How Do Regulators Set the Countercyclical Capital Buffer?*

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As part of the Basel III regulatory framework, the macroprudential countercyclical capital buffer (CCyB) was introduced to mitigate the procyclicality in the financial system. National designated authorities are supposed to set the CCyB based on a "guided discretion" approach that combines rule-based and discretionary elements. We identify a CCyB puzzle, as we do not find the credit-to-GDP gap, the recommended rule-based component of the CCyB, to be crucial for buffer decisions. Instead, designated authorities appear to base their CCyB decisions in a systematic way on the discretionary elements of the framework, namely the development of house prices and non-performing loans. We also find national institutional frameworks to be relevant for CCyB policies.

JEL Codes: G01, G21, G28.

1. Introduction

In times of financial stress, the procyclical behavior of banks is likely to generate substantial negative feedback effects on the real economy. As asset prices decline, capital positions deteriorate, pressure on margins and lending standards increases, and financial institutions restrict lending to deleverage (Brunnermeier 2009). The European Systemic Risk Board (ESRB) points out that the subsequent credit shortage aggravates the economic slowdown, with negative repercussions on banks' credit portfolios (ESRB 2014). Since most banks are both creditors and debtors, network effects are likely to emerge that threaten the stability of the financial system (Brunnermeier 2009).

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To work against such vicious circles, the countercyclical capital buffer (CCyB) was introduced as part of the global regulatory Basel III framework after a lot of preparatory work. It "is designed to help counter pro-cyclicality in the financial system. Capital should be accumulated when cyclical systemic risk is judged to be increasing, creating buffers that increase the resilience of the banking sector during periods of stress when losses materialise" (ESRB 2014). Accordingly, the CCyB should fluctuate over the financial cycle and be fully loaded at the onset of financial crises and economic downturns.

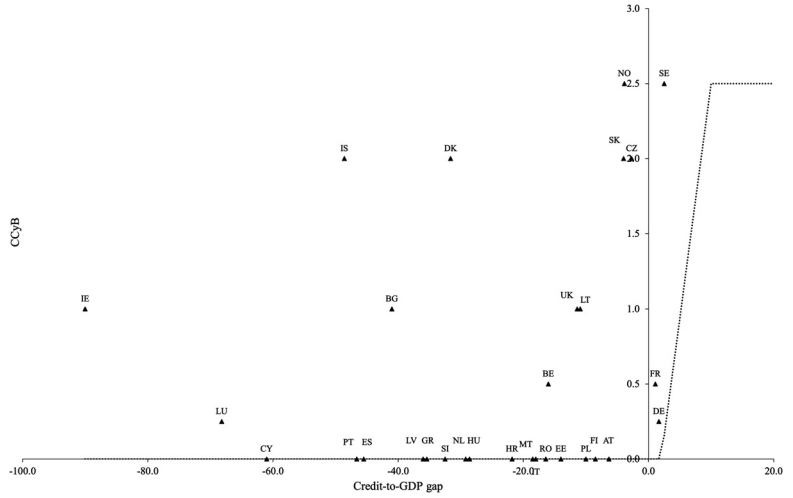
National designated authorities are supposed to implement the CCyB under a "guided discretion" approach, which combines rule-based and discretionary elements. As the rule-based component, the so-called buffer guide is based on the credit-to-GDP gap, i.e., the deviation of the credit-to-GDP ratio from its long-term trend (Basel Committee on Banking Supervision 2010; ESRB 2014). The discretionary component involves additional categories of indicators such as credit developments and private sector debt burden. These risk indicators are not specifically defined and are not subject to a specific rule so that ESRB member countries have considerable leeway in their CCyB policies.

ESRB members have used this regulatory space to a remarkable degree. On the one hand, most authorities in southern Europe (e.g., Spain, Italy, Greece, Portugal) seem to have followed ESRB recommendations and kept CCyB rates at zero, consistent with negative credit-to-GDP gaps on the national level. On the other hand, most northern European countries (e.g., Sweden, Norway, Denmark) implemented more ambitious policies and set higher CCyB rates than required by national buffer guides[1] (see Figure 1). Also, in communicating their CCyB decisions, national authorities' policies revealed a remarkable heterogeneity in how they implemented the ESRB framework on the national level.

Given that the Basel III framework has been put in place in many countries, it is time to analyze to what extent regulators actually follow these provisions. Such an analysis is particularly important given the intense discussion of the framework and the role of the

[1]Our analysis is limited to the period up to and including 2019, i.e., before the outbreak of the coronavirus pandemic. Since then, most member states have released the capital buffer.

Figure 1. Credit-to-GDP Gaps and Announced CCyB Rates



Data Source: ESRB.
Note: Latest available data as per December 2019. All values are reported in perentage points. X-axis: Credit-to-GDP gap. Y-axis: Pending CCyB. The dotted line indicates buffer guides calculated from the rule-based component.

credit-to-GDP gap as the central measure of systemic risks (see, e.g., Borio et al. 2010; Gischer, Herz, and Menkhoff 2019).

Given the wide gap between the Basel III and ESRB recommendations on the one hand and the actual CCyB policies in EU member states, on the other hand, we are interested in the key motives for national CCyB decisions. We contribute to the sparse literature on the CCyB instrument by empirically analyzing the actual drivers of CCyB decisions in European countries. In this analysis, we differentiate two dimensions of the CCyB, which are related but might be driven by different determinants. First, we address in a qualitative analysis whether or not national designated authorities make use of the countercyclical buffer. Second, we analyze the factors driving CCyB decisions over time. Both approaches provide interesting complementary information in order to better understand macroprudential policies in the EU.

In contrast to its prominent role in the ESRB (2014) recommendation, we do neither find robust empirical evidence that the

credit-to-GDP gap systematically drives the buffer activation nor its variation over time, as the coefficients of the credit-to-GDP gap are not significantly different from zero. We also test the hypothesis of designated authorities following the rule-based component of the ESRB (2014) recommendation, where the CCyB is calibrated to the credit-to-GDP gap. This alternative null hypothesis is clearly rejected. Interestingly we also do not find the selected buffer guides to be crucial for CCyB decisions.

In contrast, higher house price growth and lower non-performing loans ratios make the use of the countercyclical buffer more likely. We also find evidence that developments in house prices and credit quality are relevant for CCyB adjustments over time. Thus, additional risk indicators appear to be more relevant for CCyB decisions than the credit-to-GDP gap.

Consistent with Edge and Liang (2020), we find that the institutional role of the designated authority matters. The likelihood of using the CCyB is smaller if the existing prudential regulator or the central bank takes the final decision about the buffer. In contrast, the announcement of a positive countercyclical buffer is more likely if the domestic Financial Stability Committee (FSC) is the decisionmaker.

In line with the literature, we argue that the weak relationship between the credit-to-GDP gap and actual CCyB decisions is a major challenge for the communication and the acceptance of the macroprudential instrument.

We do not claim that the credit-to-GDP gap is not considered at all by national authorities. However, it does not seem to be systematically taken into account in decisionmaking. Against the background of its highlighted importance the gap takes in official recommendations and European legislation, the results raise the question of whether the indicator is suitable for setting the buffer at all.

The remainder of this paper is organized as follows: Section 2 discusses the concept of "guided discretion" as implemented in the CCyB context and reviews the literature. Section 3 presents the data used in our empirical investigation. In Section 4, we discuss our model selection and the results of the logit and linear panel regression. Section 5 provides several robustness checks. Finally, Section 6 concludes.

