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Bank credit risk and macro-prudential policies: Role of counter-cyclical capital buffer[☆]

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ABSTRACT

This paper investigates the impact of macro-prudential policy (proxied by the counter-cyclical capital buffer (CCyB)) on bank credit risk during uncertain times, as banking sector stability is crucial in promoting financial intermediation. Using a unique daily data set consisting of 4939 credit default swaps (CDS) of 70 banks from 25 countries over the period 2010–2019, we find that CCyB tightening decreases bank-level CDS spreads, while CCyB loosening increases CDS spreads. This heterogeneous effect of CCyB arises due to its asymmetric effect on the capital ratio (i.e., the equity-to-total assets ratio) of banks. Tightening CCyB significantly increases capital, whereas loosening CCyB does not impact capital. Thus, the risks that emanate from the banking sector during periods of heightened uncertainty and financial distress can be significantly dampened when CCyB regulation is enabled. Consequently, macro-prudential policies for banks to hold higher levels of capital during good times are justified to contain financial market risks during downturns.

1. Introduction

The perception of credit risk in the banking sector has dramatically changed since the Global Financial Crisis (GFC) and the subsequent Great Recession when the world economy witnessed a wave of defaults. The transfer of credit risk within the financial system was amplified either via Credit Default Swaps (CDS) trades – with spreads hitting record high levels – or collateralized debt obligations (CDOs) issuance. In this context, CDS spreads became a prominent measure of credit risk compared to other indicators (e.g., bond spreads) (Hull et al., 2004; Blanco et al., 2005; Houweling and Vorst, 2005; Zhu, 2006), providing valuable information about the relevance of global and domestic risk factors (Augustin, 2018), as well as the interlinkages between a country's default probability and associated currency devaluations (Augustin et al., 2020). Rapid growth of credit that contributed to the global financial crisis of 2007–09 and the Great Recession that followed gave rise to implementation of CCyBs to help limit systemic risks that could be reflected in CDS spreads.

Not surprisingly, many studies have looked at the determinants of CDS spreads (Benbouzid et al., 2017a,b), and highlighted the role played by (i) bank-level characteristics, such as asset quality, credit ratings, lending relationships, leverage, (ii) liquidity, profitability, and volatility (Campbell and Taksler, 2003; Benkert, 2004; Fabozzi et al., 2007; Casu and Chiaramonte, 2013; Kajurova, 2015; Pires et al., 2015; Caglio et al., 2019); and (iii) macroeconomic drivers, including interest rates, yield spreads and inflation (Duffie and Singleton, 1999; Lekkos and Milas, 2001; In et al., 2003; Alexander and Kaeck, 2008;

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Naifar, 2010) in determining CDS spreads.[1] The financial crisis of 2008–2009 was the trigger for a number of policy transformations. In particular, policy makers and regulators introduced stronger regulation aimed at stabilising credit markets, reducing systemic vulnerabilities and high volatility, and ensuring the resilience of the financial sector to weather future crises (IMF, 2020). Against this background, macro-prudential measures gained a front line relevance in the policy arena given their: (i) aim of ensuring the stability of the financial system and strong credit availability across financial markets (Hanson et al., 2011; Osinski et al., 2013); (ii) goal to reduce the macroeconomic costs resulting from financial distress, while considering risk as endogenous to the behaviour of the financial system (Crockett, 2000; Borio, 2003); and (iii) supplementary nature vis-a-vis micro-prudential regulation in identifying, monitoring and addressing "systemic risks" (BIS, 2016).

In this context, the existing literature has shown that macro-prudential policy is important in: (i) reducing over-borrowing (Aikman et al., 2015); (ii) encouraging domestic savings by promoting domestic intermediation; and (iii) protecting against fire sales.[2] Thus, it can effectively ensure financial stability and well-functioning financial markets (Korinek and Sandri, 2016; Kitano and Takaku, 2020). In addition, after controlling for credit shocks, counter-cyclical regulation tends to have a stronger and more effective impact than monetary policy in promoting price, financial and macroeconomic stability (Tayler and Zilberman, 2016).[3] Gambacorta and Shin (2018) find that bank equity-to-total assets ratio is an important determinant of both the bank's funding cost and its lending growth. Altunbas et al. (2018) show that macroprudential policies have significant impact on bank risk measured in terms of Z-score, especially in the case of banks that are small, have a high wholesale funding and are poorly capitalised. There are also other studies using non-performing loans (NPLs) as measures of credit risk (Chaibi and Ftiti, 2015). Despite these results, there is little evidence using high-frequency credit risk measures in terms of credit default swaps as a direct forward-looking measure of market-driven credit risk to investigate the effects of such capital-based macro-prudential policy on different types of CDS instruments at bank-level across countries. This is the major gap of the current body of research in this field that we try to fill as our main contribution.

We use the counter-cyclical capital buffer (CCyB) as a macro-prudential policy measure to protect against loan losses during downturns. Its introduction by the Basel Committee on Banking Supervision (BCBS) brought a time-varying buffer over and above minimum bank capital requirement. Maatoug et al. (2019) argue that capital buffers of both Islamic and conventional banks are counter-cyclical in MENA countries. Auer et al. (2022) find that additional capital requirements resulting from the activation of the CCyB are associated with higher growth in banks' commercial lending. Therefore, in addition to the minimum common equity requirement and the Capital Conservation Buffer (CCB), banks are also required to satisfy sufficient counter-cyclical capital buffers to sustain lending during a crisis and to maintain financial system resilience (Benetton et al., 2021; Bui et al., 2017; Bennani et al., 2014). The amount that banks are required to hold will ultimately depend on whether systemic risks are rising or declining (Jahn and Pirovano, 2019). The CCyB buffer is calculated as the weighted average of the buffers in effect, in the countries to which banks have a credit exposure and can vary between 0 and 2.5 percent of Risk-Weighted Assets (RWA) (BIS, 2015, 2019; Abad and Repullo, 2020).

In order to decide whether the CCyB should be tightened or loosened, each country will need to monitor their credit growth position and make an informed assessment of whether such growth is above or below the usual threshold. Considering that countries have different regulatory regimes, currently there is no global minimum standard for an assessment framework (BIS, 2019; Babic and Fahr, 2019). However, the common practice across countries complying with the CCyB is to ensure that there is no build-up of system-wide risks by calculating the credit-to-GDP ratio as a reference point and decide whether they should relax or tighten their buffers. In addition to this ratio, authorities need to exercise due diligence and apply their expert judgement before taking any decision (BIS, 2015; Babic and Fahr, 2019). Given that a rise in bank credit risk needs to be matched with higher bank capital, CCyB should also be set as a function of private indebtedness relative to its trend (Jokivuolle et al., 2015).

The CCyB ensures that banking-sector capital requirements take account of the macro-financial environment in which banks operate (BCBS, 2010) so that they are able to establish a stronger resilience during credit booms (Guidara et al., 2013), and to sustain themselves during potential crises and shortages of capital when they have to write off loans (Benetton et al., 2021). When credit growth is booming and there are high leverage intakes, the CCyB has the ability and power to steadily raise capital requirements in the banking sector (Gadanecz and Jayaram, 2016). In turn, when credit markets shrink, banks will have sufficient cushion to absorb losses than facing insolvency issues.[4] Gonzalez (2022) finds that capital-based policies tend to reduce bank competition and improve bank stability, whereas Igan et al. (2022) show that bank risk is less severe with activation of macroprudential policy during the pandemic. Capital buffer is therefore an important determinant of bank-level stability, especially, during crisis times. Moreover, the CCyB can lean against mounting mortgage risks, namely, by creating incentives for banks to reduce the share of mortgages with high loan to value (LTV) ratios and overall risk-weighted assets (Behncke, 2022).

Fang et al. (2022) show that the impact of capital requirements varies with economic conditions and bank characteristics. Liquidity is also important for banks, as illiquidity can increase risk, leading to insolvency. Berger et al. (2022) suggest that in uncertain times banks

[1] Benbouzid et al. (2017a) note that the impact of the financial crisis of 2008--2009 on bank CDS spreads was largely mitigated by the quality of economic and legal institutions, but they did not consider the soundness of the country-level prudential regulation that can make a country more immune to financial stress spikes. In this context, Bremus et al. (2020) show that in countries with high corporate income taxes, regulatory bank levies only partially counteract the debt bias of taxation because such levies do not significantly deter banks from leverage. Chaibi and Ftiti (2015) also highlight those macroeconomic variables (such as, exchange rate, GDP growth, interest rate and unemployment rate) and bank-specific determinants (especially, profitability and size). Additionally, while loan loss provisions and inefficiency tend to impact the credit risk of market-based economies, banks' leverage is particularly damaging for the credit risk of bank-based economies.

[2] See, for instance, di Iasio (2013), who develops a model where banks reduce the likelihood of forced liquidation at a costly effort, but this is only efficient when fundamental risk is low and regulatory capital requirements are high. Freixas and Perez-Reyna (2021) emphasise the role of a well-designed (i.e. contingent on productivity shocks and real interest rates) macro-prudential policy in terms of efficiency improvement and financial stability preservation even when there is no systemic risk.

[3] Gambacorta and Murcia (2020) also note that the effect of macro-prudential policies on credit growth can be reinforced via the use of monetary policy. Indeed, greater bank earnings retention (i.e. higher bank capital) translate into a significant reduction of debt financing costs, thus, adding the transmission of accommodative monetary policy to financial conditions (Gambacorta and Shin, 2018).

[4] Stolz and Wedow (2011) and Shim (2013) find that capital buffers behave counter-cyclically over the business cycle. Illueca et al. (2022) uncover a positive impact of counter-cyclical prudential buffers on bank risk-taking, with dynamic loan loss provisioning being linked with timely loan loss provisioning reductions. Gómez et al. (2020) show that the impact of counter-cyclical capital requirements is larger for weaker banks and riskier debtors and when economic conditions deteriorate. Moreover, these measures may be ineffective in slowing lending activity if banks can satisfy them with low-cost capital relative to higher-quality common equity (Francis and Osborne, 2012).

hoard liquidity. By contrast, de Bandt et al. (2021) use evidence from French banks, and suggest that banks' liquidity coefficients decrease in times of crisis. This could be due to the outflow of liquid assets from banks. Demirgüç-Kunt et al. (2021) show that borrower assistance, liquidity support and monetary easing dampened the negative effect of the ongoing pandemic, albeit counter-cyclical prudential policies have been linked with abnormally negative bank stock returns. Feyen et al. (2020) classify financial responses during the COVID-19 pandemic under four categories: (i) banking (e.g., flexible treatment of non-performing loans and asset classification); (ii) liquidity and funding (e.g., direct liquidity injection and lower reserve requirements; (iii) payments systems (e.g., smooth functioning of digital payment system); and (iv) financial markets and non-bank financial institutions (NBFIs) (e.g., circuit breakers and ban on short selling). There are 3000 policy measures taken due to COVID-19 pandemic in their database up to 30 October 2020 and out of that, 25% of policies are related to liquidity and funding.

