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Macroprudential Policy, Bank Competition and Bank Risk in East Asia

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Abstract

Studies of the effect of macroprudential policy on bank risk tend to disregard the potential complementary role of bank competition, which could influence policy's effectiveness in achieving its financial stability objectives. 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 whereas macroprudential policies did commonly have a beneficial effect on risk at a bank level controlling for competition, there are a number of cases where policies were deleterious through increased risk. Notably in the developing and emerging East Asian countries and in the short term, the interactions between competition and macroprudential measures often show a lesser response in terms of risk reduction for banks with more market power, a form of "competition-stability". We suggest that this links in turn to ability of such banks to undertake risk-shifting in response to macroprudential policy. On the other hand, we find for banks in advanced East Asian countries some tendency in the long term for banks facing intense competition to take relatively more risks in face of macroprudential measures, i.e. "competition fragility". These findings provide important implications for regulators.

Keywords: Macroprudential policy, bank risk, Z score, bank competition

JEL Classifications: E44, E58, G17, G28

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1 Introduction

Macroprudential policies, which seek to limit financial imbalances and generate robustness in the financial sector, have become an essential complement to monetary policy since the Sub Prime crisis. However, macroprudential policies did exist before 2007 as well. Notably, East Asian countries were among the first to adopt macroprudential policies in the wake of the earlier Asian crisis of 1997. As an illustration of this, using the IMF (2020) database of macroprudential policy actions, we find the average annual amount of macroprudential tightening over 1990-2006 was 0.48 for Asian banks and 0.18 elsewhere.[1]

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, and those were largely focused on lending growth measures. Most recently, a few papers have seen the logic that by affecting banks' management decisions, it is likely that macroprudential policy has an impact on individual bank 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 iMaPP dataset of macroprudential measures from 1990 to 2018 and accompanying data from the Fitch-Connect database of banks' financial statements. It also distinguishes short and long run effects of macroprudential policy, in contrast to most of the existing literature.

Among our results, we find 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, showing the effect of policy is not neutral across banks in terms of competition. Notably in the developing and emerging East Asian countries and in the short term, these often show a lesser response in terms of risk reduction for banks with more market power, a form of "competition stability". We suggest that this links in turn to ability of such banks to undertake risk-shifting in response to macroprudential policy. On the other hand, we find for advanced East Asian countries some tendency in the long term for banks facing intense competition to take relatively more risks in face of macroprudential measures, a form of "competition-fragility". A variant undertaking similar tests for a sample of European banks has a similar outcome. There are important implications for regulators.

The paper is structured as follows: Section 2 provides a literature survey, focusing on the one hand on work on competition, capital and risk and on the other hand on estimates of macroprudential policy effects, which together form the background for our work. Section 3 introduces the methodology and Section 4 shows the data and descriptive statistics. Section 5 presents the results and Section 6 shows robustness checks, while Section 7 shows some comparative global and European estimates, and Section 8 concludes.

2 Literature review

Our work brings together two areas of research that have to date been 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 on bank risk.

To begin with a summary point, the competition/risk literature is divided between those works which support "competition-fragility", that more competition leads to higher risk, and "competition-stability", which suggests more competition leads to lower risk. Capital adequacy is generally not included as a control variable.

[1] This calculation is based on the aggregate measure of tightening which is named as "Mapp Index" in Table 4.

According to "competition-fragility" (Keeley, 1990), 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 both by new entrants (including from abroad, where permitted) and by more intense competition between existing players. This situation gives incentives to increase balance-sheet risk to recover the previous level of profitability, since banks effectively shift risks to depositors (or deposit insurers). A key study finding "competition-fragility", whose approach to modelling we follow in this paper, is that of Beck et al (2013) with a global sample of individual banks. They found cross-country variation in the relationship between bank competition and bank stability measured by the Z-score, linked to market, regulatory and institutional features.[2] Other empirical work supporting "competition-fragility" includes studies by Yeyati and Micco (2007) of Latin American banks and Davis and Karim (2019) for European banks.[3]

An alternative view is that of "competition-stability", that increased competition reduces risk in the banking system (Boyd and De Nicolo 2005). The argument is that, on the one hand, lower lending rates in competitive banking markets increase borrowers' scope for repayment, while on the other hand, 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. Empirical studies supporting this view include Anginer et al (2014) with a global sample of individual banks. Some theoretical work suggests a U-shaped relation between competition and risk, with high and low competition being potentially adverse (Martinez-Miera and Repullo 2010). See also empirical work in Tabak et al (2012) noted below.

However, although there has been extensive work on bank risk and its link to competition, the number of empirical papers with both competition and capital as independent variables is more limited, while none to our knowledge look at the interrelation of competition and macroprudential policy.

One that does include both competition and capital is Tabak et al (2012), who used a sample of banks in Latin American countries over 2003-8 and the Z-score as a dependent variable. They 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) found that higher competition in the UK leads to lower capital ratios, although the negative effect on stability may be offset by higher profitability.

Finally, Davis et al (2020a) showed 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. Meanwhile GMM panel estimation results largely supported "competition-fragility", i.e. a positive relation of competition to risk controlling for capital; both the leverage ratio and risk adjusted capital adequacy measures controlling for competition are significant predictors of risk, but signs vary across risk measures The leverage ratio is just as widely relevant as the risk-adjusted capital ratio; and there are some differences in results between advanced countries and emerging market economies.

[2] They found that an increase in competition will have a larger impact on banks' fragility in countries with stricter activity restrictions, lower systemic fragility, better developed stock exchanges, more generous deposit insurance and more effective systems of credit information sharing.

[3] Davis and Karim (2019) did however find competition-stability for the long run effect of competition as measured by the H statistic.

Meanwhile, most work on effects of macroprudential policy has used macro data to trace effects on house prices and credit, adding macroprudential policies one at a time to a baseline equation with relevant control variables. Key papers include Cerutti et al (2017), Kuttner and Shim (2016), Carreras et al (2018) and Akinci and Olmstead-Rumsey (2018). In one of the most recent studies with macro data, Alam et al (2019) found that loan-targeted instruments have a significant impact on household credit, and a milder dampening effect on consumption.

As regards studies using micro (bank level) data, Claessens et al (2013) looked at the effectiveness of macroprudential policy in reducing bank asset growth, for 2,800 banks from 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.

Meanwhile, Davis et al (2021) looked at the effects of macroprudential measures on bank profitability on a global sample of banks. A number of measures of macroprudential policy had a negative and significant effect on banks' profitability, including some of those effective in controlling aggregate credit growth, while others had a zer or negative effect on profitability. Results varied according to factors such as country development, bank type, bank size and capitalisation. Davis et al (2020b) estimated macroprudential policy effects on the interest rate margin, the main subcomponent of profitability in advanced countries; effects were found firstly when policies were 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. Notably, Altunbas et al (2018) assessed 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. The sample covered 3,177 individual banks in 61 countries over 1990-2012. They found a significant negative effect of broad categories of macroprudential policies on risk. The negative effect on risk 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, with a sample of 365 banks in 50 countries over 2002-17. They found that macroprudential policy interacts positively with the quality of corporate governance (measured by the bank's commitment and effectiveness towards following corporate governance principles) in determining risk taking. The better is corporate governance in this sense, the greater the reduction in risk-taking from macroprudential policies, although this interaction effect was only found in advanced countries and not in emerging market economies.

Finally, Meuleman and Vander Vennet (2020), investigating the impact of macroprudential policies on systemic risk for EU banks from 2000-2017, found that whereas macroprudential policies – notably controls on credit expansion and exposure limits - do reduce the component of systemic risk related to individual bank risk, the component related to risks arising from systemic linkages is aggravated by some policies. For some retail banks this was seen as linked to risk-shifting behaviour, whereby in response to limits on exposures to certain counterparties or a need to disinvest in certain assets enforced by macroprudential policies, banks may shift their exposures to make them more vulnerable to market or business cycle shocks.

In light of these works, and the gaps in the literature, our aim is to assess how competition together with macroprudential policy interact in East Asian banks to affect bank risk, with capital as a further control variable. In light of the work above, we do expect an effect of competition, capital and macroprudential policy on risk. Regarding possible interactions of competition and macroprudential policy, we anticipate one of three possible outcomes. One is that there is no interaction effect, all banks respond similarly in terms of risk taking to macroprudential policy, given the control variables included. The second is that higher risk banks respond more in terms of risk taking to macroprudential policy, which we see as an aspect of "competition fragility". The third is that lower risk banks respond more in terms of risk taking to macroprudential policy, which we see as an aspect of "competition stability"

3 Methodology

As a risk measure we focus on the Z Score ,which 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), where ROA is the return on assets and SD is the standard deviation. 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 (hence we denote it as LOG Z SCORE). We note that existing work in both fields cited above typically also uses the Z-Score as a measure of bank risk, in some cases together with market-based data which would limit the sample to listed banks.

It is essential to include comprehensive control variables to capture the effect of macroprudential policy on risk and its possible interaction with competition, and avoid omitted variables bias. As noted, our model follows the modelling approach of the key competition-risk study by Beck et al (2013), as also employed in Davis and Karim (2019) and Davis et al (2020a). 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, denoted CUST DEP SHARE), asset structure and resultant credit risk (loans to assets ratio (LOAN/ASSETS) and provisions to loans ratio (PROVISIONS/LOANS)) and revenue mix which also captures market risk exposure as well as scope for diversification (share of non-interest income in total income, NONINT SHARE). We also control for bank growth and size via the difference and lagged level of the log of bank assets (LOG ASSETS). With our additional of aggregate leverage ratios (LEVERAGE RATIO) and banking competition (LERNER), these are key measures of bank behaviour linked to risk-taking that are relevant for macroprudential surveillance.

Banking competition is measured by the Lerner Index, derived by estimation of a translog cost function as in Anginer et al. (2014), Beck et al. (2013), Weill (2013) and Davis and Karim (2019). 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 becomes 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. The calculation of the index is set out in the Appendix 1 to this paper.

Further control is provided by the addition of key macroeconomic variables which influence bank behaviour and performance. These are respectively GDP growth (GDP GROWTH), CPI inflation (CPI INFLATION), the presence of a banking crisis (BANK CRISIS) as shown in Laeven and Valencia (2018) and the central bank policy interest rate (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 also because macroprudential policy is a country level variable. Standard errors and covariances are cluster-robust. All control variables are entered as 1-year lags to assess indicator properties, to allow for lagged responses and to reduce the risk of simultaneity, with three 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, while as noted we also include the growth and lagged level of the log of bank assets. 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%. Hence our baseline is as follows for country j and bank i:

$$RISK_{ijt} = a_1 RISK_{ijt-1} + a_2 \Delta POLICY\ RATE_{jt} + a_3 POLICY\ RATE_{jt-1} + a_4 \Delta LERNER_{jt} + a_5 LERNER_{jt-1} + a_6\ CUST\ DEP\ SHARE_{ijt-1} + a_7\ NONINT\ RATIO_{ijt-1} + a_8\ LOAN/ASSETS_{ijt-1} + a_9\ PROVISIONS/LOANS_{ijt-1} + a_{10}\ LEVERAGE\ RATIO_{ijt-1} + a_{11} \Delta\ LOG\ ASSETS_{ijt} + a_{12}\ LOG\ ASSETS_{ijt-1} + a_{13}\ GDP\ GROWTH_{jt-1} + a_{14}\ INFLATION_{jt-1} + a_{15}\ BANK\ CRISIS_{jt-1} + e_t \quad (1)$$

Having developed baseline equations as described above, we add macroprudential policy variables (MACROPRUDENTIAL) one at a time to assess their effect on risk. This is in line with the standard approach in the literature on macroprudential policy such as Cerutti et al (2017), Akinci and Olmstead-Rumsey (2018), Carreras et al (2018) and Gaganis et al (2020). In line with competition and the policy rate, we seek to distinguish short and long run effects of macroprudential policy by including the implementation or change in policy for the current year as a current-period variable, together with the lagged cumulative effect of such policy, as described in the data section below:

$$RISK_{ijt} = a_1 RISK_{ijt-1} + a_2 \Delta POLICY\ RATE_{jt} + a_3 POLICY\ RATE_{jt-1} + a_4 \Delta LERNER_{jt} + a_5 LERNER_{jt-1} + a_6\ CUST\ DEP\ SHARE_{ijt-1} + a_7\ NONINT\ RATIO_{ijt-1} + a_8\ LOAN/ASSETS_{ijt-1} + a_9\ PROVISIONS/LOANS_{ijt-1} + a_{10}\ LEVERAGE\ RATIO_{ijt-1} + a_{11} \Delta\ LOG\ ASSETS_{ijt} + a_{12}\ LOG\ ASSETS_{ijt-1} + a_{13}\ GDP\ GROWTH_{jt-1} + a_{14}\ INFLATION_{jt-1} + a_{15}\ BANK\ CRISIS_{jt-1} + a_{16}\ \Delta MACROPRUDENTIAL_{jt} + a_{17}\ MACROPRUDENTIAL_{jt-} + e_t \quad (2)$$