2. Guided Discretion

To stabilize the financial sector, the ESRB requires designated authorities to impose a capital buffer on credit institutions and relevant investment firms (Directive 2013/36/EU 2013) based on a "guided discretion" approach that combines rule-based and discretionary elements. This CCyB rate ranges from 0 percent to 2.5 percent of risk-weighted assets (RWA), in steps of at least 0.25 percentage point. As the rule-based element, the so-called benchmark buffer rate requires a 0 percent capital buffer for credit-to-GDP gaps below 2 percentage points, a linearly increasing rate ranging from 0 percent to 2.5 percent for credit-to-GDP gaps between 2 percentage points and 10 percentage points, and a top 2.5 percent CCyB rate if the corresponding ratio is more than 10 percentage points above its long-term trend (ESRB 2014) (see Equation (1) and Figure 1).

$$\text{Benchmark buffer rate}_t(\%) = \begin{cases} 0 & if \quad Gap_t \leq 2pp \\ 0.3125 * Gap_t - 0.625 & if \quad 2pp < Gap_t < 10pp, \\ 2.5 & if \quad Gap_t \geq 10pp \end{cases} \tag{1}$$

Concerning the discretionary component, the ESRB (2014) suggests complementing the credit-to-GDP gap with several additional variables[2] to gauge the buildup of systemic risk:

(a) potential overvaluation of property prices

(b) credit developments

(c) external imbalances

(d) strength of bank balance sheets

(e) private sector debt burden

[2] Among Bank for International Settlements (BIS) member states, designated authorities in Germany take into account the largest number of core systemic risk indicators in their CCyB decisions, followed by France and the United Kingdom (BIS 2017). For an extensive discussion of the forecasting quality of the different indicators, see Detken et al. (2014) and Tölö, Laakkonen, and Kalatie (2018).

(f) potential mispricing of risk

(g) model-based risk measures that combine the credit-to-GDP gap and a selection of the above-mentioned variables.

The concept of "guided discretion" is thus specified as "a rules-based approach with the exercise of their discretionary powers when deciding on the appropriate buffer rate" (ESRB 2014). Although there is scope for national authorities, the credit-to-GDP gap is formally by far the most important indicator. As the only indicator, the gap is directly and explicitly converted into a buffer guide value (ESRB 2014). Furthermore, to improve transparency, EU legislation requires national institutions to quarterly publish the credit-to-GDP ratio, the credit-to-GDP gap, and the buffer guide (Directive 2013/36/EU 2013, Article 136). In contrast, the ESRB does not impose specific guidelines on how to account for the seven other categories of risk indicators. It is only recommended to publish variables from categories (a) to (f) if they are relevant and available (ESRB 2014).

Obviously, a necessary condition for a rule-based CCyB framework is the credit-to-GDP gap to be a good predictor of financial crises. Borio and Lowe (2002b) identify the credit-to-GDP gap as the best single indicator among a wide variety of alternative variables. Borio et al. (2010) document for a set of developed countries that pronounced above-trend increases in the credit-to-GDP ratio, i.e., positive credit-to-GDP gaps, typically precede financial crises.

When calculating credit-to-GDP ratios, two elements turned out to be of particular importance: the definition of credit and the trend extraction method to filter out the cyclical component. According to the official recommendation, national designated authorities are supposed to use a "broad measure of the stock of credit" (ESRB 2014) for computing the credit-to-GDP ratio. Drehmann (2013) uses total credit to the non-financial sector and bank credit for calculating the credit-to-GDP gap. While both aggregates are helpful in constructing early-warning tools, he finds the credit gap based on total non-financial-sector debt, which is also used in the so-called standardized credit-to-GDP gap, to better reflect the underlying risk preceding financial crises.

On a more technical level, calculating credit-to-GDP gaps involves a number of crucial assumptions on how to decompose the time series into cyclical and trend components. Borio et al. (2010) recommend a high smoothing parameter when estimating the trend of the credit-to-GDP ratio by using a one-sided (i.e., recursive) Hodrick-Prescott (HP) filter to reflect the longer duration of credit cycles compared with business cycles. In particular, they estimate the median of credit cycles to be about 15 years, and therefore, three to four times longer than standard business cycles. Under such a long duration, the corresponding smoothing parameter for quarterly data should be in the range between 125,000 and 400,000 (Borio et al. 2010). The ESRB (2014) follows this literature in recommending a one-sided HP filter with large smoothing parameter ($\lambda = 400{,}000$).

In contrast, Edge and Meisenzahl (2011) find that credit-to-GDP gaps are not a reliable basis for determining CCyB rates. In particular, volatile end-of-sample trend estimates may lead to distortions when assessing credit gaps in real time, and thus, might lead to potential ex post revisions of the gap. The critique is related to the more general observation that HP filters are plagued by spurious dynamics. Hamilton (2018) advises to refrain from using HP filters completely and to use linear projections based on the four most recent values. In contrast, Drehmann and Yetman (2018) recommend the use of HP filters when estimating credit gaps, as none of the considered alternative indicators, i.e., gaps based on linear projections and 20-quarter growth rates, systematically outperform the standard credit-to-GDP gap.

Galán (2019) regards the smoothing parameter of the standardized credit-to-GDP gap as unrealistically high since he estimates the financial cycle in most European countries to be shorter. The resulting high degree of inertia implies that the standardized gap is a biased signal for the true state of the financial cycle, with recent credit gaps remaining in deeply negative territory. There is more support for using smaller and/or more adjusted smoothing parameters (e.g., Kauko and Tölö 2019; Wezel 2019). Reigl and Uusküla (2018) investigate, in particular, the weaknesses of the standardized credit-to-GDP gap. Short time series intensify exceptionally small (i.e., negative) standardized credit gaps so that in some cases, even a pronounced credit boom would not have closed the negative gap (Reigl and Uusküla 2018).

Wolf, Mokinski, and Schüler (2020) find considerable differences between standard one-sided HP filters and their corresponding two-sided version. One-sided filters suppress higher-frequency volatility more, which is what should be extracted by the filter. They advise against the standard one-sided HP filter for extracting cyclical trends in real time and propose a lower smoothing parameter together with a multiplicative rescaling factor for the cyclical component (Wolf, Mokinski, and Schüler 2020).

As the credit-to-GDP gaps in 2019 (Figure 1 and Equation (1)) imply, buffer benchmark rates have been zero or very small in most countries. Not surprisingly, the widespread practice of designated authorities to deviate from the benchmark buffer rate has led to an intensive discussion of the ESRB recommendation.

Couaillier, Idier, and Scalone (2019) and the ESRB (2019, 2020) emphasize that some national authorities follow more ambitious CCyB policies either by applying more demanding buffer guides or explicitly accounting for additional indicators besides the credit-to-GDP gap. For instance, the United Kingdom, the Czech Republic, and Lithuania have implemented a positive "neutral rate," i.e., a positive CCyB rate even when risk is considered to be only moderate (ESRB 2019, 2020).