In this paper, we rely on a novel daily database consisting of Credit Default Swaps (CDS) for the most liquid 5-year CDS spread instrument comprising of 4939 CDS across 70 banks from 25 countries over the period 2010–2019, along with bank-level and country-level variables, collected from Thomson Reuters Eikon, DataStream and ORBIS. We find that bank-level characteristics are equally important in driving bank CDS spreads. Specifically, (i) an improvement in liquidity, (ii) a rise in capital ratios, (iii) better asset quality, and (iv) a fall in leverage and improvement in operating efficiency are associated with lowering bank CDS spreads. These results corroborate the findings of Ericsson et al. (2009), who also highlight the relevance of bank characteristics in determining the credit risk dynamics.

The macroeconomic environment also helps explaining bank CDS spreads. In particular, periods of high inflation are linked with rising tensions in the banking sector, which is in line with the findings by Aizenman et al. (2013) and Thalassinos et al. (2015). Notably, a rise in (financial and macroeconomic) uncertainty is associated with a significant increase in bank CDS spreads. Our results are consistent with the view that, in uncertain times, macro-prudential policy can significantly contain the risks emanating from the banking sector. Both bank-level characteristics and macroeconomic and financial conditions explain a large fraction of the variation in credit risk. We find that tightening CCyB lowers credit risk more prominently because it increases bank capital (equity-to-total assets ratio).

The paper is structured as follows. Section 2 explains the dataset and is followed by our econometric methodology. Section 4 provides the empirical results, followed by the concluding remarks.

2. Data

We use a unique dataset consisting of daily Credit Default Swaps (CDS), bank-level & country-level data collected from Thomson Reuters Eikon, DataStream and ORBIS over the period 2010–2019. Credit Default Swap (CDS) spreads are used as a proxy for credit risk. They are expressed in basis points as 'CDS Premium Mid', which corresponds to the average of 'CDS premium bid' and 'CDS premium offered'. Thus, the CDS spread reflects the par mid-rate spread between the entity and the relevant benchmark curve. CDS data refer to bank CDS with a 5-year term (or above) issued in all available currencies. We use 5-year CDS as this is considered to be the most liquid type of CDS. The CDS types with no par mid spread values were excluded from the list. The final sample comprises 4939 CDS types related to 70 banks from 25 countries for up-to 2490 days.

Fig. 1 gives the daily average of CDS spread of some selected countries in our sample. As we can see, the sample consists of a range of countries, including both developed and emerging markets. Also for some country in the sample, the data is available for a limited period. A large number of countries in our sample has very higher average daily CSD spreads around 2012. We also find comparatively high CDS spreads for Italy, Germany and Turkey in recent times.

Fig. 2a gives the log of CDS spreads in the sample which has a distribution very similar to a normal distribution. We use log of CDS spread instead of level of CDS, as the log transformation is much closer to the normal distribution. But still it has some outliers. Fig. 2b gives the log of CDS spreads for a slightly smaller sample in which we drop the very large and small values of CDS spread and is used for robustness exercises in the paper.

Among bank-level characteristics ($\boldsymbol{Bank}_{ijy}$), we capture five dimensions. First, Asset quality, which includes (i) non-performing loans as percentage of gross loans (ii) impaired loans as percentage of equity, and (iii) unreserved impaired loans as percentage of equity.

Second, liquidity, which includes (i) liquid assets as percentage of deposits and short-term funding, and (ii) liquid assets as percentage of total deposits and borrowing. Third, capital, which includes (i) equity as proportion of net loans and (ii) equity as proportion of deposits and short-term funding. Fourth, operational efficiency, which includes (i) the net interest margin, (ii) net interest revenue as percentage of average assets, (iii) other operating income as percentage of assets (iv) average assets as proportion of non-interest expenditure, (v) the return on average assets (ROAA), (vi) the return on average equity (ROAE), (vii) the income to cost ratio, and (viii) the recurring earning power.

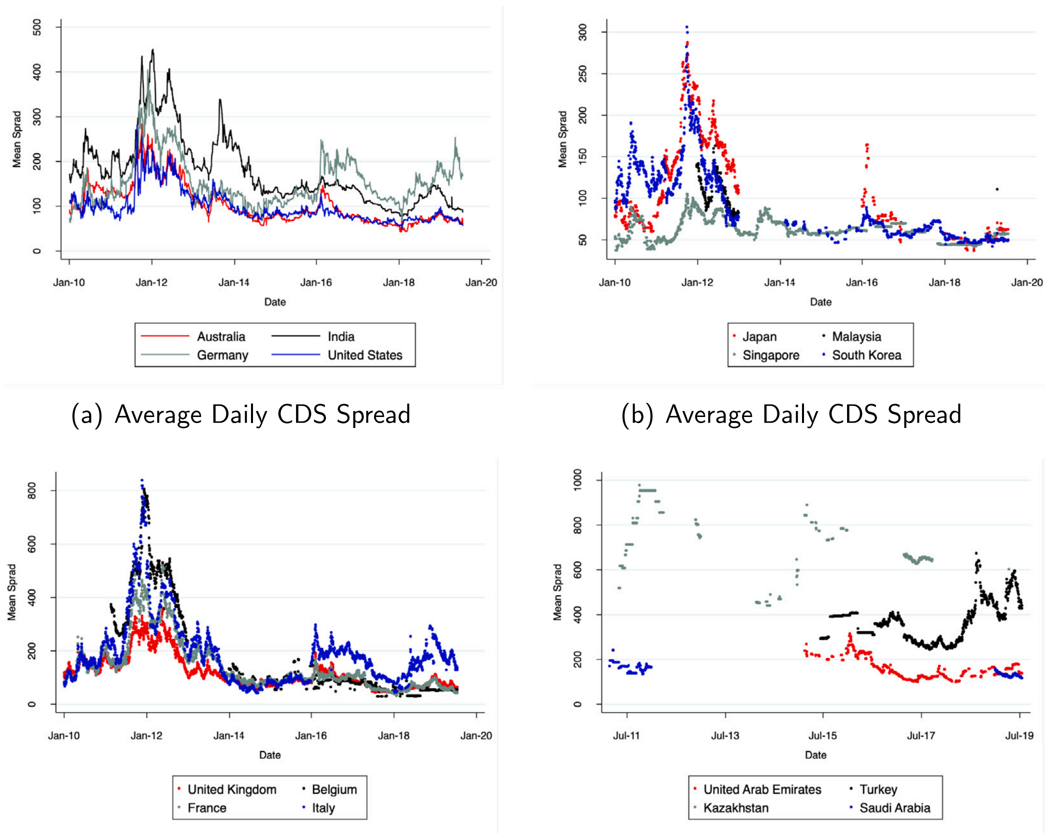
Fifth, leverage, which includes (i) total assets as percentage of equity, (ii) liabilities as percentage of equity, and (iii) total liabilities as percentage of total assets. For each of these five dimensions, we use the above mentioned bank-level characteristics, and implement a principal component analysis (PCA) to summarise the vast amount of available information in one component from each dimension. For assets and leverage, a rise denotes a deterioration of the corresponding component, while for others it corresponds to an improvement of the respective component. Table 1 lists the bank level characteristics from these five dimensions being used in the study.

For macroeconomic factors ($\boldsymbol{Macro}_{jy}$), we include GDP growth and inflation. Among uncertainty measures ($Uncertainty_{jmy}$), we consider country specific Economic policy uncertainty (EPU), which is obtained from Baker et al. (2016). [5] Fig. 3 gives the EPU indices for selected countries in our sample and these have been indexed at 100 in January 2010 and are comparable. As expected, we find spike in EPU for the United Kingdom in early 2016 which is likely to be caused by upcoming Brexit vote. We find spike in uncertainty in later part of the sample for many countries. We also use three other measures of uncertainties which are same for all countries in our sample. These measures also have been indexed to 100 in January 2010, and this makes all the uncertainty measures used in this paper comparable. Two of them, macroeconomic and financial uncertainty, are from Jurado et al. (2015).[6] Third is the Chicago Board Options Exchange's CBOE Volatility Index, which is a volatility index based on the prices of options on the S&P 500 index, and it measures global risk appetite.[7] Fig. 4 gives the uncertainty measures from Jurado et al. (2015) and VIX used in the paper. The empirical strategy adopted in this paper makes a distinction between global (VIX) and local uncertainty (EPU).

[5] The EPU index is constructed based on number of articles of a country's leading newspapers that contain at least a term from each of the following three sets of terms. The first set is 'uncertain', 'uncertainties', or 'uncertainty'. The second one includes 'economic' or 'economy'. The third set consists of policy-relevant terms, such as 'regulation', 'central bank', 'monetary policy', 'policymakers', 'deficit', 'legislation', and 'fiscal policy'.

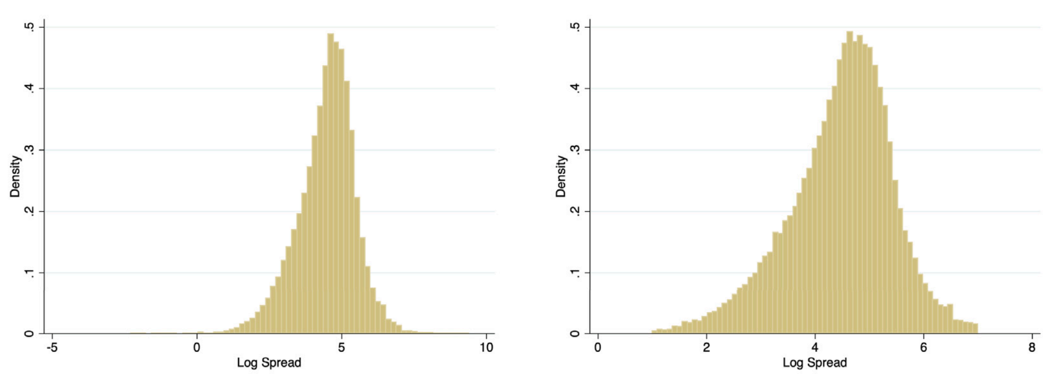
[6] These measures are based on forecast uncertainty for respective variables using a large set of variables for forecasting and they significantly differ from EPU.

[7] It should be noted that both the VIX and the uncertainty measures by Jurado et al. (2015) are forward-looking, while the EPU index is backward-looking.



(a) Average Daily CDS Spread
(b) Average Daily CDS Spread
(c) Average Daily CDS Spread
(d) Average Daily CDS Spread

Fig. 1. Average Daily CDS Spread. We take average of all the CDS in our data for the given country and date.



(a) CDS Spread (Log)
(b) CDS Spread (Log)

Fig. 2. CDS Spread.

Kumar et al. (2021, 2022) and Kim et al. (2021) also use these types of uncertainty measures.