Then finally we also leverage the macroprudential effects with the lagged level of the Lerner Index, to assess whether the response to policy in terms of risk is dependent on the market power of the bank in question:

$$RISK_{ijt} = a_1 RISK_{ijt-1} + a_2 \Delta POLICY\ RATE_{jt} + a_3 POLICY\ RATE_{jt-1} + a_4 \Delta LERNER\ INDEX_{jt} + a_5 LERNER\ INDEX_{jt-1} + a_6\ CUST\ DEP\ SHARE_{ijt-1} + a_7\ NONINT\ RATIO_{ijt-1} + a_8\ LOAN/ASSETS_{ijt-1} + a_9\ PROVISIONS/LOANS_{ijt-1} + a_{10}\ LEVERAGE\ RATIO_{ijt-1} + a_{11} \Delta\ LOG\ ASSETS_{ijt} + a_{12}\ LOG\ ASSETS_{ijt-1} + a_{13}\ GDP\ GROWTH_{jt-1} + a_{14}\ INFLATION_{jt-1} + a_{15}\ BANK\ CRISIS_{jt-1} + a_{16}\ \Delta MACROPRUDENTIAL_{jt} + a_{17}\ MACROPRUDENTIAL_{jt-} + a_{18}\ (\Delta MACROPRUDENTIAL_{jt} * LERNER\ INDEX_{ijt-1}) + a_{19}\ (MACROPRUDENTIAL_{jt-1} * LERNER\ INDEX_{ijt-1}) + e_t \quad (3)$$

As noted, our focus in this article is on results for the Z score, which is the most comprehensive measure of individual bank risk. In Appendix 3 we also show results for three other risk measures. Whereas the Z Score is a bank-wide risk measure, these other measures are specific to the loan book. First, we have the growth rate of loans is measured by the log-difference of loans (D LOG 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. Second, there is the provisions/loans ratio (PROVISIONS/LOANS) 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. Third, there is the NPL/loans ratio (NONPERFORMING 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.

4 Data and descriptive statistics

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 International Financial Statistics and the World Development Indicators databases. (3) The latest IMF iMaPP 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 (which would have been Japan). The number of banks and the countries covered are shown in Table 1.

Table 1: Country and bank coverage

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

Note: ADV – advanced country, EMDE – emerging market and developing economy according to IMF classification.

Meanwhile Table 2 provides details of the statistical properties of the baseline independent and dependent variables.

Table 2: Variable statistics (winsorised at 99% except Bank Crisis)

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
Risk measure						
LOG Z SCORE	3.790	3.869	6.990	-4.221	1.375	13217
Independent variables						
POLICY RATE	5.408	5.000	48.238	0.100	4.863	36959
LERNER	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
Alterative risk measures(Appendix 3)						
D LOG LOANS	0.103	0.097	1.447	-1.119	0.274	14958
PROVISIONS/LOANS	1.089	0.550	18.752	-3.150	2.160	13123
NON PERFORMING LOANS RATIO	0.053	0.026	0.633	0.000	0.082	10800

Note: LOG Z SCORE is the log of the bank Z Score as defined above, POLICY RATE is the central bank policy rate, LERNER is the Lerner Index as a measure of competition, CUST DEP SHARE is customer deposits to total deposits, NONINT RATIO is the share of non-interest income in total income. LOAN/ASSETS is the loans to assets ratio, PROVISIONS/LOANS is the provisions to loans ratio, LEVERAGE RATIO is unadjusted capital adequacy (equity/assets), LOG ASSETS is the log of total assets, NPL RATIO is a credit risk measure (non-performing loans/gross Loans), GDP GROWTH is the real economic growth rate in terms of GDP, INFLATION is the CPI inflation rate and BANK CRISIS is a dummy for ongoing banking crisis. D LOG LOANS is the first difference in the log of total loans and NON PERFORMING LOANS RATIO is the ratio of non performing loans to gross loans.

As noted, having estimated the baselines, we then incorporate the macroprudential policy data from the latest IMF iMaPP integrated Macroprudential Policy Dataset, which covers 134 countries with monthly data from January 1990 to December 2018 (IMF (2020) originally constructed by Alam et al (2019)). This dataset provides information on the tightening and loosening of policy measured as (0,1,-1) dummies, as well as permitting aggregation across instruments. Note that this is distinct from the earlier datasets of IMF (as in Cerutti et al 2017) which kept the dummy at 1 as long as the policies are in operation. We aggregate the monthly data to annual observations to obtain an annual indicator of short run macroprudential policy action.

We also cumulate the data before annualising to obtain an indicator of the long run macroprudential policy stance, following the approach of Bergant et al (2020) working with this dataset, as well as Meuleman and Vander Vennet (2020) with the ECB MaPPED database, work by Akinci and Olmstead-Rumsey (2018) and the earlier IMF database highlighted in Cerutti et al (2016). Tables 3 and 4 list the individual and summary variables in the database.

Table 3: Instruments in the IMF IMAPP integrated Macroprudential Policy Dataset (2020)

Instrument	Abbreviation	Description
Survey Instruments		
Countercyclical buffer	CCB	A requirement for banks to maintain a countercyclical capital buffer. Implementations at 0% are not considered as a tightening in dummy-type indicators.
Conservation buffer	Conservation	Requirements for banks to maintain a capital conservation buffer, including the one established under Basel III.
Capital requirements	Capital	Capital requirements for banks, which include risk weights, systemic risk buffers, and minimum capital requirements. Countercyclical capital buffers and capital conservation buffers are captured in the above measures respectively and thus not included here.
Leverage requirements	LVR	A limit on leverage of banks, calculated by dividing a measure of capital by the bank's non-risk-weighted exposures (e.g., Basel III leverage ratio).
Provisioning requirements	LLP	Loan-loss provision requirements for macroprudential purposes, which include dynamic provisioning and sectoral provisions (e.g. housing loans).
Credit growth limits	LCG	Limits on growth or the volume of aggregate credit, the household-sector credit, or the corporate-sector credit by banks, and penalties for high credit growth.
Loan restrictions	LoanR	Loan restrictions, that are more tailored than those captured in "LCG". They include loan limits and prohibitions, which may be conditioned on loan characteristics (e.g., the maturity, the size, the LTV ratio and the type of interest rate of loans), bank characteristics (e.g., mortgage banks), and other factors.
Limits on Foreign Currency Loans	LFC	Limits on foreign currency (FC) lending, and rules or recommendations on FC loans.
Loan-to-value limits	LTV	Limits to the loan-to-value ratios, including those mostly targeted at housing loans, but also includes those targeted at automobile loans, and commercial real estate loans.
Debt-to-income limits	DSTI	Limits to the debt-service-to-income ratio and the loan-to-income ratio, which restrict the size of debt services or debt relative to income. They include those targeted at housing loans, consumer loans, and commercial real estate loans.
Levy/Tax on Financial Institutions	Tax	Taxes and levies applied to specified transactions, assets, or liabilities, which include stamp duties, and capital gain taxes.
Liquidity measures	Liquidity	Measures taken to mitigate systemic liquidity and funding risks, including minimum requirements for liquidity coverage ratios, liquid asset ratios, net stable funding ratios, core funding ratios and external debt restrictions that do not distinguish currencies.
Loan to deposit limits	LTD	Limits to the loan-to-deposit (LTD) ratio and penalties for high LTD ratios.
Limits on FX operations	LFX	Limits on net or gross open foreign exchange (FX) positions, limits on FX exposures and FX funding, and currency mismatch regulations.
Reserve requirements	RR	Reserve requirements (domestic or foreign currency) for macroprudential purposes. This category may currently include those for monetary policy as distinguishing those for macroprudential or monetary policy purposes is often not clear-cut.
SIFI surcharges	SIFI	Measures taken to mitigate risks from global and domestic systemically important financial institutions (SIFIs), which includes capital and liquidity surcharges.
Other macroprudential measures	Other	Macroprudential measures not captured in the above categories—e.g., stress testing, restrictions on profit distribution, and structural measures (e.g., limits on exposures between financial institutions).

Source: Alam et al (2019), IMF (2020). The database covers a sample from 1990 to 2018, with monthly data which we have (1) annualised and (2) cumulated over time and annualised.

Table 4: Summary measures derived from the IMF IMAPP integrated Macroprudential Policy Dataset (2020)

Derived and summary Instruments	Abbreviation	Definition
All measures	MAPP INDEX	Sum-total of the instruments listed in Table 3
Loan-targeted measures	LOAN-TARGETED	Sum of the "Demand-targeted measures" and the "Loan-supply-targeted measures".
Demand-targeted measures	DEMAND	Sum of loan-to-value limits and debt-to-income limits
Supply-targeted measures	SUPPLY-ALL	All measures except loan-to-value limits and debt-to-income limits
Loan-supply targeted measures	SUPPLY-LOANS	Sum of provisioning requirements, credit growth limits, loan restrictions, limits to the loan to deposit ratio, and limits to foreign currency loans
General supply targeted measures	SUPPLY-GENERAL	Sum of reserve requirements, liquidity requirements, and limits to FX positions.
Capital related supply measures	SUPPLY-CAPITAL	Sum of leverage, countercyclical buffers, conservation buffers, and capital requirements.

Source: Alam et al (2019), IMF (2020). The database covers a sample from 1990 to 2018 with monthly data, which we have (1) annualised and (2) cumulated over time and annualised.

By our methodology, besides giving an indicator of policy tightening or loosening as provided in the database, by cumulating we provide an approximate measure of the stance and stringency of macroprudential regulation at each point in time, with a higher index showing a tighter stance. Cumulation shows the stance while the tightening/loosening show the implementation of policy. By entering both we can show both long and short run effects.

As noted by Meuleman and Vander Vennet (2020), cumulation is important since macroprudential measures can have effects not just initially but also subsequently, not least since it cannot be shown at what point the policy is binding (see also Cerutti et al (2017) and Akinci and Olmstead-Rumsey (2018)). Cumulative measures are also less likely to be subject to issues of endogeneity, as they are mostly predetermined (Bergant et al 2020).

5 Results

5.1 Baseline results

Our baseline results for log Z score are shown in Table 5. Note that a lower log Z score implies a rise in risk. We see that competition mainly impacts directly on the Z score, where a rise in competition (smaller Lerner index) as well as a higher level raise risk (as shown by a lower Z score) and thus the average response of East Asian banks to competition is "competition fragility". Risk is also raised according to Z Score by a 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.

Table 5: Baseline regression results

Dependent variable	LOG Z SCORE
C	1.037*** (3.8)
LAGGED DEPENDENT	0.616*** (28.6)
DPOLICY RATE	-0.007 (0.9)
POLICY RATE(-1)	0.001 (0.1)
DLERNER_FIT	0.593*** (3.3)
LERNER(-1)	0.581** (3.0)
CUST DEP SHARE(-1)	0.228* (2.0)
NONINT RATIO(-1)	-0.156* (1.8)
LOAN/ASSETS(-1)	-0.313* (2.0)
PROVISIONS/LOANS(-1)	-0.065*** (4.1)
LEVERAGE RATIO_FIT(-1)	0.278 (1.1)
DLOG ASSETS	-0.152 (1.2)
LOG ASSETS(-1)	0.029* (2.0)
GDP GROWTH(-1)	-0.014** (2.6)
INFLATION(-1)	0.002 (0.3)
BCRISISONGOING(-1)	-0.336** (2.5)
PERIODS	26
R2	0.527
OBSERVATIONS	6897
BANKS	886

Note: Independent variables' coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. The variables are winsorised at 99%. The equations are estimated by panel OLS with country-clustered standard errors and time fixed effects, and using cluster-robust standard errors. POLICY RATE is the central bank policy rate, LERNER is the Lerner Index as a measure of competition, CUST DEP SHARE is customer deposits to total deposits, NONINT RATIO is the share of non-interest income in total income, LOAN/ASSETS is the loans to assets ratio, PROVISIONS/LOANS is the provisions to loans ratio, LEVERAGE RATIO is unadjusted capital adequacy (equity/assets), LOG ASSETS is the log of total assets, GDP GROWTH is the real economic growth rate in terms of GDP, INFLATION is the CPI inflation rate and BCRISISONGOING is a dummy for banking crisis. "D" implies first difference and "FIT" shows variables instrumented by two lags of themselves prior to estimation. For more details, see Table 4.

