.00035 (0.1)	0.0003 (0.1)	-0.00001 (0.1)	-0.0029* (2.0)	0.0511 (0.7)	0.0163* (1.8)
LCG	-0.18 (0.2)	-0.0251*** (3.1)	-0.0085 (0.2)	0.0191 (0.9)	0.0188 (0.2)	-0.164* (2.0)
LOANR	-0.0047 (0.1)	-0.0027 (1.5)	-0.0037 (0.6)	0.00435 (1.2)	0.819* (2.0)	-0.0215* (1.9)
LFC	0.0603* (2.0)	0.0064 (1.6)	0.061* (2.0)	-0.00078 (0.1)	0.0283 (0.9)	0.0265*** (3.2)
LTV	0.0105* (2.0)	-0.003* (1.9)	0.0099* (2.1)	-0.0007 (0.2)	0.0375* (2.1)	-0.0071 (0.5)
DSTI	-0.0049 (0.6)	0.00066 (0.2)	-0.0036 (0.4)	-0.0008 (0.2)	0.0596 (1.4)	0.00477 (0.3)
TAX	0.0172** (2.8)	-0.0015 (0.8)	0.0175** (2.8)	0.0061 (1.4)	0.0582* (2.0)	-0.0262 (1.7)
LIQUIDITY	-0.0048 (0.5)	0.00547** (2.5)	-0.0048 (0.5)	0.0012 (0.4)	0.0611*** (3.1)	0.0145** (2.4)
LTD	0.00218 (0.2)	-0.00087 (0.1)	0.001 (0.1)	-0.0172* (1.8)	-0.0392 (1.1)	0.0634** (2.4)
LFX	-0.0058 (0.4)	-0.00247 (0.5)	-0.00525 (0.4)	0.00432 (0.3)	0.196*** (7.5)	-0.0249 (0.5)
RR	-0.001 (0.2)	-0.00123** (2.3)	-0.001 (0.2)	0.0037*** (4.1)	-0.0159 (1.5)	-0.0154*** (4.3)
SIFI	0.00702 (0.5)	-0.0166 (1.4)	0.0068 (0.5)	-0.0228 (1.3)	0.0195 (0.3)	0.0199 (0.7)
OTHER	-0.0244*** (4.2)	0.0089** (2.4)	-0.0231*** (3.6)	0.0111* (2.0)	0.0347 (1.3)	-0.0091 (0.4)

Observations on results for loan growth

- A number of macroprudential policies restrain loan growth in the short term (CONSERVATION, LVR, OTHER) and the long run (LCG, LTV and RR) although others have a significant positive sign. Claessens et al (2013) also found LCG and LTV limited loan growth
- The restraining effect of LCG and RR is greater for banks with more market power and restraint of lending is also shown for banks with more market power from CCB and LOANR. On the other hand, there is more of a boost to lending in the case of LLP, LFC and LIQUIDITY when there is market power