In the communiqués that accompany and explain CCyB decisions, national designated authorities provide further insights into their strategies and, in particular, the specific role of rule-based and discretionary elements in their CCyB policies. The Swedish Financial Supervisory Authority, e.g., declares to place "little weight on the buffer guide as an indicator to raise the buffer since the underlying trend in lending in relation to GDP deviates significantly from a level that is sustainable in the long run. Other authorities with responsibility for macroprudential tools also place little weight on the buffer guide and look at other indicators" (Finansinspektionen 2018). The BaFin (2019), as Germany's designated authority, mentions three risk categories, namely economic risk, real estate risk, and interest rate risk, by citing the recommendation of the domestic Financial Stability Committee when activating the CCyB in 2019. The BaFin (2019) further concludes that additional variables mentioned in ESRB (2014) signal the buildup of cyclical risk, e.g., developments in real estate prices, growth in housing loans, and credit growth to non-financial corporations. When activating the CCyB,

the Czech National Bank (2015) indicated that the credit-to-GDP gap is not fully suitable for CCyB rate decisions in the Czech Republic and that it takes into account other indicators that better reflect the so-called converging economy. The decision to increase the buffer is primarily justified by increased credit growth. Moreover, the debt-to-income ratio, credit standards, and the property markets are also mentioned as important factors (Czech National Bank 2015).

Not so surprisingly, national decisionmakers whose capital buffer decisions are more in line with the buffer benchmarks also give more weight to the credit-to-GDP gap in explaining their buffer decisions. For instance, the Banca d'Italia (2019) vindicated its decision to leave the CCyB unchanged at 0 percent with the standardized and the nationally adjusted credit-to-GDP gap, both of which were in negative territory. In the further step, other indicators are discussed, such as the growth of bank loans, non-performing loans, and the unemployment rate. Similarly, the Banco de Portugal (2019) in its decision to leave the CCyB unchanged at 0 percent firstly addressed the standardized and the nationally adjusted credit-to-GDP gap and then discussed additional indicators, most of which sent similar signals. In doing so, the national designated authority followed the categories recommended by ESRB (2014) and explained recent developments in credit growth, credit demand and spreads, house prices, the loan-to-deposit ratio, the debt-service-ratio, and the current account balance.

In their policy evaluation Babić and Fahr (2019) discuss how positive CCyB rates in a negative credit gap environment have created major communication challenges for national macroprudential authorities. They find that the credit-to-GDP gap has only a limited impact on CCyB decisions in European countries, as national decisionmakers rely on alternative measures to identify the state of the financial cycle, e.g., a composite indicator as in Slovakia. As a result, they advocate using additional risk measures consistently. In a rare study of the role of the institutional supervisory framework for CCyB decisions, Edge and Liang (2020) find that institutionally stronger FSCs are associated with a higher likelihood of positive CCyB rates. Their analysis also indicates that the credit-to-GDP gap is not systematically relevant for CCyB decisions.

Given this evidence that the rule-based component of the regulatory framework is only of a minor, if any, relevance for CCyB

decisions, the question arises of what actually drives buffer decisions in Europe. To the best of our knowledge, we are only aware of one study that empirically analyzes CCyB decisions. While Edge and Liang (2020) focus on how the institutional design of FSCs affects the initial use of the CCyB, they also control for other economic and financial indicators.[3] They find that most FSCs have relatively weak tools and seem to be motivated by symbolic delegation, i.e., signaling action to the public. The credit-to-GDP gap does not significantly affect the probability of setting positive CCyB rates (Edge and Liang 2020).

3. Data

As the ESRB provides the framework for national CCyB decisions,[4] we build on the ESRB data set and analyze CCyB policies during the time period between 2014, when the CCyB framework was implemented, to the end of 2019, the time up to the coronavirus pandemic. If there was more than one decision for a particular quarter and country, we kept the last decision. Our panel is unbalanced since designated authorities started to report CCyB decisions at different points in time. If available, the standardized credit-to-GDP data[5] are used in our analysis. In some cases, only measures calculated from narrower aggregates were reported. We include the 30 European countries from the ESRB data set (Table 4) except Norway, Iceland, and Greece, as comparable data on credit and house price developments were not available.

The ESRB (2014) mentions several complementary risk categories that might indicate the buildup of systemic risk. As additional indicators (see Table 1 for further details), we approximate the

[3]Earlier work focuses on a broader set of prudential tools as in Cerutti et al. (2016) and Cerutti, Claessens, and Laeven (2017), while experience with the CCyB in Europe was very limited. For macroprudential policies in general, Cerutti, Claessens, and Laeven (2017) and Akinci and Olmstead-Rumsey (2018) analyze the effectiveness of various macroprudential tools.

[4]In this paper, we concentrate on the announced (pending, future) CCyB, which has to be fulfilled at the end of the transitional period, which is usually one year. In between, the announced requirement may be different from the effective capital requirement. In this context, the terms "announced," "pending," and "future" are used interchangeably.

[5]We cross-checked ESRB data with data available from national macroprudential/designated authorities and corrected obvious errors.

Table 1. Variable Description

Variable	Description	Source
CCyB	Announced (pending) rate of the countercyclical capital buffer (in percent of RWA), quarterly, linearly interpolated in case of missing data.	ESRB
$CCyB^{>0}$	Indicator variable that equals 1 if $CCyB > 0$ and 0 otherwise, derived from CCyB, quarterly.	ESRB
Credit-to-GDP Gap	Credit-to-GDP gap (deviation of the Credit-to-GDP ratio from its long-term trend), quarterly, linearly interpolated in case of missing data.	ESRB, national authorities
Credit Growth (1Y)	Year-on-year growth rate (in percent) of debt securities and loans of the private non-financial sector, quarterly.	ECB
MFI Credit Growth (1Y)	Year-on-year growth rate (in percent) of MFI credit (loans and debt securities) granted to (domestic) non-financial corporations and households, quarterly.	ECB
Credit-to-GDP Ratio	Credit-to-GDP ratio, quarterly, linearly interpolated in case of missing data.	ESRB, national authorities
Buffer Guide	CCyB guide, quarterly, linearly interpolated in case of missing data.	ESRB
House Prices (5Y)	House price index growth (total, 2015 = 100) over five years, quarterly.	Eurostat
Stock Index (1Y)	Domestic stock market index, year-on-year growth rate of the quarterly mean of daily levels.	Datastream
Stock Index Volatility	Realized index volatility (in logs), calculated from daily stock market index levels, quarterly.	Datastream, own calculations
Current Account	Current account (in percent of GDP), quarterly.	Eurostat
Regulatory Capital	Regulatory capital (in percent of RWA), quarterly, linearly interpolated in case of missing data.	IMF
Non-performing Loans	Non-performing loans (in percent of total gross loans), quarterly, linearly interpolated in case of missing data.	IMF
PR Sets CCyB	Indicator variable, equals 1 if the prudential regulator sets CCyB and 0 otherwise.	ESRB, Edge and Liang (2020)
CB Sets CCyB	Indicator variable, equals 1 if the central bank sets CCyB and 0 otherwise.	ESRB, Edge and Liang (2020)
MF Sets CCyB	Indicator variable, equals 1 if the Ministry of Finance sets CCyB and 0 otherwise.	ESRB, Edge and Liang (2020)
FSC Sets CCyB	Indicator variable, equals 1 if the Financial Stability Committee sets CCyB and 0 otherwise.	ESRB, Edge and Liang (2020)