Regarding the macro-prudential policy, we consider the updated counter-cyclical capital buffers ($CCyB_{jmy}$) from Alam et al. (2019). These are requirements for banks to maintain a counter-cyclical capital buffer. The CCyB variable is country-specific and is coded as 0 (no change), 1 (tightening) and −1 (loosening) of counter-cyclical capital buffer norms. Since these loosening and tightening episodes are at country level when the CDS data is daily, there are many CDS in the sample from a given country in the month of CCyB tightening and loosening. In the sample, there are 1807 instances of tightening and 578 instances of loosening. Table 2 shows the country-wise details of the same. Hence, even though there are less instances of loosening and tightening, these are experienced by a large number of CDS traded during those time periods and hence the daily data allows us to estimate the effect of loosening and tightening of CCyB.

3. Econometric methodology

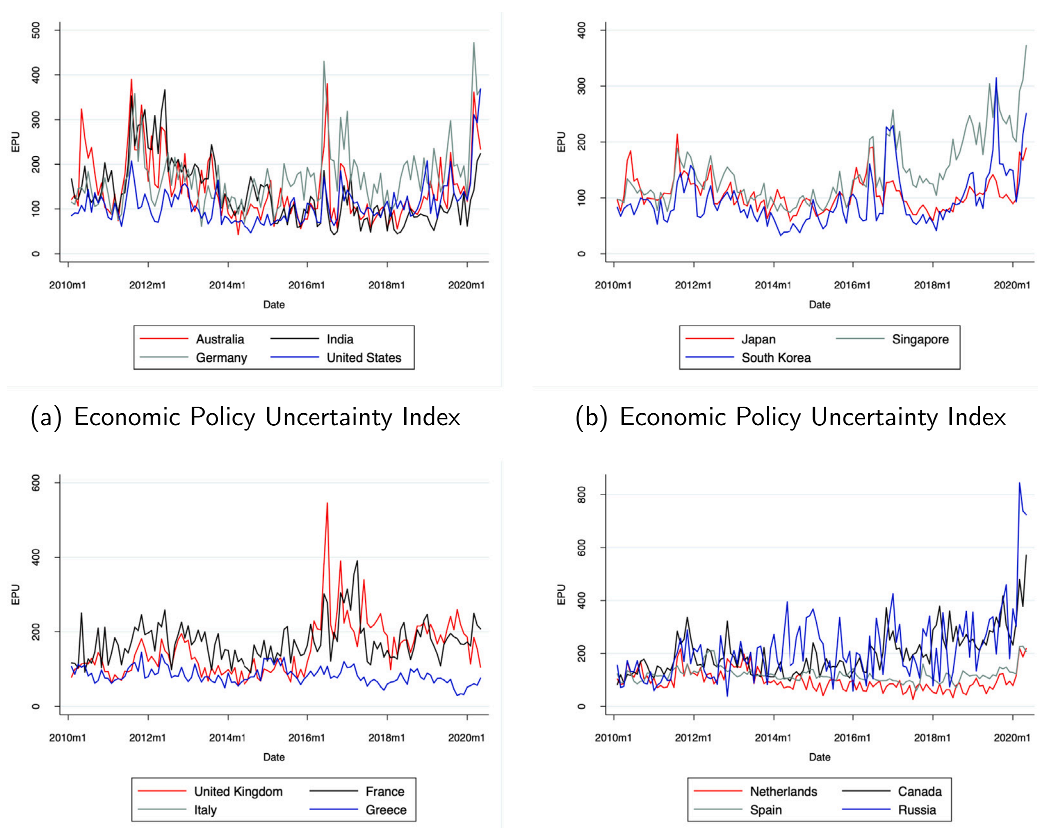
We start our empirical exercise with the following baseline model:

$$BCDS_{cijdmy} = \phi_c + \theta_i + \boldsymbol{B_1} \boldsymbol{Bank_{ijy}} + \epsilon_{cijdmy} \quad (3.1)$$

where BCDS_{cijdmy} denotes the spread of CDS type c for bank i in country j on day d, month m and year y. $\boldsymbol{Bank_{ijy}}$ is a vector of

Table 1
Bank level characteristics.

Type	Ratios	Name
Non-performing assets	Non perf. loans/Gross loans (%)	Asset quality ratio 1
	Impaired loans/Equity (%)	Asset quality ratio 2
	Unreserved impaired loans/Equity (%)	Asset quality ratio 3
Liquidity ratios	Liquid assets/Dep. & ST funding (%)	Liquidity ratio 1
	Liquid assets/Tot. Dep. & Bor. (%)	Liquidity ratio 2
Capital ratios	Equity/Net loans (%)	Capital ratio 1
	Equity/Dep. & ST funding (%)	Capital ratio 2
Efficiency ratios	Net interest margin (%)	Operations ratio 1
	Net Int. Rev./Avg assets (%)	Operations ratio 2
	Oth. Op. Inc./Avg assets (%)	Operations ratio 3
	Avg assets/Non Int. Exp. (%)	Operations ratio 4
	Return on avg assets (ROAA) (%)	Operations ratio 5
	Return on avg equity (ROAE) (%)	Operations ratio 6
	Income to cost ratio (%)	Operations ratio 7
	Recurring earning power (%)	Operations ratio 8
Leverage ratios	Total assets/Equity (%)	Leverage ratio 1
	Liabilities/Equity (%)	Leverage ratio 2
	Total liabilities/Total assets (%)	Leverage ratio 3



(a) Economic Policy Uncertainty Index
(b) Economic Policy Uncertainty Index
(c) Economic Policy Uncertainty Index
(d) Economic Policy Uncertainty Index

Fig. 3. Country Specific Economic Policy Uncertainty Indices.

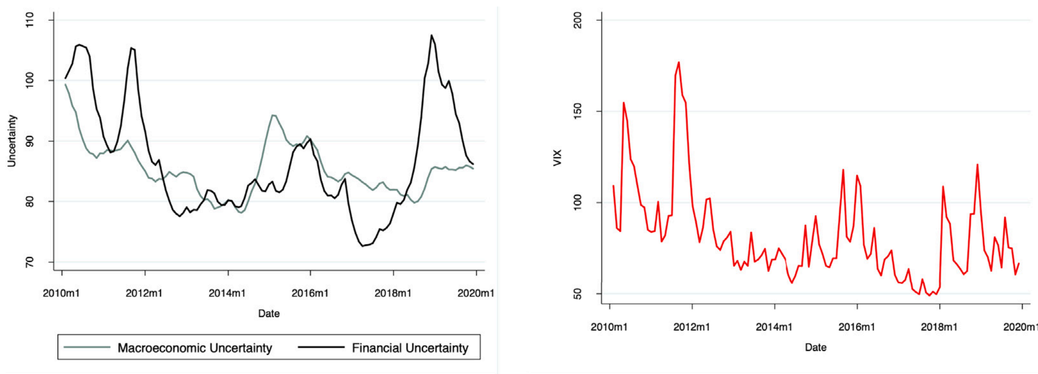
bank-level characteristics, ϕ_c denotes the CDS fixed-effects, θ_i denotes bank-level fixed-effects, and ϵ_{cijdmy} is the error term. Appendix at the end provides the names of the country used in the analysis. Hence, bank-level characteristics remain the same for all CDS spreads and are at annual frequency. Then, we extend the baseline model to include country-specific characteristics and to control for uncertainty, i.e.:

$$BCDS_{cijdmy} = \phi_c + \theta_i + \boldsymbol{B_1 Bank_{ijy}} + \boldsymbol{B_2 Macro_{jy}} + B_3 Uncertainty_{jmy} + \epsilon_{cijdmy} \tag{3.2}$$

where $\boldsymbol{Macro_{jy}}$ is a vector of macroeconomic factors for country j in year y and $Uncertainty_{jmy}$ is a specific uncertainty measure for country j in month m and year y. Next, we account for *macro-prudential policy*, that is, we estimate:

$$BCDS_{cijdmy} = \phi_c + \theta_i + \boldsymbol{B_1 Bank_{ijy}} + \boldsymbol{B_2 Macro_{jy}} + B_3 Uncertainty_{jmy} + B_4 CCyB_{jmy} + \epsilon_{cijdmy} \tag{3.3}$$

$CCyB_{jmy}$ represents the counter-cyclical capital buffers for country j in month m and year y.



(a) Uncertainty Indices (b) VIX

Fig. 4. Macroeconomic Uncertainty, Financial Uncertainty and VIX: US.

Table 2
CCyB tightening and loosening.

Tightening			Loosening		
Month	Country	No. CDS traded	Month	Country	No. CDS traded
Jan-19	Canada	20	Jul-16	United Kingdom	517
Mar-19	Denmark	40	Feb-14	India	61
Jan-17	France	179			
Jul-17	France	189			
Jul-19	France	301			
Jun-18	United Kingdom	549			
Nov-18	United Kingdom	529			
	Total	1807		Total	578

Table 3
Bank CDS spreads and bank-level characteristics.

Non-performing assets component	0.276***	0.285***	0.282***	0.308***	0.209***
	(11.97)	(12.02)	(16.14)	(26.14)	(17.21)
Liquidity component		−0.190***	−0.118***	−0.165***	−0.226***
		(−16.83)	(−9.06)	(−14.97)	(−17.58)
Capital component			−0.829***	−0.672***	−0.300***
			(−10.06)	(−11.26)	(−3.50)
Operational efficiency component				−0.270***	−0.405***
				(−8.81)	(−11.22)
Leverage component					0.303***
					(8.70)
Bank fixed-effects	Yes	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes	Yes
Observations	2804927	2804927	2804927	2802508	2802508
R-square	0.713	0.719	0.731	0.736	0.743

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance level respectively.

Since the counter-cyclical buffer (CCyB) is observed at a monthly frequency, we also estimate the monthly mean, minimum, maximum, median and standard deviation of the CDS spread using daily data and estimate monthly regressions using these five distributional characteristics of CDS as the dependent variable.

$$MCDS_{cijmy} = \theta_i + \boldsymbol{B_1 Bank_{ijy}} + \boldsymbol{B_2 Macro_{jy}} + B_3 Uncertainty_{jmy} + B_4 CCyB_{jmy} + \epsilon_{cijmy} \tag{3.4}$$

where $MCDS_{cijmy}$ denotes one of the five distributional characteristics of CDS c for bank i in country j in month m and year y. As it is mentioned above, we include CDS and bank fixed-effects in these regressions. In monthly regressions, we only include bank fixed-effects. We cannot include country fixed-effects as, for a given bank, the country is a time-invariant characteristic and bank fixed-effects take care of that. We further estimate daily regression models, adding time trend and month fixed-effects. Month fixed-effects capture the year fixed-effects as well. These regressions help in addressing the concerns regarding omitted variable bias. To control for potential reverse causality, we estimate the monthly regression models with the lagged of CCyB as well. Finally, we estimate daily regression models using a smaller sample where we drop the very large and small values of CDS (as explained in the data section),thereby, accounting for concerns related to CDS spread outliers.