We now go on to show the effect on the log Z score of the introduction (DMP) and lagged stance (MP-1) of individual macroprudential policies (Table 3) and the summary variables as defined in Table 4. These results are shown in the first two columns of Table 6 (denoted "Macroprudential variables only").

5.2 Full-sample results for Z-Score

Table 6: East Asian banks – effects on log Z score of macroprudential policies and leveraged effects of competition

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*C(-1)	MP-1*C-1
CCB	0.018	0.105***	0.479**	0.251*	-1.380**	-0.475
	(0.2)	(3.5)	(2.9)	(2.0)	(3.0)	(1.2)
CONSERVATION	-0.171**	0.069**	-0.036	0.021	-0.479*	0.167
	(2.5)	(2.2)	(0.3)	(0.4)	(2.1)	(1.5)
CAPITAL	-0.063	0.005	-0.061	0.035	0.004	-0.123*
	(1.2)	(0.3)	(0.4)	(1.0)	(0.1)	(1.8)
LVR	-0.258**	-0.014	-0.123	-0.077	-0.450**	0.21
	(2.8)	(0.2)	(0.9)	(0.6)	(2.5)	(1.0)
LLP	-0.212***	-0.032	-0.222**	-0.020	0.049	-0.044
	(6,2)	(1.6)	(2.5)	(0.7)	(0.2)	(0.8)
LCG	-0.117*	-0.023	-0.806	-0.031	-0.132	0.0288
	(2.1)	(0.3)	(0.9)	(0.2)	(0.5)	(0.1)
LOANR	-0.008	0.018**	0.059	0.058***	-0.215	-0.122***
	(0.3)	(2.6)	(0.7)	(4.4)	(0.9)	(3.7)
LFC	0.237***	-0.148***	-0.221	-0.139***	1.432	-0.031
	(4.4)	(3.9)	(0.6)	(3.2)	(1.5)	(0.5)
LTV	0.015	-0.005	-0.012	0.013	0.084	-0.056
	(0.5)	(0.3)	(0.2)	(0.4)	(0.6)	(0.9)
DSTI	0.012	-0.036	0.077	-0.026	-0.207	-0.030
	(0.3)	(1.0)	(0.9)	(0.5)	(1.2)	(0.5)
TAX	0.098***	0.031*	0.189***	0.098***	-0.362**	-0.228**
	(3.4)	(2.2)	(4.2)	(3.4)	(2.5)	(3.0)
LIQUIDITY	0.009	-0.032	0.006	-0.021	0.012	-0.038
	(0.3)	(1.6)	(0.1)	(0.8)	(0.1)	(1.0)
LTD	-0.089*	-0.282**	-0.053	-0.246*	-0.125	-0.123
	(2.2)	(2.6)	(0.8)	(1.9)	(1.2)	(0.9)
LFX	-0.060	-0.087***	-0.111**	-0.108**	0.200	0.079
	(1.4)	(3.7)	(2.4)	(2.3)	(0.8)	(0.6)
RR	0.019	0.006*	0.060**	0.015	-0.144***	-0.0289
	(0.8)	(2.2)	(2.8)	(2.2)	(3.8)	(1.7)
SIFI	-0.098	-0.078	-0.053	-0.125	-0.176	1.151
	(1.4)	(1.6)	(0.9)	(1.5)	(0.7)	(0.7)
OTHER	-0.066*	0.091***	0.022	0.178***	-0.250	-0.326*
	(2.0)	(3.5)	(0.2)	(4.1)	(0.8)	(1.9)
MAPP-INDEX	-0.007	0-.001	0.009	-0.004	-0.052	-0.008
	(1.5)	(0.4)	(0.5)	(0.7)	(1.0)	(0.8)
LOAN-TARGETED	-0.009	-0.004	-0.011	0.002	0.008	-0.017
	(0.5)	(0.5)	(0.3)	(0.1)	(0.1)	(0.9)
DEMAND	0.013	-0.008	-0.001	0.003	0.046	-0.033
	(0.6)	(0.6)	(0.1)	(0.1)	(0.4)	(0.8)
SUPPLY-ALL	-0.015	0.001	0.009	0.004	-0.078	-0.009
	(1.6)	(0.4)	(0.5)	(0.6)	(1.3)	(0.6)
SUPPLY-LOANS	-0.053*	-0.007	-0.019	0.001	-0.111	-0.023
	(1.8)	(0.5)	(0.2)	(0.1)	(0.6)	(0.7)
SUPPLY-GENERAL	0.011	0.003	0.041*	0.009	-0.102*	-0.019
	(0.6)	(0.8)	(1.8)	(1.0)	(1.9)	(1.0)
SUPPLY-CAPITAL	-0.103***	0.023	-0.038	0.02	0.020	-0.209
	(4.7)	(1.4)	(0.5)	(0.8)	(0.8)	(1.0)

Note: The macroprudential instruments' coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Table 5. The equations are estimated by panel OLS with country-clustered standard errors and time fixed effects, and using cluster-robust standard errors., with macroprudential variables added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. Individual measures are CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital

requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. Summary measures are MAPP INDEX which is the sum of dummies for all of 17 categories. The LOAN TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises: LTV and DSTI. SUPPLY-LOANS is: loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements.

We see that in the short run, the Z score is boosted (risk is lower) when there is tightening of foreign currency lending limits (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 effects of 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).

Looking at the summary measures, tightening of policies subsumed in Supply-Loans and Supply-All has a negative effect on the Z score but there are no significant long run effects for the summary measures.

There are a number of relevant points for policymakers' consideration even before we allow for leveraged effects of competition: A number of the macroprudential policies were not effective in reducing risk or were even damaging (lowering Z-score) to the Asian banks. Furthermore, other than tax measures (TAX) there is no macroprudential policy which was effective in reducing risk in both short run and long run

The third to sixth columns of Table 6 (denoted "Macroprudential and leveraged variables") show the combination of the change and lagged stance of policy as above (DMP and MP-1) with the same variables leveraged by the lagged level of competition (DMP*C(-1) and MP(-1)*C(-1)). The aim is to give an estimate of whether the effect of policy on risk varies depending on the level of market power that an individual bank has, as measured by the Lerner Index.

The same macroprudential policies are mostly 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 even counter-productive in respect of risk reduction for banks with market power. We suggest that this implies that in terms of the response to macroprudential policy, East Asia is characterised by "competition-stability", in contrast to the overall pattern of "competition-fragility". Competitive banks become more stable in response to macroprudential policies that uncompetitive ones do.

For example, the long run effect of macroprudential policy on the Z score is less positive in the case of banks with market power for loan growth limits (LOANR), tax measures (TAX) and other measures (OTH). And in the case of capital measures (CAPITAL), the effect is more negative for banks with more market power. On the other hand, there is no adjustment of the long run effect for market power where the effect of the stance on the log of Z score is negative (foreign currency lending measures (LFC), loan to deposit (LTD) and foreign currency position limits (LFX)).

Equally, the short run beneficial effect on risk of macroprudential policy tightening is mitigated in the cases of the counter cyclical buffer (CCB), tax measures (TAX) and reserve requirements (RR), while for the conservation buffer (CONSERVATION) and leverage requirements (LEVERAGE) there is a negative effect enhancing risk that is greater in the case of banks with market power.

Market power may enable banks to adjust internally to offset the effects of policy, possibly by risk-shifting, as suggested by Meueleman and Vander Vennet (2020). For example, loan growth limits may reduce household lending if that is their focus, but may raise corporate lending and securities holdings (Acharya et al 2020). A further effect may be to shift financial activities outside regulatory parameters (Cizel et al 2016) and increase cross-border borrowing by domestic or foreign banks (Aiyar et al 2014, Cerutti et al 2017). This risk-shifting effect may link in turn to moral hazard generated by the safety net of deposit insurance and lender of last resort for banks that consider themselves "too big to fail". As noted above, other mechanisms may relate to higher lending rates offered by banks in strong market positions which may lead to adverse selection, with only riskier borrowers seeking funds and moral hazard inducing borrowing firms to take greater risks. Banks with stronger market positions may be harder to supervise.

In terms of the summary measures, inclusion of leveraged measures shows a positive short run effect (risk reducing) of Supply-General measures, albeit again less so when market power is high.

5.3 Subsample results for Z-score

It may be questioned whether the main source of our results is a lower level of competition in certain East Asian countries such as the emerging market and developing economies (EMDEs), rather than distinguishing market power bank by bank. To answer this, we looked separately at the countries in our sample that are in the advanced and the EMDE categories, according to the IMF. Results are shown in Tables 7 (EMDEs) and 8 (Advanced countries). The baseline equations are shown in Appendix 2 Table A.2.1, where there are some differences in significant control variables, but both country groups have the level of competition increasing risk (i.e. "competition-fragility" overall).

There are also some differences in the effects of macroprudential policies on bank risk, as measured by the Z score, between advanced and EMDE Asian countries. The risk-reducing effect of macroprudential policy (without the leveraged effects) is most apparent in the EMDEs (Table 7). Risk is reduced by foreign currency lending limits (LFC) and tax measures (TAX) in the short run and countercyclical buffers (CCB), conservation buffers (CONSERVATION), loan restrictions (LOANR), debt-to-income limits (DSTI), tax measures (TAX) and other measures (OTHER) in the long run.

In EMDEs we also find a wide range of polices have a negative leveraged effect in both the short and long run, implying less competitive banks take relatively more risk in response to macroprudential policies (i.e. "competition stability"). This either offsets a positive direct effect or shows a significant negative effect that is larger for less competitive banks (i.e. there are elements of "competition-stability" in this response). In the short run this is shown by negative and significant effects in the short run for leveraged terms for countercyclical buffers (CCB), conservation buffers (CONSERVATION), leverage measures (LVR), loan restrictions (LOANR) and reserve requirements (RR). In the long run there are corresponding negative terms for loan restrictions (LOANR), Loan-to-value limits (LTV), tax measures (TAX) and reserve requirements (RR). There are two exceptions, namely capital measures (CAPITAL) and limits on foreign currency loans (LFC), where less competitive banks are shown as less risky in response to macroprudential policy than those that are more competitive.

These patterns are reflected in the summary measures, most of which show a beneficial effect of macroprudential policies on risk, but which is offset for banks with market power. Overall, this suggests again that lower levels of competition/higher levels of market power reduce the impact of macroprudential policy on risk in Asian EMDEs in the short and long run and there is "competition-stability" in this response.

As regards the advanced Asian economies (Table 8), effects of macroprudential policies on bank risk are to reduce risk only for limits on foreign currency loans (LFC) and loan-to-value limits (LTV) in the short run and reserve requirements (RR) in the long run. There are a number of risk-raising terms namely for leverage measures (LVR) in the short run and for conservation buffers (CONSERVATION), capital measures (CAPITAL), provisioning requirements

(LLP), limits on foreign currency loans (LFC), loan-to-value limits (LTV), debt-to-income limits (DSTI), liquidity measures (LIQUIDITY), loan to deposit limits (LTD) and limits on FX operations (LFX) in the long term.

The pattern for leveraged terms differs somewhat from the EMDEs in that there are again a majority of negative terms in the short run but tend to be positive in the long run. This suggests that there is a relative risk-raising effect for less competitive banks in the short run (e.g. for countercyclical buffers (CCB), capital measures (CAPITAL), provisioning measures (LLP) and limits on FX operations (LFX)) and hence there are elements of "competition-stability" here too. However, the less competitive firms are less risky than average in the long term (e.g. for countercyclical buffers (CCB), capital measures (CAPITAL), leverage measures (LVR) provisioning measures (LLP), loan-to-value limits (LTV), debt-to-income limits (DSTI) and tax measures (TAX)). This is also the case in the short run for limits on foreign currency loans (LFC), loan-to-value limits (LTV) and loan to deposit limits (LTD). Accordingly, there is "competition-fragility" in the policy response in the long term.

The presence of significant leverage in both samples implies that the competition effect is not just a consequence of country-development (in fact levels of competition are close - the average Lerner index for the EME banks is 0.24 and advanced countries 0.23). However, the differences between EMDEs and advanced countries show that there may be differences in the response that may link in turn to regulation as well as market structure.