potential overvaluation of property prices (a) by the growth rate of the domestic house price index over five years. Even though changes in house prices may be fundamentally justified, real estate prices can add useful information for predicting financial crises (see, e.g., Borio and Lowe 2002a). The Basel Committee's member countries consider house price growth after credit-to-GDP measures most often for setting the CCyB (BIS 2017). Accounting for property prices in macroprudential decisions is also in line with Borio (2014), who identifies real estate prices as key drivers for the financial cycle. Moreover, house price index data for European countries is typically available on a quarterly basis with a relatively short time lag. To monitor credit developments (b), we consider the year-on-year growth rate of private non-financial-sector debt securities and loans. Even though the credit-to-GDP gap is positively correlated with credit growth, some countries exhibit substantial growth rates in debt while having negative credit-to-GDP gaps. We take quarterly current account data (in percentage of GDP) as a measure for external imbalances (c). To proxy the strength of bank balance sheets (d), we employ both regulatory capital (in percentage of RWA) and nonperforming loans (in percent of total gross loans). To measure the private sector debt burden (e), the ESRB (2014) and some national supervisors propose debt-service ratios (Tente et al. 2015). Due to data limitations, we cannot take these into account. To account for potential mispricing of risk (f), we incorporate the year-on-year growth rate of the leading domestic stock market index and the corresponding realized volatility. To have comparable indicators of the domestic stock market volatilities, we calculate the volatility proxy from the quarterly sum of daily squared returns.[6] The ESRB (2014) proposes real equity price growth as a potential variable to measure the mispricing of risk. As pointed out by Tente et al. (2015), strong and sudden price increases in stock markets may indicate that risks are not correctly priced by the market. A number of studies (e.g., Detken et al. 2014; Tölö, Laakkonen, and Kalatie 2018) found

[6]In more detail, we follow Christiansen, Schmeling, and Schrimpf (2012) in defining the realized volatility as $RV_{it} = ln\sqrt{\sum_{s=1}^{Q_t} r_{its}^2}$, where Q_t denotes the number of return observations in quarter t.

that equity price developments add useful information, in particular in multivariate signaling approaches. Analogously, relatively low equity price volatility may indicate that stock investors underestimate the associated risk (Tente et al. 2015) and may lead to elevated risk-taking (Tölö, Laakkonen, and Kalatie 2018).

In addition to these macroeconomic and financial variables, we consider several institutional variables to control for differences in national regulatory governance. In investigating the decision to use the CCyB actively, we add indicator variables mirroring the role of the decisionmaker, as proposed in Edge and Liang (2020). The dummy variable "PR sets CCyB" equals one if the prudential regulator sets the CCyB and zero otherwise. Accordingly, the variables "CB sets CCyB," "MF sets CCyB," and "FSC sets CCyB" account for the central bank, the ministry of finance, and the FSC as decisionmakers. The FSC consists of multiple institutions and generally includes the central bank, the prudential regulator, and the government (Edge and Liang 2020). While the committee is the designated authority in a few cases, it has only an advisory role in most member countries. Edge and Liang (2020) show that the focus of existing institutions, e.g., financial soundness on the individual level for the prudential regulator, influences macroprudential decisions. As these institutional variables vary only between countries, but not over time in our estimation period, country fixed effects absorb their influence in the linear panel regression. Table 1 describes the time series, transformations, and raw data sources. Table 2 provides summary statistics and Table 3 coefficients of correlations for the transformed time series.

4. Estimation

There are several challenges when empirically investigating CCyB policies. First, the framework of this macroprudential tool has been implemented only recently, and many countries have not actively used the countercyclical buffer yet. Second, the dependent variable CCyB is truncated with a lower bound of CCyB = 0% and an upper bound at CCyB = 2.5%. Third, the mixture of different starting points of the CCyB reporting and diverse financial structures implies an unbalanced panel in which unobserved heterogeneity is likely to be present.

Table 2. Independent Variables: Summary Statistics

Variable	Abbreviation	Mean	Std. Dev.	Min.	Max.	Observations
Credit-to-GDP Gap	Gap	–20.24	19.85	–93.00	13.50	493
Credit Growth (1Y)	CG	2.89	4.29	–8.66	44.98	493
MFI Credit Growth (1Y)	MFI CG	2.13	5.29	–29.78	13.63	454
Credit-to-GDP Ratio	Ratio	131.65	60.29	36.20	359.00	493
House Prices (5Y)	HP	20.65	19.56	–24.32	92.99	493
Stock Index (1Y)	SI	4.82	14.43	–26.81	51.89	493
Stock Index Volatility	SIV	–2.76	0.41	–3.96	–1.64	493
Current Account	CA	1.60	6.98	–45.50	29.90	493
Regulatory Capital	RC	19.84	3.48	12.27	36.08	493
Non-performing Loans	NPL	5.74	6.52	0.36	47.75	493
PR Sets CCyB	PR	0.23	0.42	0.00	1.00	493
CB Sets CCyB	CB	0.61	0.49	0.00	1.00	493
MF Sets CCyB	MF	0.08	0.27	0.00	1.00	493
FSC Sets CCyB	FSC	0.08	0.27	0.00	1.00	493

Note: Further details on data calculation and sources are provided in Table 1.

Table 3. Correlations of Explanatory Variables

Variable	Gap	CG	MFI CG	Ratio	HP	SI	SIV	CA	RC	NPL
Gap	1.000									
CG	0.434	1.000								
MFI CG	0.575	0.483	1.000							
Ratio	–0.388	–0.248	–0.459	1.000						
HP	–0.071	0.249	0.314	–0.012	1.000					
SI	–0.008	0.141	0.052	–0.078	0.118	1.000				
SIV	0.119	–0.070	–0.056	0.220	–0.153	–0.182	1.000			
CA	0.014	–0.003	0.080	0.034	0.079	0.032	–0.078	1.000		
RC	0.042	0.128	0.110	0.118	0.382	0.116	–0.189	0.025	1.000	
NPL	–0.373	–0.347	–0.543	0.351	–0.441	–0.125	–0.020	–0.204	–0.278	1.000

Note: Further details on data calculation and sources are provided in Table 1.

Table 4. Countries and Domestic CCyB Rates

Country	Code	Decision Date	CCyB (Pending Rate)
Austria	AT	2019-09-05	0.00
Belgium	BE	2019-09-16	0.50
Bulgaria	BG	2019-09-17	1.00
Croatia	HR	2019-09-30	0.00
Cyprus	CY	2019-09-10	0.00
Czech Republic	CZ	2019-08-29	2.00
Denmark	DK	2019-10-01	2.00
Estonia	EE	2019-09-30	0.00
Finland	FI	2020-09-27	0.00
France	FR	2019-07-09	0.50
Germany	DE	2019-09-30	0.25
Greece	GR	2019-09-16	0.00
Hungary	HU	2019-09-24	0.00
Iceland	IS	2019-10-01	2.00
Ireland	IE	2019-07-04	1.00
Italy	IT	2019-09-17	0.00
Latvia	LV	2019-10-29	0.00
Lithuania	LT	2019-09-27	1.00
Luxembourg	LU	2019-10-01	0.25
Malta	MT	2019-10-01	0.00
Netherlands	NL	2019-09-24	0.00
Norway	NO	2019-09-19	2.50
Poland	PL	2019-09-23	0.00
Portugal	PT	2019-10-01	0.00
Romania	RO	2019-09-11	0.00
Slovakia	SK	2019-10-21	2.00
Slovenia	SI	2019-11-05	0.00
Spain	ES	2019-09-20	0.00
Sweden	SE	2019-10-24	2.50
United Kingdom	UK	2019-10-02	1.00

Source: ESRB. Latest available data as per December 2019.

As discussed above, we differentiate between the decisions to actively use a CCyB, i.e., to announce a non-zero rate, and to set a specific level of the buffer. Obviously, the second decision is contingent on the first.