Apart from these regressions, we also estimate a monthly regression to understand the channel through which macro-prudential policy is expected to affect the bank's CDS spread. Counter-cyclical capital buffer is intended to increase the capital ratio for banks, and this is a very important channel through which the counter-cyclical capital buffer can affect CDS spread. We estimate

$$Capital\,Ratio_{ijmy} = \theta_i + \boldsymbol{B_1 Bank_{ijy}} + \boldsymbol{B_2 Macro_{jy}} + B_3 Uncertainty_{jmy} + B_4 CCyB_{jmy} + \epsilon_{ijmy} \tag{3.5}$$

Since the bank-level characteristics are observed annually in our dataset, the capital ratio for the banks remains the same for each month in a year. We use monthly regression as the counter-cyclical capital buffer is observed monthly. While estimating the above, we do not include the capital component obtained using PCA from bank level variables as a control variable.

4. Empirical results

4.1. Bank characteristics, macroeconomic factors and uncertainty

We start by estimating (3.1), where we only include bank-level characteristics among the set of control variables. Table 3 summarises the main findings. A deterioration of asset quality is associated with an increase in bank CDS spreads. Thus, the more problematic the banks' assets (e.g. loans) are or the more exposed to risk the banks are, the higher the credit risk as captured by bank CDS spreads. This finding is in line with the existing literature that investigated the impact of asset quality and liquidity on bank risk (Casu and Chiaramonte, 2013; Koetter et al., 2010; Oshinsky and Olin, 2006; Hasan et al., 2016). Other studies also demonstrate that banks with good quality assets were able to lower their risk exposure and minimise their level of defaults (Hull et al., 2004; Fabozzi et al., 2007).

Additionally, we find significant effect of liquidity, capital, and operational efficiency on CDS spreads. Our results show that an improvement in liquidity, capital ratio and improvement in operational efficiency is linked with a fall in bank CDS spreads. Hence, banks with stronger liquidity ratios are more likely to avoid bank-runs and escape insolvency and credit risk of default (Collin-Dufresne et al., 2001; Campbell and Taksler, 2003; Benkert, 2004; Otker-Robe and Podpiera, 2010). Furthermore, we show that an increase of the leverage ratio is associated with higher CDS spreads, confirming the findings of Alexander and Kaeck (2008) and Ericsson et al. (2009). The coefficient associated with liquidity justifies the decline in CDS spread when liquidity increases.

The significance of liquidity and asset quality in driving credit risk is consistent with the events that followed the credit expansion of the 2000s. Banks dramatically increased their lending activities to low-income consumers, shifting their risky assets and off-balance sheet leverage intakes and selling them to the Special Purpose Vehicle (SPV) through securitisation. These securitised products containing excessive bundles of leverage were, subsequently, sold to uninformed end-investors, who carried high levels of toxic debt (Michalak and Uhde, 2012). With the onset of the Global Financial Crisis (GFC) of 2008–2009, the default of large investment banks and the collapse of the price of those products caused significantly higher and wider CDS spreads and a rise in overall bank credit risk across the financial system (de Mendonca and Barcelos, 2015; Michalak and Uhde, 2012; Abdelsalam et al., 2022). The coefficient associated with liquidity also justifies the emphasis on liquidity measures by central banks across the globe during the COVID-19 pandemic explained in the introduction. At the same time, banks with strong capital adequacy levels, high liquidity and low leverage faced narrower CDS spreads, suggesting that they were better equipped to absorb losses and avoid bankruptcy without government intervention (Antao and Lacerda, 2011). By contrast, other financial institutions needed to be rescued in multi-billion dollar bail-out package deals and quantitative easing measures (e.g., AIG, Freddie Mac and Fannie Mae) or either collapsed, merged or were taken over by stronger players (e.g., Lehman Brothers, Bear Sterns and Merrill Lynch).

Against this backdrop, the consequences of GFC crisis raised prominent awareness about the relevance of supplementing bank regulation with both micro- and the macro-prudential policies to avoid financial contagion and ensure systemic stability. They also witnessed the importance of the changes introduced in the Basel III Capital Accord and emphasised the close connection between micro-prudential and macro-prudential regulation.[8]

In our analysis, micro-prudential regulation is partially captured by (the monitoring of) bank-level characteristics, which can contain bank CDS spreads and reduce overall credit risk. Given the close inter-connectedness and complementarity between micro-prudential and macro-prudential regulation, it is important to investigate whether macro-prudential instruments help mitigate credit risk (especially, in times of uncertainty), and if so, via which channel is this achieved. These issues are discussed in the subsequent sub-sections of the paper.

We now extend the model specification to include uncertainty measures (i.e. economic policy uncertainty, financial, macro and real uncertainties and the VIX index) and macroeconomic factors (i.e. the inflation rate and the GDP growth) among the set of controls. These results are provided in Tables 4 and 5. Since, uncertainty measures used in this paper are obtained from different sources and are not comparable directly, we index them to 100 in January 2010 and use log of them. In this way the effect of these uncertainty measures can be compared. Since the dependent variable is in log and these uncertainty measures are also in log, the coefficients associated with them are interpreted as elasticity. In general, a rise in uncertainty is linked with higher bank CDS spreads. These results indicate that financial uncertainty has the largest influence on CDS spread and EPU has the lowest. Interestingly, we find higher effect of global uncertainty measures compared to country specific uncertainty. Overall, these findings are consistent with the idea that bank CDS spreads respond to changes in macroeconomic and financial conditions.

The previous literature identified macroeconomic variables as significant drivers of banking sector risk (Duffie and Singleton, 1999; Bevan and Garzarelli, 2000; Lekkos and Milas, 2001; In et al., 2003; Alexander and Kaeck, 2008; Naifar, 2010; Benbouzid and Mallick, 2013; Kajurova, 2015; Benbouzid et al., 2017b). Table 5 presents results with the macroeconomic variables in the model. In line with the studies of Aizenman et al. (2013) and Thalassinos et al. (2015), the coefficient associated with inflation is positive and statistically significant, suggesting an increase of banking sector tensions during periods of high inflation. Further the higher GDP growth is associated with lower bank credit risk. This suggests the counter-cyclical nature of bank credit risk that counter-cyclical capital buffer aims to address. Also, inclusion of macroeconomic variables increases the marginal effect of macroeconomic uncertainty on CDS spread significantly but it does not affect marginal effects of other uncertainty measures in any noticeable way.

Results obtained in this section suggest that bank level characteristics, uncertainty measures and macroeconomic factors significantly influence the bank credit risk. Also, we find that global uncertainty measures such as macroeconomic uncertainty, financial uncertainty and VIX have higher effect on CDS spreads compared to the country specific uncertainty EPU. This reflects the role of global capital in influencing the CDS spreads across the world. Next we move to analyse the effect of Counter-Cyclical Capital Buffer (CCyB) which is the main focus of the paper.

4.2. Macro-prudential policy

We now investigate the effectiveness of the Counter-Cyclical Capital Buffer (CCyB) in reducing credit risk in the banking sector, as proxied by the bank CDS spreads. In Table 6, we provide a summary of the main findings. The coefficient associated with CCyB is always negative irrespective of the uncertainty measures used, suggesting that a tightening of counter-cyclical capital buffer reduces bank CDS spreads.

[8] Micro-prudential regulation examines the responses of an individual bank to exogenous types of risks (Boissay and Cappiello, 2014). Its aim is to guarantee that individual firms and banks are safe and function well (Hanson et al., 2011). As for macro-prudential policy, its main goals are to ensure that there is systemic stability, strong output and wealth creation. This is achieved through the reduction of system-wide financial risk and frictions (Osinski et al., 2013).

Table 4
Bank CDS spreads, bank-level characteristics and uncertainty.

	(1) Log spread	(2) Log spread	(3) Log spread	(4) Log spread
Non-performing assets component	0.205***	0.186***	0.160***	0.233***
	(17.72)	(16.71)	(15.60)	(14.53)
Liquidity component	−0.178***	−0.255***	−0.215***	−0.237***
	(−13.50)	(−20.47)	(−18.86)	(−18.00)
Capital component	−0.375***	−0.286***	−0.307***	−0.300***
	(−4.60)	(−3.84)	(−4.86)	(−3.48)
Operational efficiency component	−0.393***	−0.417***	−0.366***	−0.411***
	(−11.46)	(−12.94)	(−13.39)	(−10.82)
Leverage component	0.282***	0.260***	0.200***	0.274***
	(8.33)	(8.37)	(7.40)	(8.09)
Macroeconomic uncertainty	1.709***			
	(20.35)			
Financial uncertainty		1.792***		
		(41.53)		
VIX			0.867***	
			(61.13)	
EPU				0.323***
				(31.73)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Observations	2802508	2802508	2802508	2415581
R-square	0.748	0.766	0.791	0.752

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively.

Table 5
Bank CDS spreads, bank-level characteristics, country-level factors and uncertainty.

	(1) Log spread	(2) Log spread	(3) Log spread	(4) Log spread
Non-performing assets component	0.186***	0.176***	0.154***	0.221***
	(18.68)	(17.35)	(16.37)	(15.36)
Liquidity component	−0.251***	−0.325***	−0.274***	−0.314***
	(−20.78)	(−26.13)	(−23.99)	(−24.71)
Capital component	−0.0974	−0.0409	−0.0976	−0.0600
	(−1.55)	(−0.66)	(−1.82)	(−0.80)
Operational efficiency component	−0.253***	−0.288***	−0.246***	−0.299***
	(−10.08)	(−11.36)	(−11.31)	(−9.62)
Leverage component	0.187***	0.186***	0.138***	0.202***
	(6.53)	(6.85)	(5.77)	(6.60)
Macroeconomic uncertainty	2.424***			
	(27.32)			
Financial uncertainty		1.785***		
		(43.08)		
VIX			0.838***	
			(62.97)	
EPU				0.268***
				(27.12)
GDP growth	−0.149***	−0.143***	−0.134***	−0.107***
	(−23.10)	(−22.30)	(−23.01)	(−15.23)
Inflation	0.102***	0.0704***	0.0553***	0.0854***
	(23.21)	(15.58)	(13.56)	(19.09)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Observations	2802508	2802508	2802508	2415581
R-square	0.770	0.783	0.804	0.765

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively.

Additionally, the coefficient estimates associated with all other control variables remain the same as before.

The major goal of CCyB is to ensure that banking sector capital requirements reflect the macro-financial environment in which banks operate in a given country (Hessou and Son Lai, 2017). CCyB is used when there is an excessive expansion of aggregate credit as a result of a build-up of system-wide risk. Thus, CCyB allows countries to ensure that their banking systems are resilient enough by having a buffer of capital to protect itself against future potential losses.

