Department of
Economics and Finance

Working Paper No. 17-23

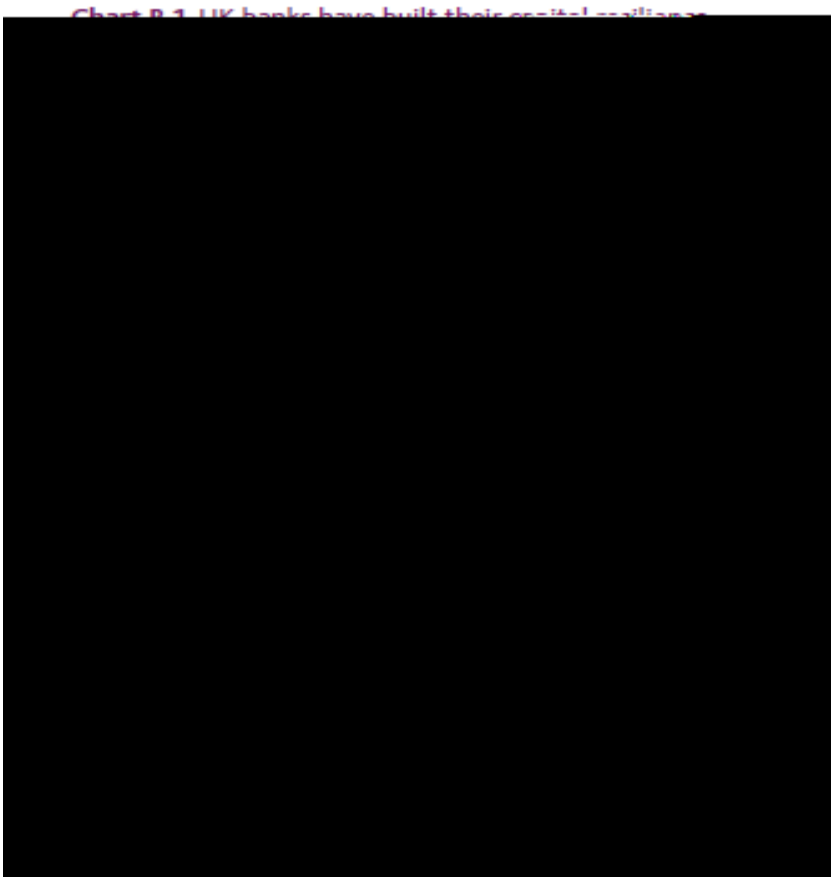
http://www.brunel.ac.uk/economics

In IMF (2013), in the context of a review and update of ongoing collection of data on financial soundness indicators (FSIs), ƛŭ ø l·ă ădzƎƎŜăŭŜŘ ŭKl·ŭ ćŭKŜ Ǝf2ōl·f ŦƛyƖ·yŎƛl·f ŎŃƛăƛă ŃŜØŜl·fŜŘ ŭKŜ ySŜŘ ŭ2 develop indicators that could identify and monitor the build-up of systemic risks in a forward-looking manner. FSIs for a sector as a whole act more as contemporaneous indicators and may hide variations within the population of financial institutions that may eventually put in danger the whole ŦƛyƖ·yŎƛl·f ăèăŭŜYźφ As contemporaneous indicators, they would also pose difficulties if there are delays in data collection.

Accordingly, data collection was undertaken for a variety of concentration and distribution measures (CDMs) of key financial soundness indicators (FSIs), and Crowley et al (2016) highlighted the main features of this experimental data collection on CDMs, from 36 countries for up to 8 years (2007-2014). The initial paper did not present statistical tests of the usefulness of CDMs for financial stability analysis. However, the fact central banks, international organisations and academics routinely use CDMs for illustration and analysis is promising.

This article seeks to deepen knowledge of the usefulness of CDMs by assessing their potential for helping predict vulnerabilities at a national level. We show some recent examples of figures using CDMs from key macroprudential reports from the IMF, ECB and Bank of England, then we note some recent academic work that relates to CDMs. We then go on to our own analytical work which is centred on panel estimates of the relation of lagged CDMs to key indicators of financial instability, with appropriate control variables to avoid omitted variables bias. We also present some preliminary results using quantile approaches. We then conclude with a summary and suggestions for extensions to the analytical work.