To examine the first question, i.e., the decision to activate the CCyB, we estimate a random-effects logit model as in Edge and Liang (2020),

$$Pr(CCyB_{it}^{>0}) = \frac{1}{(1 + exp[-(\alpha + \mathbf{x}'_{it}\boldsymbol{\beta} + \mathbf{z}'_i\boldsymbol{\gamma} + \delta_i)])}, \qquad (2)$$

where $CCyB_{it}^{>0}$ equals one if the buffer is active with a positive announced rate for country i in quarter t and zero otherwise. $\mathbf{x}_{it}$ represents the vector of economic and financial indicators as discussed in the previous section, and $\mathbf{z}_i$ the country-specific indicator variables for the decisionmaker. Finally, δ_i denotes the unobserved effect.

As we investigate whether the capital buffer is above zero for a given country and point in time, the dependent variable varies over time and country, in contrast to Edge and Liang (2020) who only examine whether the macroprudential instrument is used or has been used for a given country. Furthermore, we estimate the model based on quarterly data instead of annual data, with missing data being replaced by linear interpolations, if necessary.

Table 5 reports the random-effects logit regression results. We do not find reliable empirical evidence for a substantial role of the credit-to-GDP gap for CCyB policies in Europe. This is obviously at odds with the prominent role of the rule-based component in the ESRB recommendation. It also reflects the weak relationship of the credit-to-GDP gap and the buffer rate, as displayed in Figure 1.

To better understand the guided discretion approach proposed by the ESRB, we examine the (non) role of the credit-to-GDP gap in greater detail. As specified by Equation (1), designated authorities are expected to activate the CCyB as soon as the gap equals 2 percentage points, making this value a pivotal point. For this 2 percentage points value of the credit-to-GDP gap, we test if an increase in the gap leads to higher predicted probabilities of positive CCyBs. Additional indicators mentioned by the ESRB recommendation may be relevant for the calibration of the CCyB, which thus may also affect the probability of its implementation. Therefore, we test against different changes in the predicted probability. We perform χ^2-tests to test the null hypothesis that the conditional marginal effect of a one-unit increase in the credit-to-GDP gap on

Table 5. Random-Effects Logistic Regression

$CCyB^{>0}$	I	II	III	IV
Credit-to-GDP Gap	0.0870	0.1061*	0.0932	0.0857
	(0.0595)	(0.0574)	(0.0736)	(0.0582)
Credit Growth (1Y)	–0.2268	–0.2211	–0.2577	–0.2219
	(0.1489)	(0.1519)	(0.1645)	(0.1514)
House Prices (5Y)	0.3360***	0.3594***	0.3868***	0.3567***
	(0.0472)	(0.0461)	(0.0558)	(0.0460)
Stock Index (1Y)	–0.0488	–0.0451	–0.0464	–0.0470
	(0.0349)	(0.0352)	(0.0377)	(0.0350)
Stock Index Volatility	0.8988	1.1637	1.1349	1.0075
	(1.2663)	(1.3089)	(1.3855)	(1.2878)
Current Account	0.0020	0.0041	0.0079	0.0002
	(0.0549)	(0.0561)	(0.0611)	(0.0542)
Regulatory Capital	0.1511	0.1032	0.1604	0.1108
	(0.2670)	(0.2710)	(0.2746)	(0.2643)
Non-performing Loans	–2.7428***	–2.8124***	–3.1334***	–2.7325***
	(0.4865)	(0.5004)	(0.6435)	(0.4674)
PR Sets CCyB		–12.6473	–8.9488**	
		(10.1847)	(3.7879)	
CB Sets CCyB		–6.8194		
		(9.2117)		
MF Sets CCyB		–7.7255		
		(10.4509)		
FSC Sets CCyB				9.5632
				(9.3317)
Observations	493	493	493	493
Log-Likelihood	–78.19	–77.51	–77.68	–77.70
χ^2 (DF)	113.26 (8)	132.43 (11)	74.75 (9)	134.60 (9)

Note: The dependent variable is the binary CCyB decision. The models were estimated using a constant, which is not reported. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

the predicted probability $\Pr(CCyB^{>0} = 1)$ equals 0, 25, 50, 75, or 100 percentage points, respectively. Table 6 reports conditional marginal effects (based on the estimation results of Table 5) of a one-unit increase in the credit-to-GDP gap on the predicted probability $\Pr(CCyB^{>0} = 1)$ and the corresponding standard errors. The marginal effects are evaluated for the credit-to-GDP gap at 2 percentage points while all other variables are at their means. In line with our previous empirical results, these alternative hypotheses are rejected at conventional significance levels.

Table 6. Additional χ^2-Tests

$\Pr(CCyB^{>0}=1)$	I		II		III		IV	
	dy/dx	SE	dy/dx	SE	dy/dx	SE	dy/dx	SE
Credit-to-GDP Gap	0.0015	0.0041	0.0008	0.0026	0.0017	0.0049	0.0009	0.0027
$H_0: dy/dx$ Equals	χ^2 (1)	Prob $> \chi^2$	χ^2 (1)	Prob $> \chi^2$	χ^2 (1)	Prob $> \chi^2$	χ^2 (1)	Prob $> \chi^2$
0	0.13	0.7229	0.09	0.7583	0.12	0.7312	0.10	0.7538
0.25	3636.43	0.0000	8871.58	0.0000	2592.40	0.0000	8254.00	0.0000
0.5	14631.36	0.0000	35602.33	0.0000	10439.66	0.0000	33130.11	0.0000
0.75	32984.94	0.0000	80192.35	0.0000	23541.91	0.0000	74628.42	0.0000
1	58697.15	0.0000	$1.4 * 10^5$	0.0000	41899.15	0.0000	$1.3 * 10^5$	0.0000

Note: The table reports conditional marginal effects dy/dx (based on the estimation results of Table 5) of a one-unit increase in the credit-to-GDP gap on the predicted probability $\Pr(CCyB^{>0}=1)$ and the corresponding standard errors (Delta-method). The marginal effects are evaluated for the credit-to-GDP gap at 2 percentage points while all other variables are at their means. The 2 percentage points threshold is used, as the ESRB (2014) recommendation assigns positive buffer benchmark values for gaps exceeding 2 percentage points. The test statistics refer to the logistic regression results of Table 5. The χ^2-test tests the null hypothesis that the conditional marginal effect dy/dx of a one-unit increase in the credit-to-GDP gap on the predicted probability $\Pr(CCyB^{>0}=1)$ equals 0, 25, 50, 75, and 100 percentage points, respectively.

While our results indicate that the credit-to-GDP gap does not determine CCyB policies, this does not mean that the designated authorities decide in a discretionary way only. There are elements of "guidance" present in European CCyB policies. It seems that designated authorities use some of the indicators that have been proposed as more discretionary elements in a rather systematic, almost rule-based manner. Increases in house price growth, e.g., are significantly associated with higher log-odds ratios in the binary CCyB variable (specifications I–IV in Table 5). Stronger house price inflation increases the probability that national designated authorities make use of the CCyB. Quantitatively, a one-standard-deviation increase in house price growth (versus its mean) raises the probability of using the buffer approximately by 6 percent to 8 percent, given all other covariates are at their means. This contrasts with Edge and Liang (2020) who do not find a significant relationship between positive CCyBs and house price changes. As they use annual data, their approach might not be able to pick up the dynamics of house price inflation and subsequent reactions of the regulators.