Table 7: Asia EMDE banks - effects on log Z score of macroprudential policies and leveraged effects of competition

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*C-1	MP-1*C-1
CCB	0.076	0.110**	0.311**	0.315*	-0.994**	-0.753
	(0.9)	(3.2)	(3.6)	(2.1)	(2.7)	(1.4)
CONSERVATION	-0.106	0.086*	0.128	0.014	-0.782**	0.268
	(1.9)	(2.3)	(1.1)	(0.2)	(3.2)	(1.2)
CAPITAL	-0.102**	0.012	-0.244**	0.016	0.566*	-0.018
	(3.7)	(0.6)	(3.6)	(0.7)	(2.3)	(0.3)
LVR	-0.092	0.034	0.213	0.076	-1.000**	-0.110
	(1.0)	(0.4)	(1.5)	(0.6)	(2.8)	(0.5)
LLP	-0.156**	0.001	-0.149	0.042	-0.011	-0.136
	(3.6)	(1.4)	(1.1)	(1.3)	(0.1)	(1.3)
LCG	-0.129*	-0.001	0.070	0.100	-0.709	-0.418
	(2.3)	(0.1)	(0.7)	(0.7)	(1.6)	(1.1)
LOANR	-0.010	0.020*	0.158**	0.071***	-0.550**	-0.159***
	(0.4)	(2.2)	(2.6)	(5.2)	(2.2)	(4.2)
LFC	0.226**	-0.446	-0.787***	-0.551**	2.970***	0.344
	(3.0)	(3.5)	(4.1)	(3.5)	(7.5)	(1.3)
LTV	0.038	0.020	0.031	0.093***	0.009	-0.215***
	(1.8)	(1.8)	(0.6)_	(5.4)	(0.1)	(5.2)
DSTI	-0.159	0.016**	-0.177	0.123	0.066	-0.058
	(1.4)	(2.7)	(1.3)	(1.0)	(0.2)	(0.2)
TAX	0.092**	0.029*	0.079*	0.097***	0.034	-0.246**
	(2.9)	(2.2	(2.2)	(4.7)	(0.4)	(3.3)
LIQUIDITY	0.035	0.014	0.094	-0.059	-0.232	0.267**
	(0.7)	(0.5)	(1.5)	(1.8)	(1.1)	(2.5)
LTD	0.002	-0.073	0.017	-0.094	-0.055	0.083
	(0.1)	(1.4)	(0.5)	(1.6)	(0.6)	(0.6)
LFX	-0.055	-0.091***	-0.043	-0.080	-0.047	-0.038
	(0.9)	(4.1)	(0.5)	(1.7)	(0.1)	(0.2)
RR	0.018	0.005	0.067**	0.022**	-0.172***	-0.054**
	(0.6)	(1.3)	(2.5)	(2.8)	(4.0)	(2.7)
SIFI	-0.106*	-0.128**	-0.008	-0.264**	-0.349	0.481
	(2.1)	(3.1)	(0.1)	(2.5)	(0.7)	(1.3)
OTHER	-0.109**	0.090***	0.009	0.139***	-0.352	-0.166
	(3.1)	(4.4)	(0.1)	(5.4)	(0.9)	(1.9)
MAPP-INDEX	-0.012	0.004*	-0.001	0.013**	-0.037	-0.027**
	(1.2)	(2.3)	(0.1	(3.3)	(0.7)	(3.2)
LOAN-TARGETED	-0.010	0.011*	0.005	0.043***	-0.046	-0.095***
	(0.6)	(2.3)	(0.1)	(5.0)	(0.4)	(5.6)
DEMAND	0.014	0.020**	-0.002	0.076***	0.046	-0.167***
	(0.6)	(2.5)	(0.1)	(3.9)	(0.2)	(4.2)
SUPPLY-ALL	-0.009	0.004	0.014	0.014*	-0.075	-0.030*
	(0.6)	(1.7)	(0.9)	(2.4)	(1.4)	(2.3)
SUPPLY-LOANS	-0.037	0.018*	0.050	0.063***	-0.274	-0.014***
	(1.3)	(2.0)	(0.7)	(4.6)	(1.2)	(3.7)
SUPPLY-GENERAL	0.015	0.003	0.051*	0.015	-0.126*	-0.036
	(0.6)	(0.9)	(2.2)	(1.5)	(2.3)	(1.6)
SUPPLY-CAPITAL	-0.100***	0.036*	-0.063	0.034	-0.127	0.008
	(4.6)	(2.4)	(0.5)	(1.4)	(0.3)	(0.1)

Notes: See Table 6

Table 8: Advanced Asian banks- effects on log Z score of macroprudential policies and leveraged effects of competition

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*C(-1)	MP-1*C-1
CCB	-0.079	0.016	1.320***	-0.733***	-3.54***	1.891***
	(0.8)	(0.3)	(12.7)	(12.0)	(27.0)	(16.9)
CONSERVATION	-0.142	-0.114**	-0.157	-0.157	0.014	0.100
	(1.6)	(2.6)	(1.8)	(1.7)	(0.1)	(0.5)
CAPITAL	0.137	-0.090*	0.370*	-0.042	-0.75**	-0.122
	(1.6)	(2.3)	(2.4)	(1.0)	(3.7)	(1.2)
LVR	-0.634***	-0.182	-0.634***	-0.362*	-0.0004	0.552**
	(7.2)	(1.2)	(5.4)	(2.2)	(0.1)	(2.8)
LLP	-0.115	-0.092***	-0.017	-0.124***	-0.355***	0.114*
	(1.1)	(3.1)	(0.1)	(4.1)	(5.6)	(2.2)
LCG						
LOANR	0.036	-0.014	0.010	-0.046	0.082	0.090
	(0.5)	(0.2)	(0.1)	(0.7)	(0.4)	(0.9)
LFC	0.512***	-0.163***	0.156	-0.204***	1.470**	0.142
	(3.5)	(3.9)	(1.8)	(4.4)	(3.0)	(1.8)
LTV	0.065**	-0.064***	-0.005	-0.078***	0.222**	0.053*
	(3.0)	(3.6)	(0.1)	(4.2)	(2.7)	(2.2)
DSTI	0.053	-0.087***	0.080	-0.111***	-0.092	0.088*
	(1.2)	(5.0)	(1.3)	(5.0)	(0.7)	(2.2)
TAX	0.121	0.044	0.193	0.105	-0.316	-0.183
	(1.8)	(1.3)	(2.0)	(1.9)	(1.7)	(1.8)
LIQUIDITY	-0.053	-0.090*	0.014	-0.210**	-0.391	0.115*
	(0.7)	(2.7)	(0.2)	(3.5)	(1.4)	(2.4)
LTD	-0.090	-0.499***	-1.650***	-0.626***	5.810***	0.432
	(0.7)	(3.8)	(8.6)	(4.4)	(15.8)	(1.9)
LFX	-0.030	-0.325**	0.028	-0.260**	-0.229**	-0.258***
	(0.4)	(3.7)	(0.4)	(2.9)	(2.8)	(4.2)
RR	0.343	0.239*	0.777***	0.279**	-2.230	-0.163
	(1.7)	(2.2)	(4.6)	(2.8)	(1.7)	(0.8)
SIFI	-0.033	-0.012	-0.079	0.029	0.179	-0.109
	(0.2)	(0.2)	(0.6)	(0.2)	(0.4)	(0.5)
OTHER	-0.100	0.051	-0.039	0.105	0.107	-0.273
	(0.1)	(1.2)	(0.2)	(1.7)	(0.1)	(1.1)
MAPP-INDEX	0.022*	-0.022**	0.029	-0.026**	-0.033	0.012
	(2.1)	(3.4)	(1.3)	(3.8)	(0.6)	(1.1)
LOAN-TARGETED	0.054**	-0.029**	0.034	-0.031**	0.061	0.008
	(2.9)	(3.7)	(1.1)	(3.5)	(0.7)	(0.5)
DEMAND	0.049**	-0.043***	0.002	-0.049***	0.150	0.021
	(2.9)	(4.5)	(0.1)	(4.0)	(1.6)	(1.1)
SUPPLY-ALL	0.013	-0.038**	0.089	-0.055**	-0.261**	0.055**
	(0.4)	(2.9)	(1.6)	(3.5)	(2.6)	(3.6)
SUPPLY-LOANS	0.088	-0.058**	0.217**	-0.078**	-0.430	0.069
	(1.3)	(3.2)	(3.1)	(3.9)	(1.9)	(1.9)
SUPPLY-GENERAL	-0.042	-0.123**	-0.003	-0.144***	-0.205	0.075
	(0.8)	(3.6)	(0.1)	(4.6)	(0.9)	(1.8)
SUPPLY-CAPITAL	-0.018	-0.078	0.045	-0.114*	-0.270*	0.140**
	(0.3)	(1.5)	(0.5)	(2.4)	(2.0)	(2.7)

Notes: See Table 6. There were no cases of credit growth limits (LCG) as defined by the database.

6 Robustness checks

We contend that the subsamples in Tables 7 and 8 are already a form of robustness check, as also pointed out by Meuleman and Vander Vennet (2020). We also undertook two formal robustness checks, focusing again on the log Z score as dependent variable. The first was to add variables for the quality of supervision, while the second was to add bank as well as time dummies to the equations.

The additional supervision variables are the summary measures for activity restrictions, capital regulation and supervisory power derived from the series of World Bank publications on supervision around the world (Barth et al 2013) updated using the latest survey for 2016 (Anginer et al 2019) . These data were also used in papers such as Karolyi and Tabaoda (2015), Gaganis et al (2020) and Danisman and Demirel (2019). We note that the studies themselves are dated 1999, 2003, 2007, 2011 and 2016. To cover the sample, we have interpolated between the values given in the samples and fixed the values of 1999 for 1990-8 and 2016 for 2017-18. Karolyi and Tabaoda (2015) similarly fixed their values for 2012-2015 at the 2011 level.

Table 9 shows the results for the two checks without macroprudential variables along with the original baseline as shown in Table 5. It can be seen that the lagged dependent remains significant in each case, as do the competition variables, provisions/loans and the banking crisis dummy. Some other bank specific variables are not significant in the robustness equations, such as the customer deposit ratio and non interest income ratio. The loan/asset ratio is significant with bank dummies but not with quality of supervision variables, while the opposite is true for the log of total assets. Capital adequacy is only significant for the quality of supervision regression.

Concerning the quality of supervision variables, we note that the number of observations is lower than in Table 5, given the supervision variables do not cover all countries and time periods. We see that it is the stringency in application of capital adequacy that is significant and not activity restrictions and overall quality of supervision. This contrasts with Gaganis et al (2020) who found activity restrictions to be significant for reducing risk, while capital requirements were not. We retain the three variables for the checks for macroprudential effects.

Table 9: Robustness checks regression results: Dependent variable Log Z Score, with country-clustered standard errors and time dummies

Variant	WITH QUALITY OF SUPERVISION	WITH BANK DUMMIES	MEMO: BASELINE EQUATION
C	Subsumed in dummies	Subsumed in Dummies	1.037*** (3.8)
LAGGED DEPENDENT	0.610*** (35.2)	0.424*** (34.5)	0.616*** (28.6)
DPOLICY RATE_Q99	0.020 (0.6)	-0.005 (0.5)	-0.007 (0.9)
POLICY RATE_Q99(-1)	-0;.001 (0.1)	-0.005 (0.4)	0.001 (0.1)
DLERNER1_Q99FIT	0.653** (2.9)	0.803*** (4.1)	0.593*** (3.3)
LERNER1_Q99(-1)	0.549** (2.9)	1.722*** (3.8)	0.581** (3.0)
CUST DEP SHARE_Q99(-1)	0.109 (0.7)	0.014 (0.1)	0.228* (2.0)
NONINT RATIO_Q99(-1)	-0.158 (1.5)	-0.229 (1.5)	-0.156* (1.8)
LOAN/ASSETS_Q99(-1)	-0.220 (1.7)	-0.331* (1.9)	-0.313* (2.0)
PROVISIONS/LOANS_Q99(-1)	-0.077*** (5.8)	-0.061** (2.9)	-0.065*** (4.1)
LEVERAGE RATIO_Q99FIT(-1)	0.374*** (2.7)	-0.164 (0.6)	0.278 (1.1)
DLOG ASSETS	-0.140 (1.0)	-0.146 (1.)	-0.152 (1.2)
LOG ASSETS(-1)	0.035* (2.0)	-0.030 (0.6)	0.029* (2.0)
GDP GROWTH_Q99(-1)	-0.010 (1.1)	-0.014 (0.9)	-0.014** (2.6)
INFLATION_Q99(-1)	0.001 (0.1)	0.007 (0.7)	0.002 (0.3)
BCRISISONGOING(-1)	-0.581*** (3.5)	-0.453*** (3.2)	-0.336** (2.5)
ACTREST	-0.022 (1.1)		
CAPREQ	0.028** (2.6)		
SUPERV	0.003 (0.2)		
PERIODS	26	26	26
R2	0.521	0.618	0.527
OBSERVATIONS	6011	6897	6897
BANKS	816	886	886

Notes: See Table 5. ACTREST is the summary variable for activity restrictions, CAPREQ is the summary variable for stringency of capital requirements and SUPERV is the summary variable for supervisory power, source Barth et al (2013), Anginer et al (2019) and authors' calculations.