Alternative risk measures: Provisions ratio

	Macprudential variables only		Macprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*DC	(MP*C)-1
CCB	-0.191* (2.1)	-0.056 (0.4)	-0.284** (2.8)	-0.67** (2.9)	1.34 (1.5)	2.134*** (3.5)
CONSERVATION	0.266*** (3.9)	0.051 (0.7)	0.251*** (3.9)	-0.106 (1.1)	1.1 (1.7)	0.518 (1.7)
CAPITAL	0.096 (1.1)	-0.013 (0.4)	0.083 (0.9)	-0.073 (0.8)	-1.03 (1.5)	0.25 (0.8)
LVR	0.125 (1.0)	0.293** (2.6)	0.098 (0.9)	0.141 (0.9)	-0.805 (1.0)	0.507 (1.2)
LLP	0.151 (1.5)	0.0567** (2.5)	0.153 (1.6)	-0.0093 (0.2)	-0,764 (1.5)	0.257* (1.9)
LCG	0.449 (1.5)	0.25** (3.0)	0.461 (1.5)	0.24 (0.9)	-1.84** (2.3)	0.02 (0.2)
LOANR	0.065 (0.5)	0.0021 (0.1)	0.07 (0.6)	-0.108* (2.0)	0.025 (.1)	0.338** (2.7)
LFC	0.0761 (0.6)	0.099** (2.3)	-0.041 (0.3)	-0.022 (0.6)	-2.84 (1.5)	0.453*** (3.5)
LTV	-0.0162 (0.2)	0.0263 (1.8)	-0.0175 (0.3)	-0.0355 (1.0)	0.115 (0.1)	0.195 (1.7)
DSTI	0.124 (0.2)	0.037 (0.8)	0.0122 (.2)	-0.075 (1.3)	0.522 (0.8)	0.403*** (3.1)
TAX	-0.121** (2.5)	-0.074*** (6.5)	-0.126** (2.7)	-0.203*** (4.2)	-0.8 (1.6)	0.443** (2.7)
LIQUIDITY	-0.049 (0.6)	0.027 (1.0)	-0.05 (0.7)	-0.0468 (1.6)	0.383 (0.7)	0.263*** (4.3)
LTD	-0.516 (0.4)	-0.218** (2.6)	-0.05 (0.5)	-0.0761 (1.0)	-0.0137 (0.1)	1.11*** (5.6)
LFX	0.195** (2.2)	-0.111* (2.0)	0.197** (2.2)	0.129 (0.9)	0.495 (0.5)	-0.0679 (0.2)
RR	-0.03** (2.5)	-0.0027 (0.3)	-0.03** (2.3)	-0.03** (2.4)	0.0619 (0.4)	0.0859*** (3.2)
SIFI	0.291*** (3.6)	0.0914 (0.8)	0.277*** (3.2)	-0.05 (0.3)	1.051 (1.5)	0.451 (1.1)
OTHER	-0.034 (.4)	-0.0278 (0.4)	-0.089 (0.9)	-0.287** (2.5)	-0.946 (1.2)	0.992** (2.9)

Alternative risk measures: NPL ratio

	Macropprudential variables only		Macropprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*DC	(MP*C)-1
CCB	0.0025 (1.1)	-0.00846** (2.2)	0.0004 (0.2)	-0.022** (2.9)	0.0407 (1.4)	0.0478** (2.4)
CONSERVATION	0.00565* (2.0)	-0.00183 (0.6)	0.00668** (2.4)	0.0076 (1.2)	0.0508* (2.1)	-0.0251 (1.6)
CAPITAL	-0.00047 (0.3)	0.0008 (0.8)	-0.00022 (0.1)	0.0039** (2.5)	-0.0025 (0.2)	-0.0126** (2.7)
LVR	0.0027 (0.5)	0.00005 (0.1)	0.0041 (0.7)	0.0133* (1.8)	0.0002 (0.1)	-0.043* (2.1)
LLP	-0.0008 (0.2)	0.00128 (1.3)	0.0002 (0.1)	0.0043*** (5.0)	0.0074 (0.5)	-0.0114*** (4.7)
LCG	0.0037 (0.7)	0.0042 (1.1)	0.0039 (0.7)	0.0134 (1.5)	0.0055 (0.3)	-0.0338 (1.3)
LOANR	-0.0013 (0.5)	-0.00088 (1.3)	-0.0011 (0.4)	-0.0005 (0.3)	0.0147 (1.2)	-0.0012 (0.3)
LFC	0.0036 (0.7)	0.00017 (0.1)	0.00314 (0.6)	0.00382 (1.7)	-0.0238 (1.1)	-0.0131*** (6.1)
LTV	-0.0005 (0.3)	-0.00015 (0.2)	-0.0008 (0.5)	0.00245 (1.6)	0.00853 (1.6)	-0.0081** (2.4)
DSTI	0.003 (1.1)	-0.0012 (0.7)	0.00326 (1.2)	0.00218 (0.9)	0.00206 (0.1)	-0.0119*** (3.4)
TAX	-0.00284** (2.2)	-0.0007 (1.4)	-0.00287** (2.3)	-0.00051 (0.4)	-0.00934 (0.9)	-0.00073 (0.2)
LIQUIDITY	-0.0073** (2.9)	-0.00143 (1.8)	-0.00738** (2.7)	-0.00001 (0.1)	0.0317** (2.5)	-0.00574** (2.4)
LTD	-0.0095* (1.9)	0.00114 (0.2)	-0.0086 (1.7)	0.0107* (1.9)	0.0264*** (7.9)	-0.0355*** (5.1)
LFX	0.00455*** (3.1)	0.00333 (1.4)	0.0043*** (3.1)	0.0091* (2.0)	-0.0358 (1.2)	-0.0215* (2.0)
RR	-0.00084 (1.1)	-0.00032 (1.5)	-0.00073 (1.0)	-0.00082* (1.9)	0.0107 (1.2)	0.0016 (1.5)
SIFI	0.00543 (1.8)	0.0009 (0.4)	0.00485 (1.8)	0.0124 (1.8)	0.0463* (1.9)	-0.036* (2.4)
OTHER	-0.0038 (1.5)	-0.0015 (0.7)	-0.00383 (1.5)	0.0011 (0.3)	-0.00948 (0.6)	-0.0094 (0.9)