Building up additional capital in the banking sector acts as a shield and defence at times when the risks of system-wide stress are significantly growing (Wildmann and Pirovano, 2019), as the consequences for the banking sector can be very high, following a significant economic contraction (Antoshin et al., 2017; BIS, 2019; Borsuk et al., 2020). Such capital regulation will make banks with riskier portfolios to keep more capital aside as a cushion. In times of recession, losses can wipe out bank capital, and additional capital may be required. If banks are unable to promptly raise sufficient new capital, they would be under the obligation to cut their lending, hence significantly contributing to the worsening of the economic downturn (Kashyap and Stein, 2004; Gordy and Howells, 2006).

In order to minimise the risk of a credit crunch when the economy enters a recession, Basel III introduced the Capital Conservation Buffer (CCoB) and the Counter-Cyclical Capital Buffer (CCyB) as Macroprudential policy instruments (Andreeva et al., 2020). The CCyB is a capital buffer which was introduced under Basel III Accord requiring

Table 6
Bank CDS spreads, bank-level characteristics, country-level factors and uncertainty, and macro-prudential policy.

	(1) Log spread	(2) Log spread	(3) Log spread	(4) Log spread
CCyB	−0.198***	−0.239***	−0.185***	−0.141***
	(−21.17)	(−22.74)	(−18.00)	(−13.45)
Non-performing assets component	0.185***	0.174***	0.153***	0.219***
	(18.67)	(17.36)	(16.37)	(15.34)
Liquidity component	−0.245***	−0.317***	−0.268***	−0.310***
	(−20.10)	(−25.36)	(−23.27)	(−24.25)
Capital component	−0.0931	−0.0356	−0.0934	−0.0558
	(−1.50)	(−0.58)	(−1.76)	(−0.74)
Operational efficiency component	−0.254***	−0.289***	−0.247***	−0.300***
	(−10.13)	(−11.45)	(−11.38)	(−9.66)
Leverage component	0.187***	0.185***	0.138***	0.203***
	(6.54)	(6.87)	(5.79)	(6.63)
Macro uncertainty	2.428***			
	(27.41)			
Financial uncertainty		1.796***		
		(43.46)		
VIX			0.838***	
			(63.08)	
EPU				0.265***
				(26.55)
GDP growth	−0.148***	−0.143***	−0.133***	−0.107***
	(−23.11)	(−22.32)	(−23.01)	(−15.25)
Inflation	0.104***	0.0717***	0.0564***	0.0864***
	(23.52)	(15.96)	(13.88)	(19.33)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Observations	2802508	2802508	2802508	2415581
R-square	0.771	0.784	0.804	0.766

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance level respectively.

countries to build capital during economic boom times and draw it down during economic downturns to absorb possible losses and mitigate the increase in risk-weighted assets.

As mentioned earlier CCyB contains both tightening and loosening episodes. Since these loosening and tightening episodes are at country level and there are many CDS in the sample from a given country, we can estimate the asymmetric effect of loosening and tightening policies. As mentioned before, there are 1807 instances of tightening and 578 instances of loosening episodes. We use CCyB as a categorical variable to estimate the heterogeneous effect of tightening and loosening policy actions.

Table 7 presents the results with CCyB tightening and loosening. As we can see, the tightening episode which increases the capital requirement leads to reduction in CDS spread. The loosening episodes on the other hand increases the spread. Fig. 5 presents the coefficient associated with tightening and loosening from all the four models presented in Table 7. We find that the magnitude of the effect is much higher in the case of loosening episodes when we use common measures of uncertainty, but with EPU both tightening and loosening have similar magnitudes. We believe that the results with EPU are more reasonable, as EPU is country specific.

Our findings are in contrast with Andreeva et al. (2020) who investigated the role played by financial market pressures on the use of regulatory capital buffer in light of the current COVID-19 Pandemic, and they found that CCyB may not always be effective in helping all banks relieve pressures during economic downturns. In fact, they explain that in the case of COVID-19 Pandemic, in the midst of a strong economic downturn, pressures from financial markets transmitted through various channels affected banks' reluctance to use their CCyB to counter this negative effect. Financial market pressures translated through bondholders may require banks to maintain higher capital ratios to lower default risk, while shareholders may pressurise banks to continue dividend payments instead of using excess capital to increase their lending activities or to absorb losses (Andreeva et al., 2020).

Furthermore, our results show that uncertainty increases the CDS spread and credit risk. However, countries with better macro-prudential regulation do not see a similar increase in credit risk. Besides, the counter-cyclical capital regulation is an extra preventive measure that banks can build during good times and draw down during bad times, which is not mandatory for all countries to comply. However, any increase in CDS spread due to uncertainty could be mitigated by those banks who have higher levels of liquidity, even in the presence of bank capital requirements. Our findings show that macro-prudential policy has a negative effect on CDS spreads which we further explore in the next subsection.

4.3. Robustness

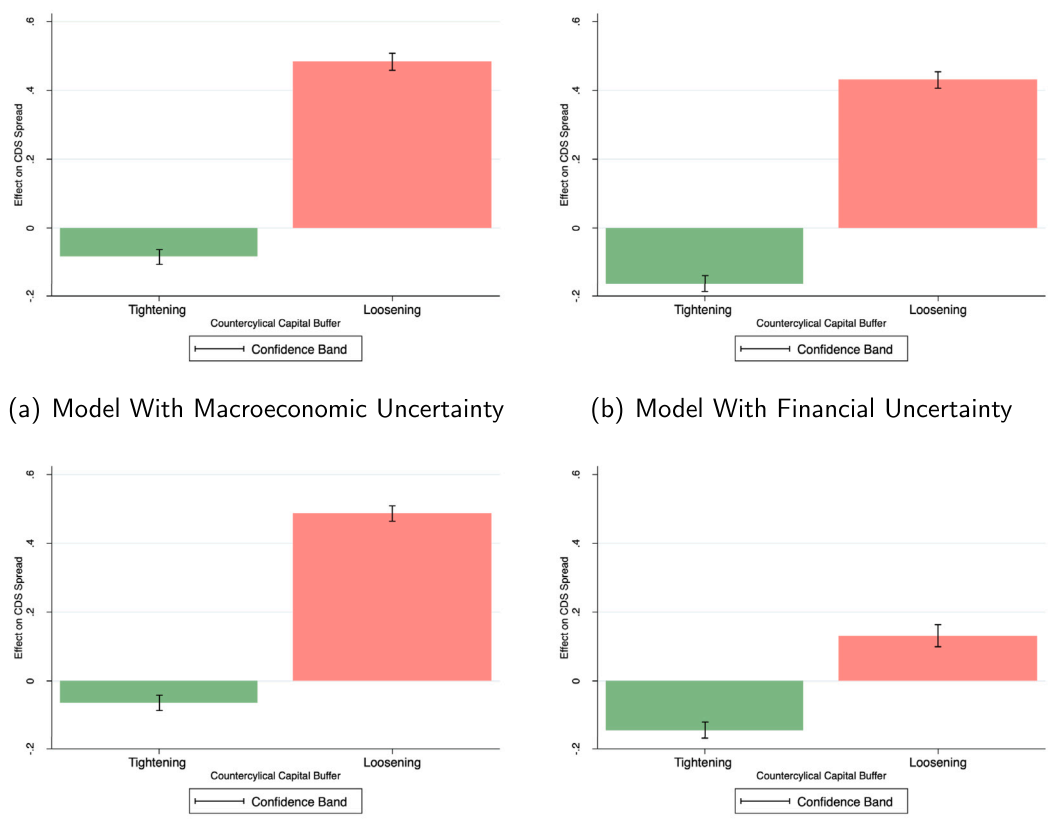
Fig. 5 and Table 7 in the previous section showed the main results of the paper which suggest significant effect of CCyB on CDS spread and heterogeneity in tightening and loosening of CCyB. In this section we present several additional regressions as robustness exercises. Figs. 6, 7 and 8 show estimates of the coefficients of interest (tightening and loosening of CCyB) from alternative estimations done in the paper. Other coefficients are similar as reported before and hence we omit them as those are not our coefficients of interest. We include CDS fixed-effects, bank fixed-effects, five principal components – non-performing assets, liquidity, capital, operational efficiency and leverage – GDP growth and inflation in all these models. Fig. 6 shows the results from the models in which we further include time trend. Time trend helps us in controlling for potential deterministic trend in the CDS spread and also address the concerns related to potential omitted variables bias. Fig. 7 shows the results from the models in which we further include both time trend and month fixed-effects. The month fixed-effects effectively capture the year fixed-effects as well. Time trend controls for potential deterministic trend in the CDS spread, and both time trend and month fixed-effects also help us in reducing the potential bias caused by omitted variables.

Result shown in Figs. 6 and 7 gives unambiguous support to the result presented in the previous section and suggests that the favourable

Table 7
Bank CDS spreads, bank-level characteristics, country-level factors and uncertainty, and macro-prudential policy.

CCyB (Tightening)	−0.0841***	−0.163***	−0.0637***	−0.144***
	(−7.73)	(−13.17)	(−5.60)	(−11.51)
CCyB (Loosening)	0.483***	0.430***	0.486***	0.131***
	(38.12)	(35.19)	(42.55)	(8.10)
Non-performing assets component	0.187***	0.176***	0.155***	0.219***
	(18.85)	(17.48)	(16.56)	(15.33)
Liquidity component	−0.245***	−0.317***	−0.268***	−0.309***
	(−20.11)	(−25.35)	(−23.29)	(−24.24)
Capital component	−0.100	−0.0401	−0.101	−0.0557
	(−1.61)	(−0.65)	(−1.89)	(−0.74)
Operational efficiency component	−0.253***	−0.288***	−0.246***	−0.300***
	(−10.12)	(−11.44)	(−11.37)	(−9.66)
Leverage component	0.185***	0.185***	0.136***	0.203***
	(6.49)	(6.84)	(5.73)	(6.63)
Macroeconomic uncertainty	2.447***			
	(27.56)			
Financial uncertainty		1.793***		
		(43.39)		
VIX			0.840***	
			(63.15)	
EPU				0.266***
				(26.06)
GDP growth	−0.148***	−0.143***	−0.133***	−0.107***
	(−23.08)	(−22.28)	(−22.95)	(−15.24)
Inflation	0.105***	0.0723***	0.0572***	0.0863***
	(23.79)	(16.10)	(14.12)	(19.33)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Observations	2802508	2802508	2802508	2415581
R-square	0.771	0.784	0.805	0.766