Table 10 shows results for adding one by one each macroprudential variable for the equations including quality of supervision. Comparing the table with Table 6, it can be seen that the results are closely comparable, in terms of significant variables and their signs and magnitude, both with and without the leveraged terms. The key result of low competition reducing the effectiveness of macroprudential policy on risk remains in the short run for variables such as countercyclical buffers (CCB), leverage measures (LVR), levy/tax on financial institutions (TAX) and in the long run

for loan limits (LOANR), tax measures (TAX) and other macroprudential measures (OTHER). There are no cases where less competitive firms have relatively less risk following macroprudential policies by the Z score measure. Accordingly, we again find “competition-stability” responses across the range of bank activities captured by the Z score.

Looking in Table 11 at the results for the equations with bank as well as time dummies, the main results for effects of macroprudential policy are similar to Table 6. We again find key long run results for low competition offsetting effects of macroprudential policies, in the case of countercyclical buffers (CCB), loan restrictions (LOANR), levy/tax on financial institutions (TAX) and reserve requirements (RR). Short run effects are found for countercyclical buffers (CCB), credit growth limits (LCG) and reserve requirements (RR). However, we also find low competition enhancing the effect of macroprudential policy to reduce risk, in the case of liquidity measures (LIQUIDITY), limits on foreign currency loans (LFC), capital requirements (CAPITAL) and SIFI surcharges (SIFI) (where we note large banks to which SIFI applies may by nature have market power).

Table 10: Quality of supervision variant - – effects on log Z score of macroprudential policies and leveraged effects of competition

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*(C-1)	MP-1*C-1
CCB	-0.047	0.181***	0.567***	0.292*	-1.91***	-0.324
	(0.3)	(3.1)	(3.3)	(2.0)	(3.5)	(0.8)
CONSERVATION	-0.139*	0.115***	-0.026	0.070	-0.410	0.150
	(1.8)	(5.2)	(0.2)	(1.5)	(1.7)	(1.3)
CAPITAL	-0.083*	-0.005	-0.079	0.013	-0.010	-0.076
	(2.1)	(0.3)	(0.6)	(0.5)	(0.1)	(1.6)
LVR	-0.211**	-0.050	-0.088	-0.027	-0.415*	0.257
	(2.7)	(0.7)	(0.7)	(0.2)	(2.0)	(1.3)
LLP	-0.234***	-0.030*	-0.260*	-0.025	0.100	-0.020
	(4.4)	(1.9)	(2.2)	(1.0)	(0.3)	(0.4)
LCG	-0.094	0.042	-0.114	-0.027	0.079	0.273
	(0.9)	(0.4)	(1.0)	(0.2)	(0.2)	().6)
LOANR	0.010	0.038***	0.062	0.073***	-0.167	-0.108**
	(0.3)	(3.4)	(0.7)	(7.4)	(0.7)	(2.8)
LFC	0.204***	-0.159***	-0.233	-0.157***	1.371	-0.008
	(3.2)	(4.4)	(0.7)	(4.3)	(1.4)	(0.2)
LTV	-0.002	0.006	-0.031	0.025	0.090	-0.057
	(0.1)	(0.4)	(0.5)	(0.9)	(0.6)	(1.1)
DSTI	-0.032	-0.053	0.009	-0.043	-0.130	-0.034
	(0.9)	(1.7)	(0.1)	(1.1)	(0.8)	(0.6)
TAX	0.092***	0.022	0.171***	0.091***	-0.031**	-0.238**
	(3.5)	(1.4)	(3.9)	(3.8)	(2.3)	(2.4)
LIQUIDITY	0.018	0.040**	-0.002	-0.029	0.078	-0.039
	(0.6)	(2.4)	(0.1)	(1.3)	(0.6)	(1.2)
LTD	-0.128*	-0.306***6	-0.167**	-0.300***	0.151	-0.022
	(1.8)	(3.3)	(2.4)	(3.2)	(1.3)	(0.2
LFX	-0.056	-0.065**	-0.084*	-0.091**	0.113	0.100
	(1.4)	(2.2)	(1.9)	(2.2)	(0.5)	(0.8)
RR	0.028	0.014***	0.053*	0.021***	-0.085*	-0.023
	(1.6)	(4.0)	(2.0)	(3.3)	(1.9)	(1.2)
SIFI	-0.092	-0.061	-0.053	-0.116	-0.151	0.177
	(1.3)	(1.1)	(1.0)	(1.4)	(0.6)	(0.9)
OTHER	-0.046	0.100***	-0.026	0.156***	-0.024	-0.211*
	(1.2)	(4.4)	(0.4)	(5.6)	(0.1)	(1.8)
MAPP-INDEX	-0.008	0.004	0.003	0.007	-0.035	-0.008
	(1.0)	(1.6)	(0.1)	(1.3)	(0.6)	(0.8)
LOAN-TARGETED	-0.021	-0.002	-0.030	0.003	0.028	-0.015
	(1.2)	(0.2)	(0.8)	().2)	(0.3)	(0.8)
DEMAND	-0.007	-0.005	-0.023	0.005	0.052	-0.031
	(0.4)	(0.4)	(0.6)	(0.2)	(0.4)	(0.9)
SUPPLY-ALL	-0.011	0.00*	0.005	0.008	-0.053	-0.008
	(1.0)	(1.8)	(0.2)	(1.3)	(0.9)	(0.5)
SUPPLY-LOANS	-0.060	-0.003	-0.050	0.003	-0.032	0.021
	(1.4)	(0.3)	(0.5)	(0.2)	(0.2)	(0.6)
SUPPLY-GENERAL	0.023	0.011**	0.035	0.016*	-0.044	-0.015
	(1.7)	(2.7)	(1.3)	(1.9)	(0.7)	(0.8)
SUPPLY-CAPITAL	-0.107***	0.023	-0.027	0.006	-0.275	0.067
	(5.4)	(1.5)	(0.4)	(0.3)	(1.3)	(1.2)

Notes: See Table 6

Table 11: Bank and time dummies variant - – effects on log Z score of macroprudential policies and leveraged effects of competition

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*(C-1)	MP-1*C-1
CCB	-0.036	0.236*	0.761***	0.661***	-2.350***	-1.260***
	(0.2)	(2.0)	(5.9)	(6.6)	(6.4)	(3.6)
CONSERVATION	-0.090	0.036	-0.100	-0.085	-0.026	0.352
	(1.1)	(0.8)	(0.7)	(1.5)	(0.1)	(1.7)
CAPITAL	-0.099	-0.047	-0.091	-0.100**	-0.059	0.212*
	(1.4)	(1.0)	(0.5)	(2.1)	(0.1)	(2.2)
LVR	-0.147	0.006	-0.172	0.164	0.026	0.603
	(1.7)	(0.1)	(1.6)	(0.8)	(0.1)	(1.4)
LLP	-0.189***	-0.022	-0.279***	-0.067	0.308	0.195
	(3.7)	(0.5)	(3.6)	(1.5)	(1.1)	(1.0)
LCG	-0.247***	-0.364*	0.109	-0.278	-1.330***	-0.383
	(3.4)	(1.9)	(1.0)	(1.5)	(4.4)	(1.6)
LOANR	0.063*	0.069**	0.190**	0.118***	-0.392	-0.147*
	(2.1)	(2.5)	(2.6)	(3.7)	(1.6)	(1.9)
LFC	0.396***	0.014	0.111	-0.128	0.916	0.544***
	(4.2)	(0.1)	(0.2)	(1.4)	(0.8)	(4.0)
LTV	0.0335	0.030	0.033	0.063	0.010	-0.093
	(1.4)	(1.7)	(0.6)	(1.4)	(0.1)	(0.7)
DSTI	0.115***	0.130*	0.135	0.144	-0.058	-0.044
	(3.3)	(2.0)	(1.1)	(1.1)	(0.2)	(0.1)
TAX	0.063*	0.047	0.159**	0.111**	-0.331	-0.201**
	(1.8)	(1.7)	(2.7)	(3.0)	(1.2)	(2.5)
LIQUIDITY	0.096**	0.172**	0.071	0.106	0.112	0.197**
	(2.2)	(2.2)	(1.3)	(1.6)	(0.8)	(3.0)
LTD	0.035	-0.122	0.022	-0.223	0.044	0.389
	(0.5)	(1.0)	(0.3)	(1.7)	(0.1)	(0.5)
LFX	-0.116**	-0.164**	-0.108*	-0.189**	-0.026	0.096
	(2.7)	(2.7)	(2.0	(2.6)	(0.1)	(0.5)
RR	0.012	0.011	0.056***	0.030**	-0.160**	-0.068***
	(0.5)	(1.2)	(4.2)	(2.4)	(2.7)	(3.3)
SIFI	-0.027	-0.084	-0.077	-0.266**	0.208	0.563**
	(0.2)	(1.0)	(0.7)	(2.2)	(0.1)	(2.5)
OTHER	-0.067*	0.088*	0.008	0.065	-0.233	0.080
	(1.9)	(1.9)	(0.1)	(0.9)	(0.7)	(0.4)
MAPP-INDEX	-0.001	0.009*	0.005	0.009	-0.020	0.001
	(0.2)	(2.0)	(0.2)	(1.1)	(0.3)	(0.1)
LOAN-TARGETED	0.020	0.026**	0.028	0.029	-0.024	-0.011
	(1.1)	(2.3)	(0.7)	(1.5)	(0.2)	(0.2)
DEMAND	0.042**	0.038*	0.038	0.064	0.023	-0.073
	(2.7)	(2.0)	(0.8)	(1.5)	(0.1)	(0.6)
SUPPLY-ALL	-0.008	0.006	0.004	0.003	-0.040	0.008
	(0.8)	(1.2)	(0.1)	(0.2)	(0.5)	(0.3)
SUPPLY-LOANS	0.004	0.034*	0.058	0.024	-0.187	0.032
	(1.0)	(2.1)	(0.5)	(0.8)	(0.6)	(0.3)
SUPPLY-GENERAL	0.009	0.008	0.015	0.014	-0.023	-0.021
	(0.4)	(0.8)	(0.7)	(0.8)	(0.3)	(0.6)
SUPPLY-CAPITAL	-0.081**	-0.003	-0.037	-0.076*	-0.216	0.250***
	(2.4)	(0.1)	(0.3)	(1.8)	(0.6)	(3.3)

Notes: See Table 6

On balance we contend that the robustness checks combined with the variants underpin the principal results of the paper.

7 Broader samples

Before concluding, we assessed results of broader samples to assess whether results are specific to East Asia, namely for a global and a European sample. The global and European samples are collected similarly to the East Asian one with the 100 largest banks for each country in 1995, 2005 and 2015 (or less if there are less in the database). There are 43348 observations for the global sample across 4601 banks in 92 countries and 22840 observations for 2193 banks in 36 European countries. As shown in Appendix 2, Table A.2.1, the determination of log Z score is similar to the baseline in the global and European samples, as also for subsamples of the East Asia group. Notably we find in each case both short and long run effects of competition on risk consistent with "competition fragility".

Table 12 shows that for a global sample, the consistent effects of macroprudential policy on risk in the short run are limited to credit growth limits (LCG) which reduce risk and foreign currency lending limits (LFC) which increase it. In the long run the significant effects are for countercyclical buffers (CCB) and conservation buffers (CONSERVATION) to reduce risk and debt-to income limits (DSTI), loan to deposit measures (LTD) and limits on FX operations (LFX) to increase it. There are less significant leveraged effects of competition than in the Asian samples. Less competitive banks become less risky in the case of liquidity measures (LIQUIDITY) in the short run and for capital measures (CAPITAL) and limits on FX operations (LFX) in the long run. Only for foreign currency lending limits do we find less competitive banks take more risk in the wake of these measures.

The result for the global sample suggests there may be differences across regions in the effect of competition on risk responses to macroprudential policies. To assess this we chose to finally estimate across a European sample of banks (Table 13). Looking first at the effects of macroprudential policy without leveraged effects, we find mostly that they accompany a reduction in risk. This is the case for the countercyclical buffer (CCB), conservation buffer (CONSERVATION), provisioning requirements (LLP) in the long run and for the conservation buffer (CONSERVATION) and leverage measures (LVR) in the short term. There are exceptions to this as debt-to-income limits (DSTI) raise risk in the long term and credit growth limits (LCG), tax measures (TAX) and liquidity measures (LIQUIDITY) raise risk in the short term.