Also, an increase in distressed credit tends to lower the likelihood of the CCyB requirement, as indicated by a significant and negative coefficient for the non-performing loans as a percentage of total gross loans variable. The negative sign is consistent with the stabilizing objective of the CCyB, namely, to build up buffers under favorable economic conditions when the share of non-performing loans is low. The CCyB provides a preemptive cushion to be built up in good times when accumulating additional capital via retained earnings and raising capital is relatively easy (Couaillier, Idier, and Scalone 2019). In bad times, the CCyB allows the release of capital to support banks in providing sufficient credit to the real economy, even when experiencing unexpected write-offs (ESRB 2014). Given that non-performing loans are included as a contemporaneous variable, rising shares of non-performing loans signal that risks are already materializing to some extent, which implies a reduction of capital requirements as a countercyclical measure. Please note that the share of non-performing loans has been decreasing in almost all countries during the observation period. Interestingly, as with the credit-to-GDP gap, we do not find robust links to other systemic risk indicators mentioned before. This might reflect

heterogeneous cross-sectional policy responses (e.g., ESRB 2019) when taking additional risk indicators into account.

Institutional indicator variables that reflect which specific policymaker is ultimately responsible for CCyB decisions are generally not significant. However, coefficients of the prudential regulator and the central bank are always negative. When controlling only for the Financial Stability Committee as the decisionmaking authority (FSC sets CCyB), the coefficient is positive, however, at an insignificant level. In contrast, the coefficient was significant in our robustness exercises. Overall, the results support the findings of Edge and Liang (2020). The probability of a positive CCyB is lower if the central bank or the prudential regulator decides. For the prudential regulator, the reduced likelihood to activate the countercyclical buffer may be explained by the focus—and possibly preference—on microprudential policy (Edge and Liang 2020). Countries use the CCyB more likely if the FSC takes the final decision. FSCs that can set the CCyB directly are relatively powerful. Given their macroprudential focus, it is not surprising that they use the capital buffer more often.

So far, we have examined whether or not the countercyclical capital buffer is used, regardless of the specific setting of the rate. This aspect is in particular relevant for the decision of designated authorities to use the CCyB at all. In a second step, we analyze a complementary question, namely how decisionmakers vary CCyB rates with respect to the macrofinancial environment by estimating the following linear unobserved effects model

$$CCyB_{it} = \alpha + \mathbf{x}'_{it}\boldsymbol{\beta} + u_i + v_t + \epsilon_{it}, \tag{3}$$

where $CCyB_{it}$ denotes the latest pending rate of the countercyclical capital buffer in country i for quarter t, α a constant, $\mathbf{x}_{it}$ the vector of aforementioned risk indicators for country i in quarter t, and $\boldsymbol{\beta}$ the corresponding parameters. u_i is the unobserved country effect, v_t the aggregate time effect, and ϵ_{it} the error term. We only include observations of countries that have already announced non-zero CCyB rates at at least one point in time through 2019.

Table 7 summarizes the results of the linear (fixed-effects) regression with the announced buffer rate as the dependent variable. Again, as the insignificant coefficients of the credit-to-GDP gap

Table 7. Linear Regression

CCyB	**I**	**II**	**III**
Credit-to-GDP Gap	0.0107	0.0084	0.0021
	(0.0071)	(0.0058)	(0.0041)
Credit Growth (1Y)	0.0156	0.0124	0.0088
	(0.0131)	(0.0133)	(0.0059)
House Prices (5Y)	0.0290**	0.0190*	0.0092
	(0.0096)	(0.0099)	(0.0073)
Stock Index (1Y)	–0.0029	–0.0044	0.0007
	(0.0029)	(0.0030)	(0.0035)
Stock Index Volatility	–0.0497	0.0182	0.0226
	(0.1614)	(0.0953)	(0.0521)
Current Account	–0.0082	–0.0014	0.0001
	(0.0072)	(0.0031)	(0.0026)
Regulatory Capital	0.0035	0.0500	0.0278
	(0.0654)	(0.0421)	(0.0211)
Non-performing Loans	–0.0069	–0.1171**	–0.0337
	(0.0422)	(0.0423)	(0.0288)
Country FE	No	Yes	Yes
Year Effects	No	No	Yes
Observations	229	229	229
$R^2(within)$	0.42	0.52	0.72

Note: The dependent variable is the announced CCyB level. All observations of countries were used which have announced positive CCyB rates at least once within the observation period. The models were estimated using a constant, which is not reported. Clustered standard errors (at country level) are reported in parentheses. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

(specifications I–III in Table 7) indicate, there is no evidence that designated authorities base their CCyB decisions systematically on the officially recommended credit-to-GDP gap.

Analogous to the above discussion, we investigate in greater detail the potential role of the credit-to-GDP gap as the recommended rule-based element in CCyB policies. For the coefficients of the credit-to-GDP gap in Table 7 we perform additional F-tests (reported in Table 8). The coefficients are not tested against zero but against the linear slope parameter of the recommended

Table 8. Additional F-Tests

Table	Coefficient	H_0	I		II		III	
			F Statistic	**Prob > F**	**F Statistic**	**Prob > F**	**F Statistic**	**Prob > F**
7	Credit-to-GDP Gap	$\beta = 0.3125$	F(1,11) = 1831.79	0.0000	F(1,11) = 2722.99	0.0000	F(1,11) = 5854.55	0.0000
10	Credit-to-GDP Gap	$\beta = 0.3125$	F(1,11) = 1083.30	0.0000	F(1,11) = 1493.49	0.0000	F(1,11) = 3748.66	0.0000
12	Credit-to-GDP Gap	$\beta = 0.3125$	F(1,9) = 1620.66	0.0000	F(1,9) = 4042.28	0.0000	F(1,9) = 4327.57	0.0000
14	Credit-to-GDP Gap	$\beta = 0.3125$	F(1,11) = 1850.34	0.0000	F(1,11) = 3350.67	0.0000	F(1,11) = 10463.67	0.0000
17	Credit-to-GDP Gap	$\beta = 0.3125$	F(1,11) = 2922.61	0.0000	F(1,11) = 1113.29	0.0000	F(1,11) = 5069.77	0.0000
17	Buffer Guide	$\beta = 1$	F(1,11) = 9.70	0.0098	F(1,11) = 35.54	0.0001	F(1,11) = 102.57	0.0000

Note: The F-test tests the null hypothesis $\beta = 0.3125$ for the credit-to-GDP gap and $\beta = 1$ for the buffer guide, respectively.

buffer benchmark rule, H_0: $\beta_{Credit-to-GDP\ gap} = 0.3125$. The results of these tests imply that the alternative null hypotheses are clearly rejected on conventional significance levels, i.e., authorities do not set the CCyB according to the rule-based component (Equation (1)).

Once again, house price growth seems to be policy relevant, at least if we do not account for aggregate time effects (specification I–II). Thus, higher house price growth is associated not only with an increasing probability of setting a positive CCyB but also with higher rates, given the buffer is already activated. Quantitatively, an increase in house price inflation by 10 percentage points is associated with a rise in the buffer of approximately 0.2–0.3 percentage point. When we control for time effects, the sign remains robust while the coefficient becomes insignificant. This pattern may be caused by time trends, which are captured by the aggregate time effects in specification III.

When we control for both country fixed effects and aggregate time effects (specification III), all explanatory variables become insignificant. We will further elaborate on this finding in our robustness exercises.

In contrast to the binary response regression, improved credit quality, as measured by a decreased non-performing loans ratio, does not seem to result consistently in significantly higher buffer rates, given that the country has already implemented a CCyB policy. Country and time effects seem to play a crucial role when considering domestic non-performing loans ratios. This result might reflect that the standard deviation of non-performing loans within a given country is much lower than the standard deviation between different countries.