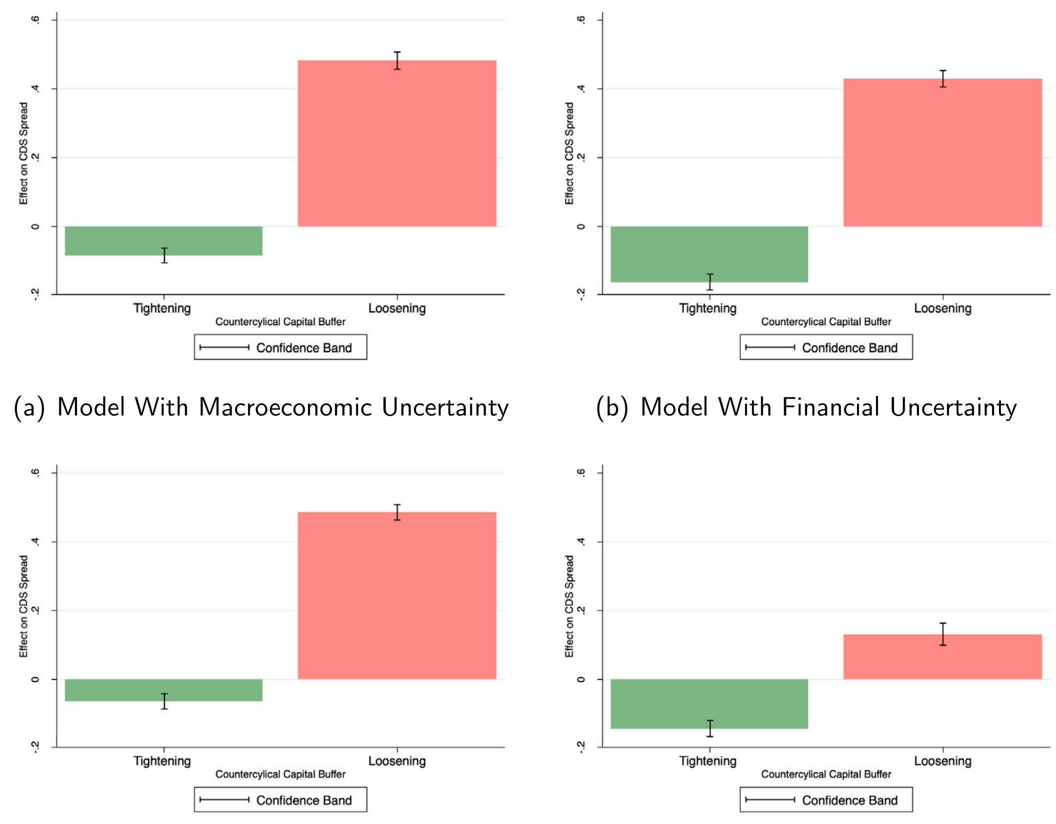
Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively.



(a) Model With Macroeconomic Uncertainty (b) Model With Financial Uncertainty

(c) Model With VIX (d) Model With Country Specific EPU

Fig. 5. We include CDS and bank fixed effects, five principal components – non-performing assets, liquidity, capital, operational efficiency and leverage – GDP growth and inflation in all these models, using daily data for the time Period: 2010–2019.



(a) Model With Macroeconomic Uncertainty (b) Model With Financial Uncertainty

(c) Model With VIX (d) Model With Country Specific EPU

Fig. 6. We include CDS and bank fixed effects, five principal components – non-performing assets, liquidity, capital, operational efficiency and leverage – GDP growth and inflation in all these models. We further include time trend; Daily data is used for the time Period: 2010–2019.

effect of CCyB tightening on CDS spread reported in this paper is not likely to be driven by omitted variable bias.

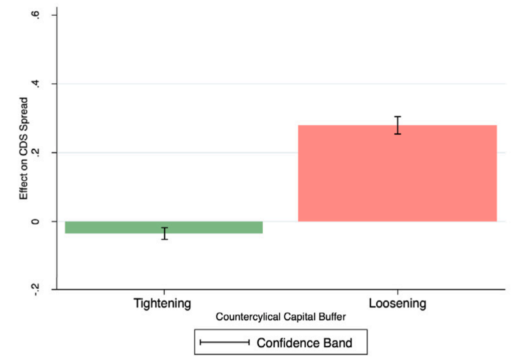
Fig. 8 presents the coefficient associated with tightening and loosening from all the four models which we estimate using a smaller sample where we drop the very large and small values of CDS as explained in the data section. These results are similar to the ones reported before and suggest that the favourable effect of CCyB tightening on CDS spread reported in this paper is not likely to be influenced by outliers in CDS spread.

Since the counter-cyclical buffer (CCyB) is observed at a monthly frequency, we also estimate the monthly mean, median, minimum, maximum, and standard deviation of the CDS spread using daily data and estimate monthly regressions with these five distributional characteristics of CDS as the dependent variable. These results are reported in Tables A.1–A.5 (appendix A) and they suggest that CCyB not only affects the mean but has a desirable effect on other distributional characteristics as well. Comparing the effect of these uncertainty measures, we find that the macroeconomic uncertainty has the highest effect on these distributional characteristics including standard deviation of the CDS spreads. Interestingly, we also find that the elasticity of standard deviation of CDS with these uncertainty measures is much higher than other distributional charactristics of these CDS spreads. Finally, since CCyB is observed at a monthly frequency, these monthly regressions allow us to address concerns related to reverse causality. We estimate regression models with these five distributional characteristics as dependent variable where we include the lag of CCyB (tightening and loosening). These results are presented in Tables B.1–B.5 (appendix B) and suggest desirable effect of CCyB tightening on entire distribution of CDS spread. Further, these regressions with lagged CCyB diminish the effect of tightening on the mean, but magnify the effect on the standard deviation of CDS spread. Overall, these robustness exercises provide evidence that the desirable effect of CCyB tightening on the entire distribution of CDS spread is not likely to be driven by omitted variable bias, reverse causality and outliers.

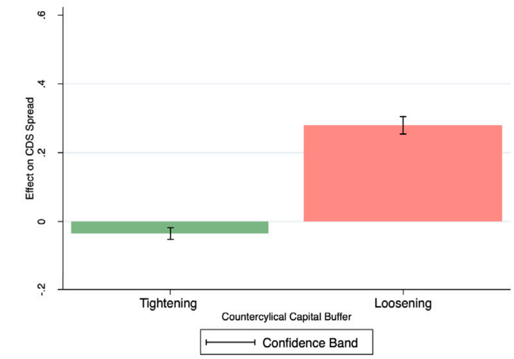
4.4. Exploring the capital channel

Results so far suggest that the CCyB significantly affects CDS spread. The CCyB is expected to increase capital ratio and hence it may affect CDS spread due to changes in capital ratio for banks. Higher capital reduces the probability of default and hence affects CDS spread in a favourable way. To explore this, we estimate additional regression models with the capital ratio for banks as a dependent variable.

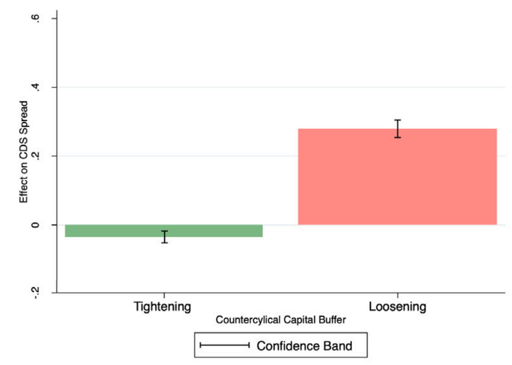
Table 8 presents the results using CCyB and suggests that higher CCyB, i.e. tightening, leads to higher capital ratio as expected. Table 9 presents the results from using tightening and loosening episodes. These results suggest that tightening leads to significantly higher capital but loosening does not have significant effect on capital ratio. Also the coefficient associated with tightening is higher in Table 9 compared to Table 8, as Table 9 makes the distinction between tightening and loosening, capturing their heterogeneous effect on bank capital. Table 10 and Fig. 9 present the coefficient with tightening and loosening episodes with model that includes time trend. These results are similar to the one presented in Tables 8 and 9 and confirm that tightening leads to increase in capital ratio, and loosening does not have statistically significant effect on capital ratio. This implies that the CCyB mainly works through capital as expected.



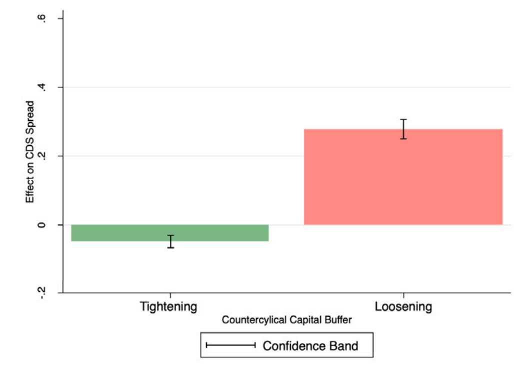
(a) Model With Macroeconomic Uncertainty



(b) Model With Financial Uncertainty



(c) Model With VIX



(d) Model With Country Specific EPU

Fig. 7. We include CDS and bank fixed effects, five principal components – non-performing assets, liquidity, capital, operational efficiency and leverage – GDP growth and inflation in all these models. We also include month fixed effects and a time trend. These fixed effects imply country and year fixed effects as well. Time period: 2010–2019.

Table 8
Bank capital, bank-level characteristics, country-level factors and uncertainty, and macro-prudential policy.

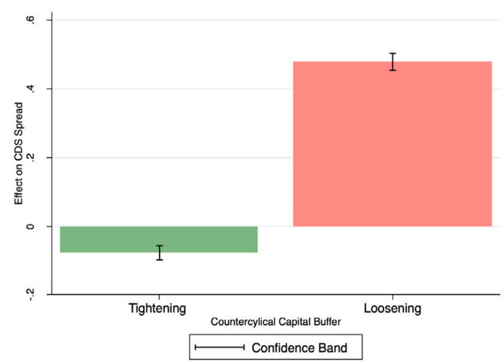
	(1) Total Capital Ratio	(2) Total Capital Ratio	(3) Total Capital Ratio	(4) Total Capital Ratio
CCyB	0.623* (2.20)	0.674* (2.21)	0.623* (2.16)	0.427 (1.65)
Bank fixed-effects	Yes	Yes	Yes	Yes
Observations	2977	2977	2977	2461
R-square	0.720	0.721	0.723	0.763

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance leves respectively. We include bank fixed-effects, four principal components – Non-performing assets, liquidity, operational efficiency and leverage – GDP growth and inflation in all these models, using bank-level monthly data. First, second, third and fourth columns are with macroeconomic uncertainty, financial uncertainty, VIX and EPU respectively; Time period: 2010–2019.

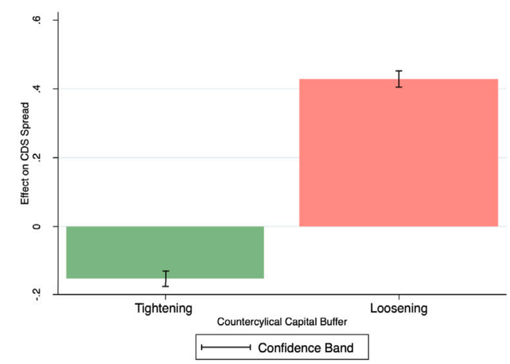
Table 9
Bank capital, bank-level characteristics, country-level factors and uncertainty, and macro-prudential policy.