The leveraged effects are somewhat akin to the Advanced Asian sample in Table 8. In the short run, it is the less competitive banks that take relatively more risk (i.e. "competition stability") following countercyclical buffers (CCB) and leverage measures (LVR) although the opposite is true for liquidity measures (LVR). The long run leveraged effects are consistently positive across a number of measures, namely capital measures (CAPITAL), leverage measures (LVR), loan-to-value limits (LTV), debt-to-income limits (DSTI), levy/Tax on Financial Institutions (TAX) and limits on FX operations (LFX). As above this implies that the less competitive banks take less risk, a "competition fragility" result. Accordingly, in such cases more supervisory attention should be given to the more competitive firms which are shown to take relatively more risk.

Table 12:: Global sample - – effects on log Z score of macroprudential policies and leveraged effects of competition

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*C-1	MP-1*C-1
CCB	0.007	0.100***	0.090	0.136*	-0.309	-0.096
	(0.1)	(3.5)	(1.6)	(1.9)	(1.3)	(0.7)
CONSERVATION	0.011	0.119***	-0.002	0.096***	0.053	0.083
	(0.3)	(4.2)	(0.1)	(3.7)	(0.4)	(1.0)
CAPITAL	-0.030	-0.013	-0.041	-0.030**	0.049	0.074**
	(1.0)	(1.0)	(1.6)	(2.5)	(0.7)	(2.3)
LVR	-0.033	0.091	-0.027	0.125**	-0.017	-0.123
	(0.4)	(1.5)	(0.3)	(2.2)	(0.1)	(1.3)
LLP	-0.064	-0.004	-0.042	0.009	-0.077	-0.052
	(1.2)	(0.2)	(0.5)	(0.4)	(0.4)	(0.9)
LCG	-0.139***	0.043	-0.213***	-0.013	0.303	0.220
	(2.9)	(0.9)	(3.1)	(0.1)	(1.2)	(1.0)
LOANR	0.007	0.009	-0.009	0.007	0.058	0.004
	(0.2)	(0.9)	(0.2)	(0.3)	(0.6)	(0.1)
LFC	0.117***	-0.029	0.098***	-0.011	0.078	-0.078*
	(4.8)00	(1.4)	(3.3)	(0.8)	(0.8)	(1.7)
LTV	0.009	-0.010	0.006	-0.028	0.009	0.061
	(0.5)	(0.7)	(0.3)	(1.3)	(0.1)	(1.2)
DSTI	0.021	-0.053**	0.109	-0.071***	0.037	0.074
	(0.7)	(2.3)	(0.3)	(2.8)	(0.3)	(0.9)
TAX	0.038	0.004	0.007	0.002	0.137	0.006
	(1.6)	(0.2)	(0.2)	(0.1)	(1.0)	(0.1)
LIQUIDITY	-0.000	-0.001	-0.038	0.005	0.159**	-0.023
	(0.1)	(0.1)	(1.2)	(0.4)	(2.4)	(0.6)
LTD	0.1	-0.120*	-0.016	-0.177***	0.348	0.160
	(1.4)	(1.7)	(0.3)	(3.6)	(1.5)	(0.9)
LFX	-0.023	-0.030*	-0.061	-0.057**	0.161	0.100*
	(0.6)	(1.8)	(0.9)	(2.4)	(0.8)	(1.8)
RR	0.007	-0.002	0.012	-0.005	-0.025	0.011
	(0.6)	(0.4)	(1.0)	(0.7)	(0.9)	(1.1)
SIFI	-0.052	0.031	-0.064	0.006	0.051	0.078
	(1,4)	(0.9)	(1.6)	(0.2)	(0.4)	(0.8)
OTHER	-0.016	0.037	-0.018	0.023	0.002	0.058
	(0.7)	(1.6)	(0.5)	(0.8)	(0.1)	(0.9)
MAPP-INDEX	-0.000	-0.001	-0.004	-0.004	0.012	0.009
	(0.1)	(0.3)	(0.4)	(0.9)	(0.8)	(1.1)
LOAN-TARGETED	0.002	-0.004	-0.005	-0.007	0.025	0.011
	(0.1)	(0.7)	(0.4)	(0.9)	(0.7)	(0.6)
DEMAND	0.009	-0.013	0.008	-0.026*	0.004	0.045
	(0.6)	(1.2)	(0.5)	(1.9)	(0.1)	(1.3)
SUPPLY-ALL	-0.002	-0.001	-0.005	-0.004	0.012	0.011
	(0.2)	(0.3)	(0.4)	(0.8)	(0.6)	(1.1)
SUPPLY-LOANS	-0.003	-0.001	-0.013	0.002	0.039	-0.011
	(0.1)	(0.1)	(0.5)	(0.2)	(0.7)	(0.4)
SUPPLY-GENERAL	0.004	-0.003	0.002	-0.006	0.009	0.013
	(0.4)	(0.5)	(0.2)	(0.9)	(0.3)	(1.2)
SUPPLY-CAPITAL	-0.019	0.008	-0.018	-0.007	0.003	0.059**
	(0.7)	(0.5)	(0.6)	(0.5)	(0.1)	(2.4)

Notes: See Table 6

Table 14: European sample - – effects on log Z score of macroprudential policies and leveraged effects of competition

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*C-1	MP-1*C-1
CCB	-0.016	0.108***	0.102**	0.154*	-0.510***	-0.105
	(0.2)	(3.1)	(2.5)	(1.9)	(4.6)	(0.6)
CONSERVATION	0.089*	0.127***	0.038	0.110***	0.235**	0.067
	(1.9)	(3.2)	(0.7)	(3.7)	(2.3)	(0.6)
CAPITAL	0.046	0.004	0.033	-0.027	0.061	0.118**
	(1.3)	(0.2)	(1.0)	(1.0)	(0.7)	(2.1)
LVR	0.139**	0.254	0.255***	0.164**	-0.436**	0.380***
	(2.2)	(4.1)	(3.3)	(2.8	(2.4)	(5.0)
LLP	0.084	0.215***	0.001	0.205***	0.308	0.045
	(0.9)	(4.1)	(0.1)	(4.2)	(0.9)	(0.2)
LCG	-0.180***	0.058	-0.270***	-0.003	0.430	0.302
	(3.6)	(0.7)	(3.2)	(0.1)	(1.4)	(1.2)
LOANR	0.008	-0.014	-0.014	-0.028	0.095	-.0-570
	(0.2)	(0.4)	(0.3)	(0.6)	(0.7)	(0.50
LFC	0.109	-0.010	0.102**	-0.003	0.028	-0.031
	(2.8)	(0.9)	(2.30	(0.3)	(0.5(	(1.3)
LTV	-0.032	-0.032	-0.039	-0.065**	0.002	0.142**
	(0.9)	(1.4)	(1.0)	(2.60	(0.1)	(2.0)
DSTI	0.004	-0.083**	-0.034	-0.122***	0.141	0.219*
	(0.1)	(2.1)	(0.50	(3.5)	(0.6)	(2.40
TAX	-0.142*	-0.058	-0.221**	-0.111**	0.322	0.235**
	(2.0)	(1.7)	(2.3)	(2.7)	(1.1)	(2.6)
LIQUIDITY	-0.010**	0.016	-0.128***	0.012	0.148*	0.029
	(2.6)	(1.1)	(3.3)	(0.8)	(2.0)	(0.9)
LTD						
LFX	0.134	-0.019	0.135	-0.045	0.012	0.156**
	(0.8)	(0.6)	(0.8)	(1.5)	(0.2)	(2.8)
RR	-0.011	-0.011	-0.013	-0.011	0.012	0.002
	(0.5)	(0.9)	(0.6)	(1.0)	(0.2)	(0.1)
SIFI	-0.025	0.077	-0.039	0.049	0.082	0.116
	(0.5)	(1.2)	(0.7)	(0.8)	(0.5)	(1.0)
OTHER	-0.014	0.011	-0.021	-0.010	0.030	0.099
	(0.4)	(0.2)	(0.6)	(0.2)	(0.3)	(1.4)
MAPP-INDEX	0.002	-0.002	-0.007	-0.009	0.038	0.026*
	(0.2)	(0.3)	(0.5)	(1.2)	(1.4)	(2.0)
LOAN-TARGETED	0.003	-0.009	-0.022	-0.024*	0.069	0.064*
	(0.2)	(0.9)	(1.1)	(2.0)	(1.3)	(1.8)
DEMAND	-0.110	-0.029*	-0.020	-0.052***	0.014	0.105**
	(0.4)	(1.8)	(0.6)	(3.2)	(0.1)	(2.2)
SUPPLY-ALL	0.015	0.000	0.002	-0.005	0.062**	0.020
	(0.9)	(0.1)	(0.1)	(0.6)	(2.3)	(1.3)
SUPPLY-LOANS	0.014	0.011	-0.005	0.009	0.089*	0.007
	(0.5)	(0.7)	(0.2)	(0.6)	(1.7)	(0.2)
SUPPLY-GENERAL	-0.027	-0.008	-0.041	-0.014	0.082	0.025
	(1.1)	(0.7)	(1.6)	(1.4)	(1.4)	(1.1)
SUPPLY-CAPITAL	0.061**	0.022	0.055	0.004	0.032	0.066*
	(2.0)	(1.4)	(1.7)	(0.2)	(0.4)	(2.0)

Notes: See Table 6. There were no cases of loan to deposit limits (LTD) as defined by the database.

8 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. In East Asia, and notably in EMDEs the policies tend to be less effective where there is market power, which is an issue relevant to policy makers. This is consistent with "competition stability". Market power may enable banks to adjust internally to offset the effects of policy, possibly by risk-shifting as suggested inter alia by Meuleman and Vander Vennet (2020). On the other hand, in East Asian advanced countries as well as in Europe there is a long run tendency for the more competitive banks to take relatively more risk, suggesting "competition fragility". We note also that in East Asia, risk measures other than the log Z score (Appendix 3) tend to show more mixed results on the relative riskiness of banks depending on competition in response to macroprudential policies. These are less comprehensive measures of risk than the Z score however.

We suggest that a key result of our work is the widespread significance of the leveraged terms. These results imply that market power is a relevant consideration when applying macroprudential policy and it should be monitored closely when applying such policy, quite apart from its direct effect on risk-taking which is found in this and many other papers. It could be considered what further regulation Is needed so that risk shifting/risk taking can be minimised in the wake of macroprudential policy measures.

We suggest that further research could undertake similar analyses for other regions such as Latin America and Africa. Given the approach is based on individual bank data, it can also be readily undertaken for individual countries wishing to assess the effectiveness of their macroprudential policies.

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Appendix 1: Lerner Index calculation

To calculate the Lerner Index, we first estimate the following log cost function:

$$\log(C_{it}) = \alpha + \beta_1 \times \log(Q_{it}) + \beta_2 \times (\log(Q_{it}))_2 + \beta_3 \times \log(W_{1,it}) + \beta_4 \times \log(W_{2,it}) + \beta_5 \times \log(W_{3,it}) + \beta_6 \times \log(Q_{it}) \times \log(W_{1,it}) + \beta_7 \times \log(Q_{it}) \times \log(W_{2,it}) + \beta_8 \times \log(Q_{it}) \times \log(W_{3,it}) + \beta_9 \times (\log(W_{1,it}))_2 + \beta_{10} \times (\log(W_{2,it}))_2 + \beta_{11} \times (\log(W_{3,it}))_2 + \beta_{12} \times \log(W_{1,it}) \times \log(W_{2,it}) + \beta_{13} \times \log(W_{1,it}) \times \log(W_{3,it}) + \beta_{14} \times \log(W_{2,it}) \times \log(W_{3,it}) + \Theta \times \text{Year Dummies} + \varepsilon_{it} \quad (4)$$

Where Cit is total costs; Qit is the quantity of output and is measured as total assets; W1,it is the ratio of interest expenses to the sum of total deposits and money market funding. W2,it is measured as personnel expenses divided by total assets. W3,it is the ratio of administrative and other operating expenses to total assets. Having estimated this equation, we impose the following restrictions again in line with the earlier authors, to ensure homogeneity of degree one in input prices:

$$\beta_3+\beta_4+\beta_5 = 1;\ \beta_6+\beta_7+\beta_8 = 0;\ \beta_9+\beta_{12}+\beta_{13} = 0;\ \beta_{10}+\beta_{12}+\beta_{14} = 0;\ \beta_{11}+\beta_{13}+\beta_{14} = 0 \quad (5)$$

We then use the coefficient estimates from the previous regression to estimate marginal cost for bank *i* in calendar year *t*:

$$MC_{it} = \delta C_{it}/\delta Q_{it} = C_{it}/Q_{it} \times [\beta_1 + 2\times\beta_2\times\log(Q_{it}) + \beta_6\times\log(W_{1,it}) + \beta_7\times\log(W_{2,it}) + \beta_8\times\log(W_{3,it})] \quad (6)$$

And the Lerner index for each bank-year is:

$$Lerner_{it} = (P_{it} - MC_{it}) / P_{it} \quad (7)$$

where, P_{it} is the price of assets and is equal to the ratio of total revenue to total assets.