Taken together, our empirical results indicate that the policy to set a specific buffer rate should be distinguished from the general decision on using the CCyB at all. However, and not surprisingly, there exists considerable overlap. For both decisions, we do not find robust evidence that the credit-to-GDP gap is relevant—despite its prominent role in official communications. In contrast, in both decisions, house price inflation seems to play an important, systematic role. In the case of other risk indicators listed in the ESRB (2014) recommendation, policymakers do not seem to focus on external imbalances or—interestingly—current regulatory bank capital. For

the role of equity prices and their role in the buildup of risk, the timing might be crucial.[7]

5. Robustness

In the subsequent robustness analysis, we account for additional variables that signal the buildup of risk and discuss data availability issues as well as alternative estimation approaches.

National authorities are required to announce the credit-to-GDP ratio each quarter together with the credit-to-GDP gap (Directive 2013/36/EU 2013, Article 136). To account for diverging signals of alternative credit measures, we include the credit-to-GDP ratio[8] alongside the credit-to-GDP gap in the random-effects logit model and in the linear panel model. The ratio provides a debt measure standardized by the country's GDP.

As reported in Table 9, the main findings in specifications I–IV do not alter. The coefficients of house price inflation are positive on the 1 percent significance level and have similar magnitudes. The negative effect of the contemporaneous share of non-performing loans is also robust against the additional consideration of the credit-to-GDP ratio. The institutional indicator variables have the expected sign, i.e., negative coefficients for the prudential regulator and the central bank and a positive coefficient for the FSC. In terms of the linear level regression (Table 10), credit gaps remain insignificant. The coefficients of house price growth are qualitatively unaffected by the consideration of the additional variable. In accordance with our previous results (Table 7), house price growth seems to be less critical when controlling both for country fixed effects and aggregate time effects.

Given the fundamental role of bank-based financing in Europe, decisionmakers may focus more on bank credit than total non-financial debt. To assess if the specific measure of credit is crucial for our findings, we replace broad credit with bank credit (loans

[7]For instance, Borio and Lowe (2002a) found that equity price gaps peak earlier than other risk indicators.

[8]We retrieved credit-to-GDP ratios from the ESRB and national authorities. In most cases, we used the ratio based on the broad credit aggregate. However, for some countries, the ratio is available based on narrower aggregates only.

Table 9. Random-Effects Logistic Regression (robustness—including credit-to-GDP ratio)

$CCyB^{>0}$	I	II	III	IV
Credit-to-GDP Gap	0.0724	0.0966	0.0908	0.0782
	(0.0594)	(0.0594)	(0.0607)	(0.0580)
Credit Growth (1Y)	–0.2293	–0.2235	–0.2354	–0.2206
	(0.1531)	(0.1532)	(0.1541)	(0.1512)
Credit-to-GDP Ratio	0.0237	0.0161	0.0267	0.0120
	(0.0248)	(0.0256)	(0.0251)	(0.0230)
House Prices (5Y)	0.3406***	0.3513***	0.3395***	0.3427***
	(0.0482)	(0.0465)	(0.0447)	(0.0448)
Stock Index (1Y)	–0.0460	–0.0453	–0.0469	–0.0462
	(0.0353)	(0.0350)	(0.0358)	(0.0346)
Stock Index Volatility	0.9340	1.1609	1.0572	0.9966
	(1.2959)	(1.3077)	(1.3102)	(1.2788)
Current Account	0.0050	0.0069	0.0060	0.0037
	(0.0565)	(0.0572)	(0.0578)	(0.0549)
Regulatory Capital	0.1278	0.0717	0.1818	0.1018
	(0.2723)	(0.2676)	(0.2709)	(0.2640)
Non-performing Loans	–2.8586***	–2.8453***	–2.9178***	–2.7471***
	(0.5067)	(0.5189)	(0.5366)	(0.4772)
PR Sets CCyB		–13.2799	–7.9125**	
		(9.6087)	(3.8240)	
CB Sets CCyB		–5.3819		
		(9.3447)		
MF Sets CCyB		–7.1296		
		(10.7378)		
FSC Sets CCyB				8.9232*
				(4.7253)
Observations	493	493	493	493
Log-Likelihood	–77.82	–77.36	–77.38	–77.61
χ^2 (DF)	109.34 (9)	132.43 (12)	115.13 (10)	140.84 (10)

Note: The dependent variable is the binary CCyB decision. The models were estimated using a constant, which is not reported. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

and debt securities granted by monetary financial institutions). As data are missing for some countries, the number of observations shrinks slightly. There are no material differences in the binary case (Table 11), as house prices and non-performing loans seem to be the main drivers of CCyB policies. However, we do not see a clear pattern for adjustments over time (Table 12), as the house price

Table 10. Linear Regression (robustness—including credit-to-GDP ratio)

CCyB	I	II	III
Credit-to-GDP Gap	0.0134	0.0042	0.0030
	(0.0091)	(0.0080)	(0.0051)
Credit Growth (1Y)	0.0188	0.0141	0.0083
	(0.0119)	(0.0133)	(0.0060)
Credit-to-GDP Ratio	0.0019	0.0056	–0.0012
	(0.0024)	(0.0058)	(0.0033)
House Prices (5Y)	0.0298**	0.0173*	0.0094
	(0.0104)	(0.0092)	(0.0073)
Stock Index (1Y)	–0.0039*	–0.0044	0.0007
	(0.0020)	(0.0027)	(0.0036)
Stock Index Volatility	–0.1251	0.0510	0.0167
	(0.1761)	(0.0799)	(0.0567)
Current Account	–0.0086	–0.0008	–0.0000
	(0.0070)	(0.0030)	(0.0026)
Regulatory Capital	–0.0080	0.0528	0.0268
	(0.0649)	(0.0425)	(0.0214)
Non-performing Loans	–0.0020	–0.1304***	–0.0294
	(0.0511)	(0.0417)	(0.0293)
Country FE	No	Yes	Yes
Year Effects	No	No	Yes
Observations	229	229	229
$R^2(within)$	0.43	0.53	0.72

Note: The dependent variable is the announced CCyB level. All observations of countries were used which have announced positive CCyB rates at least once within the observation period. The models were estimated using a constant, which is not reported. Clustered standard errors (at country level) are reported in parentheses. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

variable becomes insignificant when we control for the unobserved country and time effects.