	(1) Total Capital Ratio	(2) Total Capital Ratio	(3) Total Capital Ratio	(4) Total Capital Ratio
CCyB (Tightening)	1.384* (2.24)	1.497* (2.28)	1.401* (2.18)	1.364* (2.33)
CCyB (Loosening)	0.264 (0.51)	0.289 (0.55)	0.243 (0.48)	−0.381 (−0.75)
Bank fixed-effects	Yes	Yes	Yes	Yes
Observations	2977	2977	2977	2461
R-square	0.721	0.722	0.723	0.764

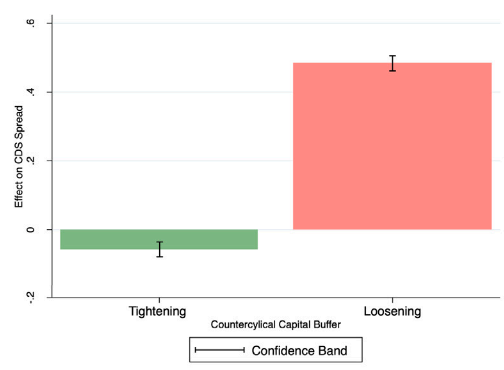
Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively. We include bank fixed-effects, four principal components – Non-performing assets, liquidity, operational efficiency and leverage – GDP growth and inflation in all these models, with bank-level monthly data. First, second, third and fourth columns are with macroeconomic uncertainty, financial uncertainty, VIX and EPU, respectively; Time period: 2010–2019.



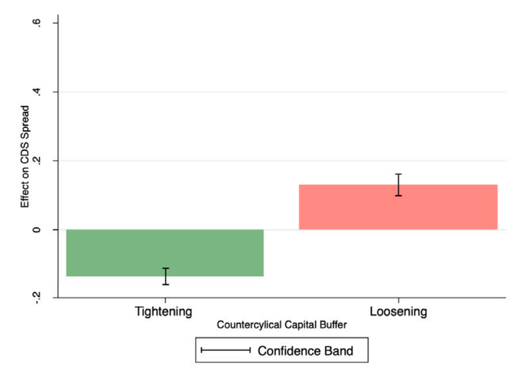
(a) Model With Macroeconomic Uncertainty



(b) Model With Financial Uncertainty



(c) Model With VIX



(d) Model With Country Specific EPU

Fig. 8. We include CDS and bank fixed-effects, five principal components – non-performing assets, liquidity, capital, operational efficiency and leverage – GDP growth and inflation in all these models. We have estimated with the sample obtained after dropping very small and large CDS spreads. Time period: 2010–2019.

Table 10
Bank capital, bank-level characteristics, country-level factors and uncertainty, and macroprudential policy.

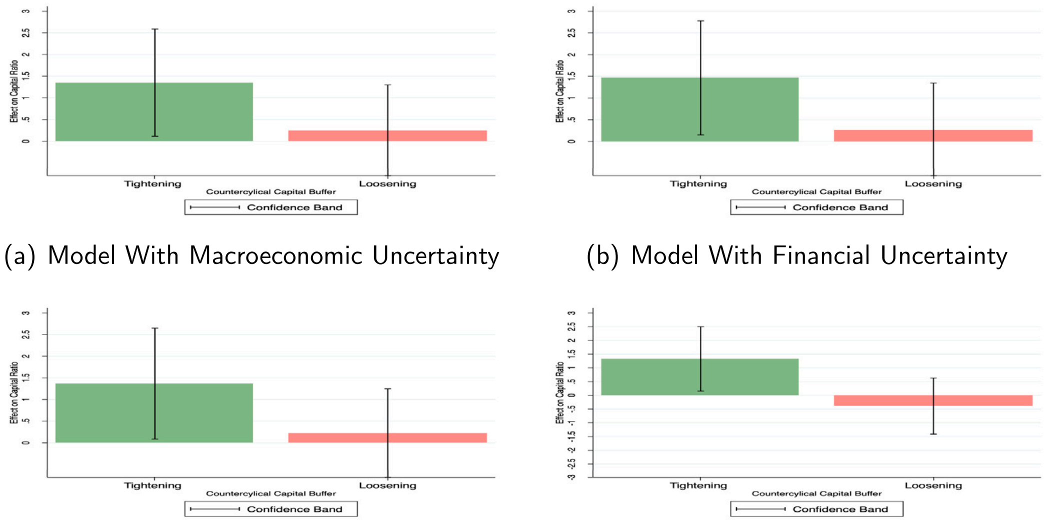
	(1) Total Capital Ratio	(2) Total Capital Ratio	(3) Total Capital Ratio	(4) Total Capital Ratio
CCyB (Tightening)	1.351*	1.464*	1.365*	1.327*
	(2.19)	(2.23)	(2.13)	(2.27)
CCyB (Loosening)	0.241	0.266	0.218	−0.393
	(0.46)	(0.49)	(0.43)	(−0.77)
Bank fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	2977	2977	2977	2461
R-square	0.721	0.722	0.723	0.764

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively. We include bank fixed-effects, four principal components – Non-performing assets, liquidity, operational efficiency and leverage – GDP growth and inflation in all these models. We further include a time trend; Bank-level monthly data is used. First, second, third and fourth columns are with macroeconomic uncertainty, financial uncertainty, VIX and EPU, respectively; Time period: 2010–2019.

5. Conclusions

Building on a novel database consisting of daily Credit Default Swaps (CDS), along with bank-level and country-level data, comprising 4939 CDS types of 70 banks from 25 countries for up-to 2490 days over the period 2010–2019, we investigate the impact of macro-prudential policy on bank credit risk. We find that macro-prudential policy measures significantly reduce bank credit risk. Our empirical findings also suggest that capital-based macro-prudential policies (e.g. a tightening of counter-cyclical capital buffers (CCyB)) are effective in dampening bank credit risk. Results obtained in this paper also give unambiguous evidence regarding the desirable effect of CCyB tightening on the entire distribution of bank CDS spreads. CCyB tightening moves the entire distribution to the left (i.e., it reduces the mean, median, minimum and maximum) and also shrinks the distribution of bank CDS spreads (i.e., it reduces the standard deviation). These tightening episodes narrow spreads, as they are also associated with an increase in the capital ratio for banks.

Additionally, we show that bank-level factors, such as (i) an improvement in liquidity, (ii) a rise in capital ratios, (iii) an increase in operational efficiency, (iv) better asset quality and (v) a fall in leverage, are associated with lowering bank CDS spreads. Thus, these results emphasise the relevance of bank characteristics in explaining credit risk dynamics. Finally, the macroeconomic environment matters: periods of high inflation are linked with rising tensions in the banking sector; and a rise in (financial and macroeconomic) uncertainty is associated with a significant increase in bank CDS spreads. Further, global uncertainty



(a) Model With Macroeconomic Uncertainty (b) Model With Financial Uncertainty

(c) Model With VIX (d) Model With Country Specific EPU

Fig. 9. We include bank fixed-effects, four principal components – non-performing assets, liquidity, operational efficiency and leverage – GDP growth and inflation in all these models. We further include a time trend; Bank-level monthly data is used. Time period: 2010–2019.

measures, such as macroeconomic uncertainty, financial uncertainty and VIX, have significantly higher effect on CDS spreads compared to the country-specific EPU index. This suggests the role of global capital in affecting bank CDS spreads across the world. The recent COVID-19 episode was associated with the implementation of a large number of macro-prudential policies especially related to enhancing liquidity in the banking system. Further research is required to understand the effect of such policies on bank CDS spreads.

Data availability

The authors do not have permission to share data.

Appendix A. Robustness regressions: Monthly data

See Tables A.1–A.5.

Table A.1
Robustness regression: Log mean spread.

	(1) Mean spread	(2) Mean spread	(3) Mean spread	(4) Mean spread
CCyB tightening	−0.131***	−0.227***	−0.125***	−0.204***
	(−10.27)	(−15.44)	(−9.19)	(−14.24)
CCyB loosening	0.489***	0.443***	0.503***	0.107***
	(39.23)	(37.26)	(44.25)	(6.53)
Non-performing assets	0.176***	0.161***	0.144***	0.216***
	(18.37)	(16.26)	(15.34)	(15.21)
Liquidity component	−0.242***	−0.309***	−0.261***	−0.299***
	(−19.82)	(−24.36)	(−22.47)	(−22.92)
Capital component	−0.0569	−0.00723	−0.0675	−0.0105
	(−0.88)	(−0.11)	(−1.22)	(−0.14)
Operational efficiency component	−0.199***	−0.239***	−0.201***	−0.262***
	(−7.10)	(−8.38)	(−8.17)	(−7.64)
Leverage component	0.158***	0.167***	0.115***	0.179***
	(4.70)	(5.18)	(4.06)	(4.95)
Macroeconomic uncertainty	2.555***			
	(29.20)			
GDP growth	−0.133***	−0.125***	−0.119***	−0.0869***
	(−17.28)	(−16.48)	(−17.30)	(−10.38)
Inflation	0.111***	0.0766***	0.0603***	0.0889***
	(24.51)	(16.82)	(14.70)	(18.95)
Financial uncertainty		1.763***		
		(45.24)		
VIX			0.849***	
			(64.62)	
EPU				0.288***
				(28.47)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	144643	144643	144643	124523
R-square	0.777	0.788	0.811	0.770

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance level respectively. We estimate with monthly CDS data obtained from transforming daily CDS data.

Table A.2
Robustness regression: Log median spread.

	(1) Median spread	(2) Median spread	(3) Median spread	(4) Median spread
CCyB tightening	−0.117***	−0.214***	−0.112***	−0.191***
	(−8.86)	(−14.16)	(−7.98)	(−12.82)
CCyB loosening	0.435***	0.388***	0.448***	0.0540***
	(36.88)	(34.54)	(42.73)	(3.35)
Non-performing assets	0.177***	0.161***	0.144***	0.216***
	(18.43)	(16.29)	(15.37)	(15.26)
Liquidity component	−0.242***	−0.310***	−0.262***	−0.300***
	(−19.81)	(−24.37)	(−22.48)	(−22.92)
Capital component	−0.0581	−0.00769	−0.0680	−0.0105
	(−0.90)	(−0.12)	(−1.23)	(−0.14)
Operational efficiency component	−0.197***	−0.238***	−0.201***	−0.261***
	(−7.06)	(−8.35)	(−8.14)	(−7.60)
Leverage component	0.156***	0.166***	0.114***	0.178***
	(4.64)	(5.14)	(4.03)	(4.92)
Macroeconomic uncertainty	2.595***			
	(29.50)			
GDP growth	−0.133***	−0.125***	−0.119***	−0.0868***
	(−17.20)	(−16.38)	(−17.18)	(−10.32)
Inflation	0.112***	0.0776***	0.0612***	0.0898***
	(24.79)	(17.05)	(14.95)	(19.09)
Financial uncertainty		1.774***		
		(45.15)		
VIX			0.849***	
			(64.34)	
EPU				0.285***
				(28.30)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	144643	144643	144643	124523
R-square	0.776	0.786	0.809	0.768

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance level respectively. We estimate with monthly CDS data obtained from transforming daily CDS data.