Appendix 2: Alternative Z score baselines

Table A.2.1: Log Z score estimates for subsamples and wider samples

Dependent variable	Asian Advanced countries	Asian EMEs	Global sample	European samples	Memo: Baseline equation
C	1.362** (3.1)	1.350** (2.6)	1.205*** (5.7)	1.170*** (3.5)	1.037*** (3.8)
LAGGED DEPENDENT	0.642*** (18.5)	0.584*** (37.5)	0.665*** (32.8)	0.690*** (31.4)	0.616*** (28.6)
DPOLICY RATE_Q99	0.119 (1.8)	-0.006 (1.7)	-0.077*** (2.8)	-0.002 (0.1)	-0.007 (0.9)
POLICY RATE_Q99(-1)	0.0468*** (4.4)	-0.006 (0.5)	-0.012*** (4.4)	-0.018* (1.7)	0.001 (0.1)
DLERNER1_Q99FIT	0.475 (1.7)	0.827** (3.5)	0.554*** (14.5)	0.534*** (9.1)	0.593*** (3.3)
LERNER1_Q99(-1)	0.271** (3.0)	1.036*** (3.9)	0.590*** (9.4)	0.572*** (7.0)	0.581** (3.0)
CUST DEP SHARE_Q99(-1)	0.349*** (5.4)	0.236 (1.3)	0.082* (1.9)	0.153*** (3.1)	0.228* (2.0)
NONINT RATIO_Q99(-1)	-0.087 (0.6)	-0.296** (3.1)	-0.174*** (4.0)	-0.202*** (3.4)	-0.156* (1.8)
LOAN/ASSETS_Q99(-1)	-0.228 (1.1)	-0.396*** (3.8)	0.049 (0.7)	0.125 (1.5)	-0.313* (2.0)
PROVISIONS/LOANS_Q99(-1)	-0.085** (3.9)	-0.055** (3.2)	-0.035*** (8.5)	-0.268*** (3.2)	-0.065*** (4.1)
LEVERAGE RATIO_Q99FIT(-1)	0.360 (1.2)	0.172 (0.5)	-0.348*** (3.1)	-0.425*** (3.7)	0.278 (1.1)
DLOG ASSETS	-0.290** (2.7)	-0.184 (1.0)	-0.214*** (4.0)	-0.341*** (5.7)	-0.152 (1.2)
LOG ASSETS(-1)	0.017 (1.7)	0.031 (1.9)	0.009 (1.0)	0.006 (0.5)	0.029* (2.0)
GDP GROWTH_Q99(-1)	-0.018 (0.7)	-0.010 (1.0)	-0.004 (0.8)	0.011 (1.3)	-0.014** (2.6)
INFLATION_Q99(-1)	-0.005 (0.4)	0.008 (1.3)	0.032** (2.5)	-0.126 (1.0)	0.002 (0.3)
BCRISISONGOING(-1)	-0.010 (0.3)	-0.353 (1.7)	-0.158*** (4.4)	-0.102* (2.0)	-0.336** (2.5)
PERIODS	26	26	26	26	26
R2	0.551	0.526	0.557	0.568	0.527
OBSERVATIONS	2527	4370	43348	22840	6897
BANKS	352	464	4601	2193	886

Notes: See Table 5.

Appendix 3: Results for alternative risk measures

In this Appendix we show baselines and results for three alternative risk measures, namely loan growth, the provisions/loans ratio and the non-performing loans ratio. We note that these measures are specific to the loan book and are hence less general than the Z score. Looking first at the baselines (Table A.3.1)) we see that 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. Direct competition effects are not found for these dependent variables. There are significant lagged dependent variables for each equation. There are no direct competition effects in these equations for alternative risk measures.

Table A.3.1 Baselines for the alterative risk measures

Dependent variable	LOAN GROWTH	PROVISIONS RATIO	NON PERFORMING LOAN RATIO
C	0.173* (2.0)	-0.690 (0.9)	0.037** (2.8)
LAGGED DEPENDENT	0.123*** (4.0)	0.360*** (3.8)	0.735*** (21.9)
DPOLICY RATE	-0.001 (0.1)	0.304*** (19.0)	0.007*** (8.0)
POLICY RATE(-1)	-0.001 (0.5)	0.128*** (5.5)	0.002*** (4.8)
DLERNER_FIT	0.016 (1.3)	0.378 (1.1)	-0.016 (1.0)
LERNER(-1)	0.064 (1.7)	0.183 (0.5)	0.001 (0.1)
CUST DEP SHARE(-1)	0.023 (1.1)	-0.284 (1.7)	-0.019 (1.5)
NONINT RATIO(-1)	-0.013 (0.6)	-0.043 (0.1)	-0.002 (0.4)
LOAN/ASSETS(-1)	-0.166** (3.0)	0.441 (1.1)	0.007 (0.5)
PROVISIONS/LOANS(-1)	-0.007 (1.8)		0.001 (0.8)
LEVERAGE RATIO_FIT(-1)	-0.103** (2.4)	0.309 (0.8)	-0.019 (1.1)
DLOG ASSETS	0.738*** (11.9)	-0.978** (2.9)	-0.050*** (3.3)
LOG ASSETS(-1)	-0.004 (1.4)	0.042 (1.2)	-0.001 (1.1)
GDP GROWTH(-1)	0.002 (1.1)	-0.019 (0.7)	-0.001 (1.5)
INFLATION(-1)	-0.001 (0.4)	-0.017 (0.8)	0.001 (0.5)
BCRISISONGOING(-1)	0.031 (1.7)	0.356* (1.9)	-0.013 (0.8)
PERIODS	26	26	26
R2	0.581	0.400	0.711
OBSERVATIONS	7342	7072	5711
BANKS	894	890	770

Notes: See Table 5

We now go on to consider the results for macroprudential policies and competition in Tables A.3.2-A.3.4. Note that in these cases competition does not enter the baseline as a control variable, so any interacted response to macroprudential policy shows the only significant effect of competition on risk.

Table A.3.2: Effects on log loan growth of macroprudential policies and leveraged effects of competition

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*(C-1)	MP-1*C-1
CCB	-0.013	-0.008	0.033	0.041***	-0.120	-0.166**
	(0.8)	(0.8)	(1.1)	(3.3)	(1.0)	(2.8)
CONSERVATION	-0.022**	-0.006	-0.017	-0.010	-0.021	0.014
	(2.8)	(0.9)	(0.8)	(1.1)	(0.3)	(0.9)
CAPITAL	0.002	0.003	0.034***	0.001	-0.122**	0.009
	(0.4)	(1.3)	(3.9)	(0.2)	(2.6)	(0.5)
LVR	-0.034*	-0.002	-0.023	-0.010	-0.042	0.027
	(2.1)	(0.3)	(0.1)	(0.7)	(0.6)	(0.5)
LLP	-0.001	0.001	0.00012	-0.004*	-0.005	0.016*
	(0.1)	(0.1)	(0.1)	(1.9)	(0.1)	(2.0)
LCG	-0.180	-0.025***	0.165***	0.021	-0.630***	-0.172*
	(0.2)	(3.1)	(6.0)	(1.0)	(6.0)	(2.1)
LOANR	-0.005	-0.003	0.017	0.004	-0.069	-0.020**
	(0.1)	(1.5)	(1.5)	(1.4)	(1.5)	(2.3)
LFC	0.060*	0.006	-0.118	-0.001	0.560***	0.026***
	(2.0)	(1.6)	(1.7)	(0.1)	(3.2)	(3.2)
LTV	0.011*	-0.003*	0.012**	-0.001	-0.004	-0.008
	(2.0)	(1.9)	(2.7)	(0.1)	(0.3)	(0.5)
DSTI	-0.005	0.001	-0.021	-0.001	0.052	0.002
	(0.6)	(0.2)	(1.3)	(0.1)	(1.2)	(0.1)
TAX	0.017**	-0.002	0.019*	0.006	-0.009	-0.027*
	(2.8)	(0.8)	(2.1)	(1.4)	(0.3)	(1.8)
LIQUIDITY	-0.005	0.005**	0.009	0.001	-0.0531***	0.020**
	(0.5)	(2.5)	(0.7)	(0.1)	(3.3)	(2.9)
LTD	0.002	-0.001	-0.012	-0.019*	0.054*	0.068**
	(0.2)	(0.1)	(1.4)	(1.8)	(2.1)	(2.7)
LFX	-0.006	-0.002	0.003	0.004	-0.034	-0.026
	(0.4)	(0.5)	(0.1)	(0.3)	(0.5)	(0.4)
RR	-0.001	-0.001**	0.006	0.004***	-0.023	-0.015***
	(0.2)	(2.3)	(1.7)	(3.4)	(1.5)	(3.9)
SIFI	0.007	-0.017	-0.008	-0.014	0.059	-0.011
	(0.5)	(1.4)	(0.4)	(0.8)	(1.1)	(0.4)
OTHER	-0.024***	0.001**	-0.001	0.010	-0.075	-0.005
	(4.2)	(2.4)	(0.1)	(1.7)	(1.1)	(0.2)
MAPP-INDEX	-0.001	-0.001	0.002	-0.001	-0.007	-0.001
	(0.1)	(1.6)	(1.0)	(0.1)	(0.8)	(0.5)
LOAN-TARGETED	0.003	-0.001	0.007*	-0.001	-0.011	0.001
	(1.2)	(1.3)	(2.1)	(1.2)	(0.7)	(0.1)
DEMAND	0.006*	-0.002	0.004	-0.001	0.008	-0.004
	(1.9)	(1.3)	(1.0)	(0.3)	(0.6)	(0.5)
SUPPLY-ALL	-0.002	-0.001	0.003	-0.001	-0.016	-0.001
	(0.6)	(1.5)	(0.8)	(0.1)	(1.3)	(0.4)
SUPPLY-LOANS	0.001	-0.001	0.021**	-0.003**	-0.071**	0.005
	(0.1)	(0.9)	(3.0)	(2.5)	(2.2)	(0.7)
SUPPLY-GENERAL	-0.001	-0.001	0.002	0.002**	-0.011	-0.010***
	(0.5)	(1.7)	(0.4)	(2.4)	(0.7)	(3.1)
SUPPLY-CAPITAL	-0.010	0.002	0.016	-0.003	-0.077**	0.012*
	(1.1)	(1.0)	(1.1)	(1.0)	(2.2)	(1.9)

Notes: See Table 6

Table A.3.2 shows that a number of macroprudential policies restrain loan growth in the short term. These include the conservation buffer (CONSERVATION), leverage requirements (LVR) and other macroprudential measures (OTHER). Similar signs are found in the long run for credit growth limits (LCG), loan-to-value limits (LTV) and reserve requirements (RR). However, others have a significant positive sign such as limits on foreign currency loans (LFC),

loan-to-value limits (LTV) and levy/tax on financial institutions (TAX) in the short run and liquidity measures (LIQUIDITY) in the long run. Claessens et al (2013) also found credit growth limits (LCG) and loan-to-value limits (LTV) limited loan growth across a global sample.

When adding leveraged effects for competition, we find a short term pattern for capital measures (CAPITAL), credit growth limits (LCG) where the boost to loan growth following tightening is mitigated for less competitive banks, and for liquidity measures (LIQUIDITY) there is a decline in lending that is greater for less competitive banks. On the other hand, less competitive banks raise lending more than more competitive ones following introduction of limits to foreign currency loans (LFC) and loan to deposit limits (LTD).

In the long run we see that growth in lending following countercyclical buffers (CCB) and reserve requirements (RR) is mitigated for less competitive banks. For credit growth limits (LCG), loan restrictions (LOANR) and tax measures (TAX), there is a decline in lending that is greater for less competitive banks. The opposite is the case for provisioning requirements (LLP) and loan to deposit limits (LTD) where the baseline effect is negative on lending but the less competitive banks boost their lending. Following limits in foreign currency loans (LFC) and liquidity measures (LIQUIDITY) there is a boost to lending that is greater for less competitive banks.