Observations on results for provisions and NPLs

- Provisions are lower in the long run with TAX, LTD and LFX but higher with LVR, LLP, LCG and LFC. There is a less negative or more positive effect for a number of these measures when market power is greater
- NPLs are only seen to be affected in the long term by CCB (negatively) if market power is not taken into account. When market power is allowed for a number of positive effects emerge, but these are less marked for banks with market power.

Conclusions

- We have found that macroprudential policies did have an effect on bank risk in East Asian countries, and whereas there is commonly a beneficial effect on risk, there are a number of cases where policies were deleterious (increasing risk)
- The implication is that the introduction of such policies should lead to heightened microprudential oversight and macroprudential surveillance.
- There are a number of interactions between competition and macroprudential measures showing a different response for banks with more or less market power.
- On balance the policies tend to be less effective where there is market power, which is an issue relevant to policy makers. Market power may enable banks to adjust internally to offset the effects of policy, possibly by risk-shifting as suggested by Meulemann and Vandervennet (2019).

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Appendix: Advanced Asia Z Score

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*DC	(MP*C)-1
CCB	-0.0796 (0.8)	0.0158 (0.3)	-0.0286 (0.3)	0.0685 (1.2)	-1.66*** (5.4)	-0.289*** (4.1)
CONSERVATION	-0.142 (1.6)	-0.114** (2.6)	-0.117 (1.3)	-0.112 (1.1)	-0.653** (2.9)	-0.0409 (0.3)
CAPITAL	0.137 (1.6)	-0.0896* (2.3)	0.147 (1.5)	-0.0451 (1.0)	0.417 (0.9)	-0.151 (1.3)
LVR	-0.634*** (7.2)	-0.182 (1.2)	-0.575*** (6.8)	-0.351** (2.4)	-1.278*** (3.9)	0.452** (2.7)
LLP	-0.115 (1.1)	-0.0921*** (3.1)	-0.119 (1.2)	-0.118*** (4.1)	-0.282 (1.1)	0.0898* (1.8)
LCG						
LOANR	0.0363 (0.5)	-0.014 (0.2)	0.0344 (0.5)	-0.0013 (0.1)	-1.261*** (5,2)	-0.0253 (0.2)
LFC	0.512*** (3.5)	-0.163*** (3.9)	0.623*** (4.1)	-0.204*** (4.4)	2.6*** (9.5)	0.141 (1.8)
LTV	0.065** (3.0)	-0.0636*** (3.6)	0.084*** (4.0)	-0.0782*** (4.2)	-0.448*** (3.8)	0.052* (2.1)