Table A.3
Robustness regression: Log minimum spread.

	(1) Minimum spread	(2) Minimum spread	(3) Minimum spread	(4) Minimum spread
CCyB tightening	−0.122***	−0.215***	−0.118***	−0.190***
	(−10.46)	(−15.84)	(−9.32)	(−14.67)
CCyB loosening	0.442***	0.395***	0.451***	0.0919***
	(35.46)	(33.17)	(39.38)	(5.80)
Non-performing assets	0.168***	0.153***	0.138***	0.206***
	(17.92)	(15.80)	(14.90)	(14.88)
Liquidity component	−0.247***	−0.312***	−0.267***	−0.306***
	(−19.28)	(−23.45)	(−21.69)	(−22.15)
Capital component	−0.0153	0.0335	−0.0232	0.0445
	(−0.24)	(0.53)	(−0.42)	(0.61)
Operational efficiency component	−0.202***	−0.242***	−0.206***	−0.264***
	(−7.33)	(−8.57)	(−8.37)	(−7.82)
Leverage component	0.155***	0.166***	0.118***	0.178***
	(4.75)	(5.25)	(4.22)	(5.03)
Macroeconomic uncertainty	2.518***			
	(27.46)			
GDP growth	−0.130***	−0.121***	−0.116***	−0.0866***
	(−17.07)	(−16.19)	(−16.89)	(−10.45)
Inflation	0.108***	0.0743***	0.0592***	0.0875***
	(23.67)	(16.33)	(14.37)	(18.68)
Financial uncertainty		1.702***		
		(40.51)		
VIX			0.796***	
			(58.25)	
EPU				0.259***
				(26.01)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	144641	144641	144641	124521
R-square	0.784	0.793	0.810	0.776

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively. We estimate with monthly CDS data obtained from transforming daily CDS data.

Table A.4
Robustness regression: Log maximum spread.

	(1) Maximum spread	(2) Maximum spread	(3) Maximum spread	(4) Maximum spread
CCyB tightening	−0.150***	−0.248***	−0.142***	−0.227***
	(−11.02)	(−16.01)	(−9.91)	(−14.84)
CCyB loosening	0.578***	0.532***	0.596***	0.168***
	(41.59)	(40.04)	(46.00)	(9.54)
Non-performing assets	0.182***	0.166***	0.147***	0.224***
	(18.51)	(16.43)	(15.49)	(15.33)
Liquidity component	−0.241***	−0.308***	−0.258***	−0.295***
	(−20.20)	(−24.91)	(−22.97)	(−23.32)
Capital component	−0.0777	−0.0279	−0.0914	−0.0436
	(−1.17)	(−0.43)	(−1.62)	(−0.56)
Operational efficiency component	−0.200***	−0.241***	−0.201***	−0.264***
	(−7.02)	(−8.32)	(−8.13)	(−7.58)
Leverage component	0.162***	0.170***	0.114***	0.182***
	(4.71)	(5.15)	(3.98)	(4.92)
Macroeconomic uncertainty	2.547***			
	(29.68)			
GDP growth	−0.134***	−0.126***	−0.121***	−0.0855***
	(−17.27)	(−16.55)	(−17.44)	(−10.11)
Inflation	0.111***	0.0765***	0.0590***	0.0880***
	(24.25)	(16.41)	(14.10)	(18.42)
Financial uncertainty		1.820***		
		(48.08)		
VIX			0.896***	
			(69.28)	
EPU				0.313***
				(29.98)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	144643	144643	144643	124523
R-square	0.756	0.769	0.798	0.751

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively. We estimate with monthly CDS data obtained from transforming daily CDS data.

Table A.5
Robustness regression: Log standard deviation spread.

	(1) SD spread	(2) SD spread	(3) SD spread	(4) SD spread
CCyB tightening	−0.316***	−0.472***	−0.295***	−0.448***
	(−6.47)	(−9.24)	(−5.87)	(−8.93)
CCyB loosening	1.314***	1.234***	1.355***	0.620***
	(41.22)	(39.01)	(44.81)	(14.56)
Non-performing assets	0.419***	0.397***	0.361***	0.389***
	(22.50)	(22.19)	(21.66)	(18.69)
Liquidity component	−0.370***	−0.478***	−0.399***	−0.428***
	(−17.77)	(−22.42)	(−20.65)	(−19.54)
Capital component	−0.164	−0.0731	−0.173	−0.315*
	(−1.49)	(−0.68)	(−1.95)	(−2.42)
Operational efficiency component	−0.278***	−0.343***	−0.274***	−0.369***
	(−6.33)	(−7.72)	(−7.40)	(−7.16)
Leverage component	0.0912	0.103*	−0.0101	0.191***
	(1.80)	(2.11)	(−0.25)	(3.73)
Macroeconomic uncertainty	4.188***			
	(32.75)			
GDP growth	−0.110***	−0.0962***	−0.0835***	−0.0134
	(−8.35)	(−7.43)	(−6.86)	(−0.86)
Inflation	0.180***	0.124***	0.0935***	0.136***
	(15.19)	(10.05)	(7.97)	(10.25)
Financial uncertainty		2.859***		
		(44.79)		
VIX			1.605***	
			(80.70)	
EPU				0.523***
				(24.11)

(*continued on next page*)

Table A.5 (*continued*).

	(1) SD spread	(2) SD spread	(3) SD spread	(4) SD spread
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	142235	142235	142235	122505
R-square	0.398	0.409	0.448	0.408

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively. We estimate with monthly CDS data obtained from transforming daily CDS data.

Table B.1
Robustness regression: Log mean spread.

	(1) Mean spread	(2) Mean spread	(3) Mean spread	(4) Mean spread
L.CCyB tightening	−0.0397**	−0.166***	−0.0983***	−0.0908***
	(−3.02)	(−10.71)	(−7.00)	(−6.20)
L.CCyB loosening	0.242***	0.191***	0.285***	0.0960***
	(20.47)	(17.29)	(28.39)	(8.06)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	137149	137149	137149	118367
R-square	0.776	0.788	0.810	0.772

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively. We estimate with monthly CDS data obtained from transforming daily CDS data. We also include five principal components – non-performing assets, liquidity, capital, operational efficiency and leverage – GDP growth and inflation in all these models. First, second, third and fourth columns are with macroeconomic uncertainty, financial uncertainty, VIX and EPU respectively; Time period: 2010–2019.

Table B.2
Robustness regression: Log median spread.

	(1) Median spread	(2) Median spread	(3) Median spread	(4) Median spread
L.CCyB tightening	−0.0325*	−0.160***	−0.0914***	−0.0834***
	(−2.49)	(−10.30)	(−6.50)	(−5.73)
L.CCyB loosening	0.225***	0.173***	0.267***	0.0787***
	(18.81)	(15.41)	(26.24)	(6.52)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	137149	137149	137149	118367
R-square	0.775	0.787	0.808	0.770

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively. We estimate with monthly CDS data obtained from transforming daily CDS data. We also include five principal components – non-performing assets, liquidity, capital, operational efficiency and leverage – GDP growth and inflation in all these models. First, second, third and fourth columns are with macroeconomic uncertainty, financial uncertainty, VIX and EPU respectively; Time period: 2010–2019.

Table B.3
Robustness regression: Log minimum spread.

	(1) Minimum spread	(2) Minimum spread	(3) Minimum spread	(4) Minimum spread
L.CCyB tightening	0.0168	−0.104***	−0.0386**	−0.0307*
	(1.22)	(−6.72)	(−2.70)	(−2.02)
L.CCyB loosening	0.244***	0.194***	0.281***	0.107***
	(19.77)	(16.70)	(26.34)	(8.64)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	137147	137147	137147	118365
R-square	0.783	0.792	0.809	0.778

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively. We estimate with monthly CDS data obtained from transforming daily CDS data. We also include five principal components – non-performing assets, liquidity, capital, operational efficiency and leverage – GDP growth and inflation in all these models. First, second, third and fourth columns are with macroeconomic uncertainty, financial uncertainty, VIX and EPU respectively; Time period: 2010–2019.

Table B.4
Robustness regression: Log maximum spread.

	(1) Maximum spread	(2) Maximum spread	(3) Maximum spread	(4) Maximum spread
L.CCyB tightening	−0.0856***	−0.216***	−0.147***	−0.140***
	(−6.46)	(−13.64)	(−10.29)	(−9.43)
L.CCyB loosening	0.306***	0.257***	0.356***	0.154***
	(25.48)	(22.88)	(34.43)	(12.78)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	137149	137149	137149	118367
R-square	0.756	0.769	0.796	0.753

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively. We estimate with monthly CDS data obtained from transforming daily CDS data. We also include five principal components – non-performing assets, liquidity, capital, operational efficiency and leverage – GDP growth and inflation in all these models. First, second, third and fourth columns are with macroeconomic uncertainty, financial uncertainty, VIX and EPU respectively; Time period: 2010–2019.

Table B.5
Robustness regression: Log standard deviation spread.

	(1) SD spread	(2) SD spread	(3) SD spread	(4) SD spread
L.CCyB tightening	−0.566***	−0.772***	−0.675***	−0.659***
	(−14.32)	(−17.34)	(−15.57)	(−16.32)
L.CCyB loosening	0.709***	0.621***	0.805***	0.443***
	(22.17)	(19.57)	(26.62)	(13.35)
Bank fixed-effects	Yes	Yes	Yes	Yes
CDS fixed-effects	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes
Observations	135847	135847	135847	117354
R-square	0.405	0.415	0.454	0.416

Notes: *, **, and *** denote significance at 5%, 1%, and .1% significance levels respectively. We estimate with monthly CDS data obtained from transforming daily CDS data. We also include five principal components – non-performing assets, liquidity, capital, operational efficiency and leverage – GDP growth and inflation in all these models. First, second, third and fourth columns are with macroeconomic uncertainty, financial uncertainty, VIX and EPU respectively; Time period: 2010–2019.

Appendix B. Robustness regressions: Monthly data – lag CCyB

See Tables B.1–B.5.

List of countries

1. Australia 2. Austria 3. Belgium 4. Canada 5. Denmark 6. France 7. Germany 8. Greece 9. India 10. Italy 11. Japan 12. Kazakhstan 13. Malaysia 14. Netherlands 15. Russia 16. Saudi Arabia 17. Singapore 18. South Korea 19. Spain 20. Sweden 21. Switzerland 22. Turkey 23. United Arab Emirates 24. United Kingdom 25. United States

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