On balance we again see a pattern of more risk taking by less competitive banks but this is not true across all macroprudential measures. This more heterogeneous pattern between “competition-stability” and “competition fragility” nonetheless shows important differences between the response to policy of more or less competitive banks to different policies that necessitates attention by regulators. We note also that the Z score is a more comprehensive measure of risk – risk in the loan book is only one aspect of overall risk.

Table A.3.3: Effects on provisions ratio of macroprudential policies and leveraged effects of competition

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*(C-1)	MP-1*C-1
CCB	-0.191*	-0.056	0.278*	-0.722***	-1.840***	2.350***
	(2.1)	(0.4)	(1.9)	(3.5)	(3.1)	(4.3)
CONSERVATION	0.266***	0.051	0.107	-0.021	0.520	0.178
	(3.9)	(0.7)	(0.9)	(0.2)	(1.2)	(0.6)
CAPITAL	0.096	-0.013	-0.057	-0.070	0.564	0.238
	(1.1)	(0.4)	(0.3)	(0.7)	(0.77)	(0.8)
LVR	0.125	0.293**	-0.189	0.164	0.985**	0.414
	(1.0)	(2.6)	(1.2)	(1.0)	(2.5)	(1.0)
LLP	0.151	0.057**	-0.036	-0.002	0.625**	0.225*
	(1.5)	(2.5)	(0.3)	(0.1)	(2.2)	(1.8)
LCG	0.449	0.250**	0.240	0.242	0.777	0.032
	(1.5)	(3.0)	(0.6)	(0.9)	(0.5)	(0.1)
LOANR	0.065	0.002	0.039	-0.106*	0.097	0.332**
	(0.5)	(0.1)	(0.2)	(2.1)	(0.4)	(2.7)
LFC	0.076	0.099**	1.610***	-0.023	-4.830***	0.457***
	(0.6)	(2.3)	(10.9)	(0.6)	(9.2)	(3.6)
LTV	-0.016	0.026	-0.081	-0.032	0.211	0.185
	(0.2)	(1.8)	(0.7)	(1.0)	(0.6)	(1.8)
DSTI	0.124	0.037	-0.197*	-0.066	0.656**	0.369**
	(0.2)	(0.8)	(1.8)	(1.1)	(2.6)	(3.0)
TAX	-0.121**	-0.074***	-0.155	-0.203***	0.123	0.449**
	(2.5)	(6.5)	(1.4)	(4.2)	(0.4)	(2.7)
LIQUIDITY	-0.049	0.027	-0.126	-0.029	0.300	0.202**
	(0.6)	(1.0)	(1.5)	(0.7)	(0.8)	(2.5)
LTD	-0.516	-0.218**	-0.645***	-0.138	2.175***	1.318***
	(0.4)	(2.6)	(4.8)	(1.4)	(9.7)	(5.7)
LFX	0.195**	-0.111*	0.496***	0.153	-1.197**	-0.160
	(2.2)	(2.0)	(3.8)	(1.3)	(2.6)	(0.6)
RR	-0.030**	-0.003	-0.095*	-0.029*	0.223	0.084**
	(2.5)	(0.3)	(1.9)	(2.1)	(1.3)	(2.9)
SIFI	0.291***	0.091	0.178	0.054	0.445	0.107
	(3.6)	(0.8)	(1.7)	(0.3)	(1.0)	(0.3)
OTHER	-0.034	-0.028	-0.344	-0.276**	0.889	0.938**
	(0.4)	(0.4)	(1.4)	(2.3)	(1.5)	(2.7)
MAPP-INDEX	0.007	0.002	-0.013	-0.011**	0.063	0.041***
	(0.5)	(0.6)	(0.6)	(2.4)	(0.9)	(3.5)
LOAN-TARGETED	0.011	0.012*	-0.031	-0.009	0.136	0.069*
	(0.3)	(2.2)	(0.6)	(0.8)	(0.8)	(2.1)
DEMAND	-0.014	0.020	-0.083	-0.022	0.219	0.140*
	(0.3)	(1.5)	(0.9)	(1.0)	(0.8)	(2.1)
SUPPLY-ALL	0.015	0.003	-0.014	-0.015**	0.091	0.057***
	(0.9)	(0.7	(0.8)	(2.8)	(1.0)	(3.9)
SUPPLY-LOANS	0.070	0.022**	-0.0059	-0.016	0.249	0.124**
	(0.8)	(2.5)	(0.1)	(0.9)	(0.9)	(2.5)
SUPPLY-GENERAL	-0.014	0.001	-0.059	-0.032**	0.163	0.104***
	(1.2)	(0.1)	(1.6)	(2.6)	(1.2)	(3.4)
SUPPLY-CAPITAL	0.100	0.018	0.0039	-0.027	0.262	0.154
	(1.5)	(0.7)	(0.1)	(0.5)	(0.8)	(0.9)

Notes: See Table 6

Turning now to the provisions/loans equation (Table A.3.3), and focusing first on the results without leveraged terms, provisions are lower in the short run following countercyclical buffers (CCB), levy/tax on financial institutions (TAX) and reserve requirements (RR) but higher with the conservation buffer (CONSERVATION), limits on FX operations (LFX) and SIFI surcharges (SIFI). In the long run, provisions are lower following tax measures (TAX), loan to

deposit limits (LTD) and reserve requirements (RR) but higher with leverage measures (LVR), provisioning requirements (LLP), credit growth limits (LCG) and limits on foreign currency loans (LFC). LCG and LFC may boost higher risk lending in areas that are not controlled, while the result for LLP is to be expected.

The effect of banking competition is again mixed in the short run, with a tendency for more provisioning by less competitive banks in the case of leverage measures (LVR), provisioning requirements (LLP), debt-to-income measures (DSTI) and loan to deposit measures (LTD), but the opposite for countercyclical buffer (CCB), limits to foreign currency lending (LFC) and limits on FX operations (LFX). In the long run the pattern is more consistent with relatively more provisioning by less competitive banks for all significant cases (countercyclical buffer (CCB), provisioning requirements (LLP) loan restrictions (LOANR), limits on foreign currency lending (LFC), debt-to-income limits (DSTI), tax measures (TAX), liquidity measures (LIQUIDITY), loan to deposit lilts (LTD), reserve requirements (RR) and other measures (OTHER)). Corresponding positive effects are shown for the long run changes in the summary measures.

We have suggested that provisioning shows risk taking and accordingly, in line with the Z-Score we have more risk taken in response to macroprudential policy by less competitive banks, notably in the long term, implying the response shows “competition stability”. However, an alternative interpretation of the result is that while provisioning may be due to risk taking, it also requires banks to have scope from their income to build up such reserves, and it is less competitive banks that should have a greater cashflow. Hence the result does not clearly distinguish between “competition-stability” and “competition-fragility” owing to the ambiguity of the dependent variable as a risk measure.

Table A.3.4: Effects on NPL ratio of macroprudential policies and leveraged effects of competition

	Macroprudential variables only		Macroprudential and leveraged variables			
	DMP	MP-1	DMP	MP-1	DMP*(C-1)	MP-1*C-1
CCB	0.003	-0.008**	0.011	-0.023**	-0.033	0.051**
	(1.1)	(2.2)	(1.3)	(3.0)	(1.3)	(2.5)
CONSERVATION	0.006*	-0.002	0.013**	0.006	-0.024*	-0.022
	(2.0)	(0.6)	(2.5)	(0.9)	(2.0)	(1.3)
CAPITAL	-0.001	0.001	-0.007	0.004**	0.025	-0.013**
	(0.3)	(0.8)	(1.5)	(2.7)	(1.8)	(2.9)
LVR	0.003	0.001	0.018*	0.013*	-0.045**	-0.040*
	(0.5)	(0.1)	(2.1)	(1.8)	(3.0)	(2.1)
LLP	-0.001	0.001	0.019	0.004***	-0.072*	-0.009***
	(0.2)	(1.3)	(1.3)	(4.7)	(1.8)	(3.6)
LCG	0.004	0.004	0.002	0.013	0.007	-0.034
	(0.7)	(1.1)	(0.1)	(1.5)	(0.2)	(1.3)
LOANR	-0.001	-0.001	-0.006	-0.001	0.014	-0.022
	(0.5)	(1.3)	(0.9)	(0.1)	(0.9)	(0.5)
LFC	0.004	0.001	0.0085	0.004	-0.014	-0.013***
	(0.7)	(0.1)	(0.7)	(1.7)	(0.5)	(6.1)
LTV	-0.001	-0.001	-0.003	0.003	0.009	-0.009**
	(0.3)	(0.2)	(1.1)	(1.6)	(1.1)	(2.2)
DSTI	0.003	-0.001	0.015	0.002	-0.037	-0.011***
	(1.1)	(0.7	(1.0)	(0.8)	(0.9)	(3.2)
TAX	-0.003**	-0.001	-0.004*	-0.001	0.004	-0.001
	(2.2)	(1.4)	(1.9)	(0.4)	(0.4)	(0.2)
LIQUIDITY	-0.007**	-0.001	-0.006	0.001	-0.006	-0.006
	(2.9)	(1.8)	(1.5)	(0.2)	(0.7)	(1.7)
LTD	-0.010*	0.001	-0.016**	0.010*	0.024**	-0.033***
	(1.9)	(0.2)	(2.2)	(1.8)	(2.4)	(3.6)
LFX	0.005***	0.003	0.003	0.009*	0.007	-0.022*
	(3.1)	(1.4)	(1.2)	(2.0)	(1.3)	(2.0)
RR	-0.001	-0.001	-0.001	-0.001*	0.001	0.001
	(1.1)	(1.5)	(0.4)	(1.8)	(0.1)	(1.4)
SIFI	0.005	0.001	0.013***	0.010	-0.030***	-0.029*
	(1.8)	(0.4)	(4.4)	(1.4)	(5.3)	(1.9)
OTHER	-0.004	-0.002	-0.013**	0.002	0.029**	-0.011
	(1.5)	(0.7)	(2.5)	(0.4)	(2.3)	(1.1)
MAPP-INDEX	-0.001	-0.001	0.001	0.001	-0.001	-0.001
	(1.0)	(1.0)	(0.1)	(0.7)	(0.4)	(1.2)
LOAN-TARGETED	-0.001	-0.001	-0.002	0.001*	0.004	-0.003***
	(0.4)	(0.2)	(0.9)	(1.9)	(0.9)	(3.7)
DEMAND	0.001	-0.001	-0.001	0.002	0.002	-0.006***
	(0.2)	(0.4)	(0.2)	(1.6)	(0.4)	(3.7)
SUPPLY-ALL	-0.001	-0.001	0.001	0.001	-0.003	-0.001
	(1.2)	(1.2)	(0.1)	(0.6)	(0.5)	(1.0)
SUPPLY-LOANS	-0.002	-0.001	-0.004	0.002*	0.008	-0.001***
	(1.0)	(0.2)	(1.3)	(1.9)	(0.9)	(3.3)
SUPPLY-GENERAL	-0.001**	-0.001*	-0.001	-0.001	-0.003	-0.001
	(3.0)	(1.8)	(0.2)	(0.3)	(0.5)	(0.4)
SUPPLY-CAPITAL	0.001	-0.001	0.005	0.003**	-0.008	-0.011**
	(0.9)	(0.1)	(1.1)	(2.5)	(0.7)	(2.7)

Notes: See Table 6

In Table A.3.4, while there are a number of short term effects, NPLs are only seen to be affected in the long term by countercyclical buffers (CCB) negatively if market power is not taken into account.

When market power is allowed for, there are mixed effects in the short run. Less competitive banks have relatively less NPLs following conservation buffers (CONSERVATION), leverage erasures (LVR), provisioning requirements (LLP) and SIFI surcharges (SIFI) whereas the opposite is the case for loan to deposit measures (LTD) and other measures (OTHER). As is the case for provisions, there is more consistency in the results for the long term, but with the opposite sign as most significant terms show that less competitive banks have relatively less NPLs. This is the case for Capital requirements (CAPITAL), leverage requirements (LLP), provisioning requirements (LLP), limits on Foreign Currency Loans (LFC), loan-to-value limits (LTV), debt-to-income limits (DSTI), loan to deposit limits (LTD), limits on FX operations (LFX) and SIFI surcharges (SIFI). This carries through to a number of the summary measures.

We note that the response of NPLs to macroprudential policy may be expected to be gradual. Over the long term "competition-fragility" appears to hold for East Asian banks' lending activities. But we emphasise again that the broader measure of bank risk is the Z score, on which we mainly focus.