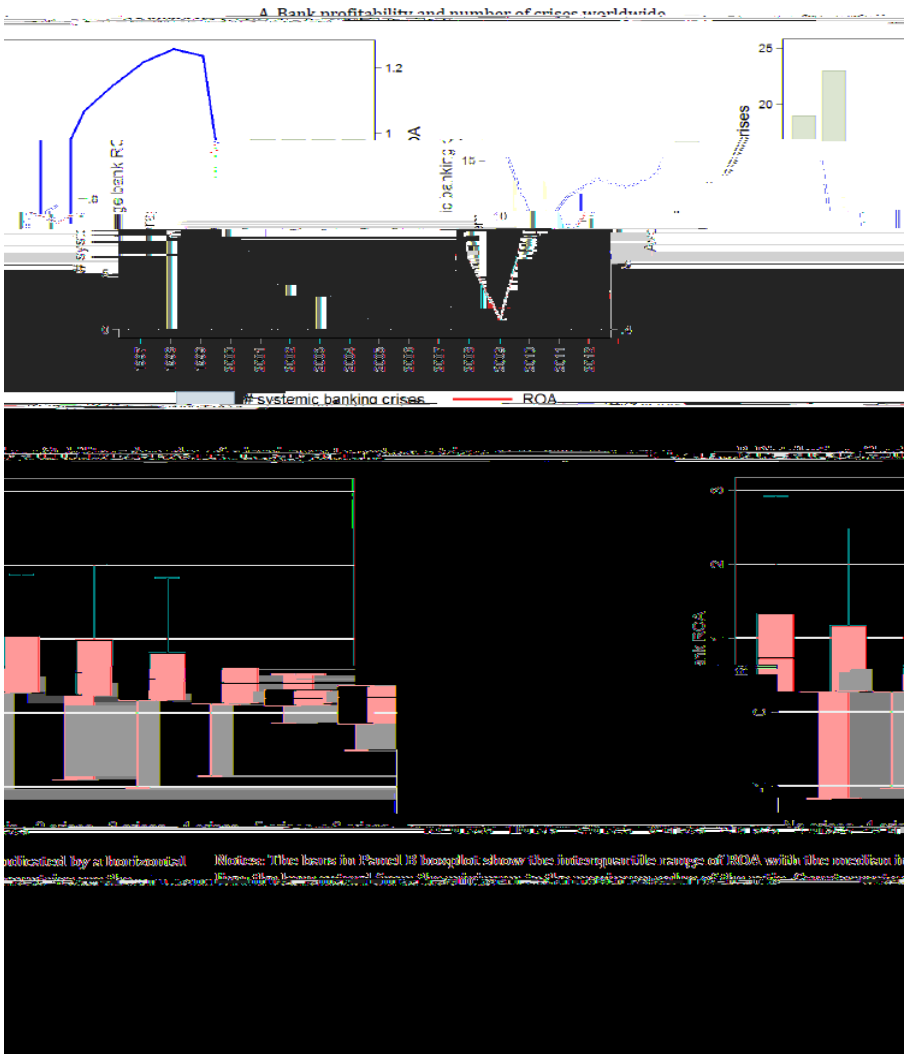
A first motivation for the use of CDMs is their growing use in policy analysis by institutions at the cutting edge of financial stability analysis. So for example the Bank of England, FSR (2016) (Figure 1) shows here the varying distribution of bank capital adequacy across the interquartile range, as the mean increased in the wake of tighter regulation, recapitalisation and the approach of Basel III, with the aggregate common equity Tier 1 (CET1) ratio of major UK banks being 13.5% of risk-weighted assets in September 2016.



Similarly the ECB, FSR (2016) shows in Figure 2 how the evolution of capital adequacy varied according to the measure used in early 2016, but was generally increasing, as shown by the median, the interquartile range and 90-10 percentile range. ¢KŜ℠Ŏ2ŸŸŜyŕŭ ø l·ă ŭKl·ŭ ǻEuro area significant

We cite here three recent articles that utilise CDMs, while noting that the literature on their use is fairly sparse, although in principal calculation is fairly straightforward using individual bank data.

Figure 5: Bank performance and systemic banking crises, 1997-2012



Hale et al (2014) showed that interconnected financial systems are prone to shock transmission, and network position matters for bank performance. In that context they show in the charts on the right (Figure 4), first an inverse relationship between average bank ROA and the number of systemic banking crises that occurred during 1997-2012 and, second, that the entire ROA distribution shifts downwards as median profitability declines, monotonically, with the number of crises in counterparty countries (while its dispersion measured by the interquartile range remains relatively stable).

Using data for 69 countries over 1980-1997, Beck et al (2006) found crises are less likely in economies with more concentrated banking systems (measured as the share of assets of the three largest banks in total banking system assets, and in one regression breaking concentration into quintiles), controlling for differences in bank regulatory policies, national institutions affecting competition, macroeconomic conditions, and shocks to the economy. Regulatory policies and institutions that limit competition are related with greater banking system fragility.