DSTI	0.053 (1.2)	-0.0871*** (5.0)	0.05 (1.1)	-0.11*** (4.7)	-0.0604 (0.2)	0.0821 (2.0)
TAX	0.121 (1.8)	0.044 (1.3)	0.124 (1.8)	0.103 (1.9)	0.085 (0.2)	-0.19 (1.9)
LIQUIDITY	-0.053 (0.7)	-0.0898* (2.7)	-0.2 (0.3)	-0.0846*** (4.1)	-1.15*** (9.3)	-0.0065 (0.2)
LTD	-0.09 (0.7)	-0.499*** (3.8)	1.622*** (11.2)	-0.624*** (4.3)	21.1*** (49.3)	0.426 (1.8)
LFX	-0.03 (0.4)	-0.325** (3.7)	-0.0347 (0.5)	-0.265** (3.0)	0.484 (1.9)	-0.219** (3.2)
RR	0.343 (1.7)	0.239* (2.2)	0.342 (1.9)	0.269** (2.7)	-0.405 (0.6)	-0.108 (0.6)
SIFI	-0.033 (0.2)	-0.012 (0.2)	-0.0044 (0.1)	0.0519 (0.5)	-0.761* (2.5)	-0.173 (0.8)
OTHER	-0.1 (0.1)	0.051 (1.2)	-0.01 (0.1)	0.106 (1.6)	-0.324 (0.5)	-0.278 (1.0)

Asia EME Z Score

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*DC	(MP*C)-1
CCB	0.0761 (0.9)	0.11** (3.2)	0.0463 (0.6)	0.314* (2.1)	-2.5 (1.1)	-0.752 (1.5)
CONSERVATION	-0.106 (1.9)	0.086* (2.3)	-0.102 (1.7)	0.075 (1.5)	0.249 (0.8)	0.051 (0.3)
CAPITAL	-0.102** (3.7)	0.0119 (0.6)	-0.089** (3.1)	0.015 (0.6)	1.18* (2.0)	-0.0134 (0.2)
LVR	-0.092 (1.0)	0.034 (0.4)	-0.0554 (0.7)	0.0756 (0.5)	1.042 (1.6)	-0.127 (0.5)
LLP	-0.156** (3.6)	0.0095 (1.4)	-0.122** (2.5)	0.04 (1.3)	0.863** (2.8)	-0.13 (1.2)
LCG	-0.129* (2.3)	-0001 (0.1)	-0.138* (2.2)	0.097 (0.7)	1.98** (3.2)	-0.392 (1.1)
LOANR	-0.01 (0.4)	0.0197* (2.2)	-0.017 (0.7)	0.0779*** (5.6)	-0.141 (0.4)	-0.18*** (4.6)
LFC	0.226** (3.0)	-0.446 (3.5)	0.253** (3.6)	-0.545** (3.4)	0.712* (2.4)	0.322 (1.1)
LTV	0.0378 (1.8)	0.0198 (1.8)	0.034* (2.1)	0.093*** (5.1)	-0.052 (0.2)	-0.215*** (5.0)
DSTI	-0.159 (1.4)	0.016** (2.7)	-0.158 (1.5)	0.123 (1.0)	0.022 (0.1)	-0.058 (0.2)
TAX	0.092** (2.9)	0.029* (2.2)	0.084** (2.5)	0.1*** (5.2)	-0.32 (0.8)	-0.253*** (3.9)
LIQUIDITY	0.035 (0.7)	0.0138 (0.5)	0.0335 (0.7)	-0.0416 (1.4)	0.0359 (0.2)	0.2** (2.7)
LTD	0.0019 (0.1)	-0.0728 (1.4)	-0.021 (1.0)	-0.12* (2.3)	1.02*** (11.1)	0.189 (1.4)
LFX	-0.055 (0.9)	-0.091*** (4.1)	-0.051 (0.8)	-0.0811 (1.7)	0.337* (2.1)	-0.034 (0.2)
RR	0.018 (0.6)	0.0047 (1.3)	0.0134 (0.5)	0.0222** (3.0)	-0.219** (3.0)	-0.055** (2.8)
SIFI	-0.106* (2.1)	-0.128** (3.1)	-0.102* (2.1)	-0.229** (3.6)	0.434 (1.8)	0.365 (1.6)
OTHER	-0.109** (3.1)	0.09*** (4.4)	-0.086** (2.9)	0.151*** (4.8)	0.545 (1.3)	-0.211* (2.3)