Finally, Fahlenbrach et al (2016) showed that U.S. banks with loan growth in the top quartile of banks over a three-year period between 1973-2014 underperform the common stock of banks with loan growth in the bottom quartile over the next three years, as growth slows and provisions increase. They link this in turn to overoptimism on loans made in fast growth period.

In order to further elucidate the usefulness of CDMs. we undertook panel estimation using CDMs for the IMF sample of up to 36 countries over a period up to 2007-2014, comparing the CDMs in each case with the predictive power of the traditional mean for up to six financial soundness indicators calculated economy-wide for the banking sector. These are the leverage ratio, liquidity ratio return on equity (ROE), return on assets (ROA), Tier 1/risk adjusted assets ratio and the non-performing loans (NPL)/total loans ratio.

The countries in the sample are as follows (Crowley et al 2016): Armenia, Republic of, Macedonia, FYR, Bosnia and Herzegovina, Malta, Brazil, Mauritius, Canada, Namibia, Chile, Netherlands, China, P.R.: Macao, Nigeria, Costa Rica, Norway, Cyprus, Panama, Czech Republic, Paraguay, Dominican Republic, Romania, El Salvador, Slovak Republic, France, South Africa, Georgia, Sri Lanka, Germany, Turkey, India, Uganda, Ireland, Ukraine, Israel, Zambia and Italy. In terms of income level, 37% are higher income, 34% upper-middle income, 23% lower middle income, and 6% lower income.

Three dependent variables of macroprudential relevance were drawn from the World Bank Global Financial Development Database (GFDD) (Cihak et al (2012), World Bank (2017)): First, the Z-Score[2] captures the probability of default of a country's commercial banking system. Z-score compares the buffer of a country's commercial banking system (capitalization and returns) with the volatility of those returns. Hence Z-Score = (ROA+(Capital/Assets))/SD(ROA)).[3] Second, we use the NPL/loans ratio[4] which 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. It is defined as the ratio of defaulting loans (payments of interest and principal past due by 90 days or more) to total gross loans (total value of

COMPLERNER (Lerner index for bank competition)[9] and DEPASSET (ratio of deposits of deposit money banks to total assets of deposit money banks), which shows the dependence of banks on deposits for their funding[10]

There remain some statistical issues. Firstly there are o

	Leverage ratio	Liquid assets /Short term liabilities	ROE	ROA	Tier1 capital /risk weighted assets	NPL/total loans
Equation (1) mean only						
Mean	-0.48*** (3.2)	0.0009 (0.8)	0.059* (1.9)	0.386 (0.9)	-0.449** (2.4)	-0.494*** (4.4)
R-bar-sq RSS	0.314 0.185	0.295 0.186	0.251 0.204	0.227 0.211	0.274 0.183	0.376 0.16
Equation (2) skewness and standard deviation						
Skew	-0.0018 (1.2)	-0.0003 (1.2)	0.00002 (0.0)	0.0009 (1.1)	0.0007 (1.1)	-0.0017* (1.9)
Stdev	-0.514*** (3.8)	0.00002 (0.5)	-0.023**			

Leverage
ratio

	(1)	(2)	(3)	(4)	(5)
Mean	-0.448** (2.4)	-0.529*** (3.1)	-0.739*** (2.8)	-0.609** (2.0)	-0.41** (2.4)
Skew		0.001** (2.4)			
Stdev		-0.33*** (4.3)			
Q1			-0.091*** (3.0)		
Q2			-0.136 (0.8)		
Q3			0.592* (1.7)		
Q4			0.035 (0.3)		

Excluding:	High income	Upper middle Income	Lower middle Income	Total	Memo: with Income level dummies
IQ range leverage	-0.149*** (3.4)	-0.153***			

CDM/FSI	Leverage	Tier 1 ratio
Equation (1) mean only		
Mean	-0.26 (1.3)	-0.28 (1.6)
Equation (2) skewness and standard deviation		
Skewness	0.009 (0,9)	0.001 (0.9)
Standard deviation	-0.208 (2.1)	-0.28 (0.7)
Equation (3) Four quartiles of the distribution		
Q1	-	

range of countries would allow more systematic analysis of country groups at different income levels.

Further empirical work could use additional controls (e.g. for financial regulation) and also alternative estimation methods; use of quarterly data for prediction could also be helpful. To show potential in this regard, we included results of simple quantile regressions, showing CDMs can help predict the lower tail of the distribution of Z-Scores for a pool of countries, that may be helpful in multilateral surveillance.

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	Leverage ratio	Liquid assets/Short term liabilities	ROE	ROA	Tier1 capita/risk weighted assets
Mean					