Global sample Z Score

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*DC	(MP*C)-1
CCB	0.0072 (0.1)	0.1*** (3.5)	0.019 (0.4)	0.123** (2.2)	-0.483*** (3.1)	-0.07 (0.6)
CONSERVATION	0.0105 (0.3)	0.119*** (4.2)	0.0116 (0.3)	0.0975*** (3.7)	-0.136 (1.5)	0.08 (1.0)
CAPITAL	-0.0301 (1.0)	-0.0125 (1.0)	-0.028 (0.9)	-0.0339*** (2.9)	0.0773 (1.6)	0.09*** (3.1)
LVR	-0.033 (0.4)	0.091 (1.5)	-0.0332 (0.4)	0.126** (2.2)	0.219 (0.9)	-0.128 (1.4)
LLP	-0.064 (1.2)	-0.004 (0.2)	-0.0576 (1.1)	0.0096 (0.4)	0.146 (1.3)	-0.053 (0.9)
LCG	-0.139*** (2.9)	0.043 (0.9)	-0.148*** (3.1)	0.01 (0.1)	0.07 (0.5)	0.131 (0.5)
LOANR	0.0067 (0.2)	0.0089 (0.9)	0.004 (0.1)	0.008 (0.3)	-0.229* (1.8)	0.003 (0.1)
LFC	0.117*** (4.8)	-0.0292 (1.4)	0.114*** (4.7)	-0.0113 (0.8)	0.0206 (0.3)	-0.0762 (1.6)
LTV	0.0089 (0.5)	-0.01 (0.7)	0.0116 (0.6)	-0.0277 (1.2)	-0.233*** (3.2)	0.0583 (1.1)
DSTI	0.0207 (0.7)	-0.053** (2.3)	0.0217 (0.7)	-0.071*** (2.9)	-0.167* (1.9)	-0.073 (0.9)
TAX	0.038 (1.6)	0.00383 (0.2)	0.038 (1.6)	0.0013 (0.1)	-0.0095 (0.2)	0.0096 (0.2)
LIQUIDITY	-0.00036 (0.1)	-0.00065 (0.1)	-0.0017 (0.1)	0.00068 (0.1)	-0.176** (2.3)	-0.0066 (1.2)
LTD	0.1 (1.4)	-0.12* (1.7)	0.085 (1.3)	-0.167*** (3.6)	-0.238 (1.1)	0.139 (0.8)
LFX	-0.0228 (0.6)	-0.03* (1.8)	-0.0223 (0.6)	-0.057** (2.5)	0.0658 (0.4)	0.103* (1.9)
RR	0.00672 (0.6)	-0.002 (0.4)	0.0069 (0.6)	-0.0051 (0.7)	-0.032 (1.2)	0.011 (1.0)
SIFI	-0.0523 (1.4)	0.0305 (0.9)	-0.0489 (1.3)	0.012 (0.3)	-0.229** (2.0)	0.0618 (0.6)
OTHER	-0.0164 (0.7)	0.0368 (1.6)	-0.0179 (0.8)	0.0229 (0.8)	-0.0684 (0.7)	0.059 (0.9)