While the credit-to-GDP ratio and gap data are those available at the time of decision (ESRB data set), we typically use contemporary observations that have not been publicly available at the time of decision in the case of the additional variables. Thus, we implicitly assume that decisionmakers have a considerable information advantage for these variables. As a further problem, we only have ex post revised time series that might differ from those available at the time

Table 11. Random-Effects Logistic Regression (robustness—MFI credit growth)

$CCyB^{>0}$	I	II	III
Credit-to-GDP Gap	0.0130	0.0064	0.0045
	(0.0658)	(0.0697)	(0.0756)
MFI Credit Growth (1Y)	0.2463	0.1974	0.1977
	(0.1912)	(0.1920)	(0.2374)
House Prices (5Y)	0.3918***	0.3753***	0.4209***
	(0.0466)	(0.0495)	(0.0855)
Stock Index (1Y)	–0.0154	–0.0156	–0.0140
	(0.0366)	(0.0355)	(0.0392)
Stock Index Volatility	2.4010	2.1623	2.5014
	(1.6737)	(1.6434)	(1.8624)
Current Account	–0.0078	–0.0051	–0.0036
	(0.0522)	(0.0525)	(0.0557)
Regulatory Capital	–0.0928	–0.1261	0.0260
	(0.3043)	(0.2943)	(0.3362)
Non-performing Loans	–2.5832***	–2.5446***	–2.8701***
	(0.4465)	(0.4813)	(0.5586)
PR Sets CCyB		–1.0146	–3.2881
		(6.4524)	(4.3199)
CB Sets CCyB		–1.3422	
		(5.4938)	
Observations	454	454	454
Log-Likelihood	–60.20	–60.50	–60.29
χ^2 (DF)	149.83	119.68	51.86

Note: The dependent variable is the binary CCyB decision. The models were estimated using a constant, which is not reported. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

of the decision. To account for potential information lags, we regress the CCyB on the first lags of the independent variables other than credit-to-GDP data, stock market variables, and the institutional indicators. Credit-to-GDP gaps and ratios from the ESRB data set were available at the time of the decision. Hence, we do not have to account for further information lags. Similarly, we do not use lagged values of the stock market data, as stock index data are available in real time. We notice differences for the CCyB indicator regression (Table 13) as we identify more significant coefficients. While the influence of house price inflation and non-performing loans does not change qualitatively, the credit-to-GDP gap and stock price changes

Table 12. Linear Regression (robustness—MFI credit growth)

CCyB	I	II	III
Credit-to-GDP Gap	0.0123	0.0058	0.0038
	(0.0075)	(0.0048)	(0.0047)
MFI Credit Growth (1Y)	–0.0303	–0.0390	–0.0177
	(0.0378)	(0.0214)	(0.0209)
House Prices (5Y)	0.0304**	0.0207*	0.0090
	(0.0119)	(0.0097)	(0.0074)
Stock Index (1Y)	–0.0008	–0.0020	0.0022
	(0.0030)	(0.0032)	(0.0038)
Stock Index Volatility	–0.0826	0.0263	0.0249
	(0.1837)	(0.1039)	(0.0627)
Current Account	–0.0117	–0.0023	–0.0000
	(0.0067)	(0.0028)	(0.0024)
Regulatory Capital	–0.0159	0.0265	0.0340
	(0.0693)	(0.0431)	(0.0310)
Non-performing Loans	–0.0194	–0.1334**	–0.0631*
	(0.0515)	(0.0443)	(0.0294)
Country FE	No	Yes	Yes
Year Effects	No	No	Yes
Observations	190	190	190
$R^2(within)$	0.42	0.56	0.73

Note: The dependent variable is the announced CCyB level. All observations of countries were used which have announced positive CCyB rates at least once within the observation period. The models were estimated using a constant, which is not reported. Clustered standard errors (at country level) are reported in parentheses. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

become important. Consistent with intuition and the ESRB (2014) recommendation, higher credit gaps are associated with a higher likelihood to use the capital buffer. The negative sign of the year-on-year change of stock prices is against intuition, which states that higher equity valuations may indicate a buildup of systemic risk. Interestingly, we also identify more significant coefficients for the linear level regression. Credit growth and house price inflation are relevant when we control for the unobserved country and aggregate time effects (Table 14, specification III). The coefficient of the credit-to-GDP gap is insignificant in all of the three specifications.

Analogous to the approach of Edge and Liang (2020), we check if the selection of the specific logit models is crucial for our outcomes.

Table 13. Random-Effects Logistic Regression (lags)

$CCyB^{>0}$	I	II	III	IV
Credit-to-GDP Gap	0.1029	0.1061*	0.1158*	0.0872**
	(0.0672)	(0.0627)	(0.0644)	(0.0391)
Credit Growth (1Y, L1)	–0.2171	–0.2300	–0.2343	–0.1327
	(0.1510)	(0.1475)	(0.1525)	(0.1066)
House Prices (5Y, L1)	0.3802***	0.3530***	0.3738***	0.2471***
	(0.0506)	(0.0453)	(0.0464)	(0.0322)
Stock Index (1Y)	–0.0962***	–0.0963***	–0.0983***	–0.0786***
	(0.0364)	(0.0354)	(0.0362)	(0.0249)
Stock Index Volatility	–1.1079	–1.0599	–1.1061	–0.9390
	(0.8720)	(0.8684)	(0.8750)	(0.7498)
Current Account (L1)	0.0009	0.0083	0.0079	–0.0080
	(0.0545)	(0.0548)	(0.0564)	(0.0418)
Regulatory Capital (L1)	0.3469	0.4245*	0.4099*	0.2001
	(0.2553)	(0.2257)	(0.2351)	(0.1609)
Non-performing	–2.6573***	–2.6122***	–2.7503***	–1.6300***
Loans (L1)	(0.4876)	(0.4673)	(0.4805)	(0.2616)
PR Sets CCyB		–14.7971	–8.8388**	
		(9.6831)	(4.0135)	
CB Sets CCyB		–7.3223		
		(9.0534)		
MF Sets CCyB		–7.4182		
		(10.3989)		
FSC Sets CCyB				3.4595*
				(1.8554)
Observations	512	512	512	512
Log-Likelihood	–78.62	–77.71	–77.84	–83.10
χ^2 (DF)	144.46 (8)	155.61 (11)	156.01 (9)	257.47 (9)

Note: The dependent variable is the binary CCyB decision. The models were estimated using a constant, which is not reported. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

Amemiya (1981) argues that probit and logit models lead to similar results as long as the data are not strongly concentrated at the end of the probability distribution. This concentration could be an issue since many non-positive CCyBs imply a high distribution mass at zero. Amemiya (1981) shows that logit coefficients can be approximately converted into probit estimates by applying the formula $\hat{\beta}_L = 1.6\hat{\beta}_P$, where $\hat{\beta}_L$ denotes the logit coefficient and $\hat{\beta}_P$ the probit estimate. Again, the credit-to-GDP gap is insignificant in the probit estimation (Table 15). In contrast, house prices remain significant. The probit estimates show stronger evidence for the negative

Table 14. Linear Regression (lags)

CCyB	**I**	**II**	**III**
Credit-to-GDP Gap	0.0125	0.0076	0.0042
	(0.0070)	(0.0053)	(0.0030)
Credit Growth (1Y, L1)	0.0141	0.0182*	0.0128**
	(0.0115)	(0.0096)	(0.0053)
House Prices (5Y, L1)	0.0315***	0.0227**	0.0174**
	(0.0089)	(0.0083)	(0.0071)
Stock Index (1Y)	–0.0026	–0.0054*	0.0005
	(0.0027)	(0.0029)	(0.0036)
Stock Index Volatility	–0.0980	–0.1438	–0.0271
	(0.1353)	(0.0893)	(0.0578)
Current Account (L1)	–0.0062	–0.0003	–0.0007
	(0.0080)	(0.0018)	(0.0027)
Regulatory Capital (L1)	–0.0041	0.0403	0.0286
	(0.0636)	(0.0334)	(0.0227)
Non-performing	0.0112	–0.0740*	–0.0250
Loans (L1)	(0.0413)	(0.0410)	(0.0336)
Country FE	No	Yes	Yes
Year Effects	No	No	Yes
Observations	236	236	236
$R^2(within)$	0.45	0.55	0.69

Note: The dependent variable is the announced CCyB level. All observations of countries were used which have announced positive CCyB rates at least once within the observation period. The models were estimated using a constant, which is not reported. Clustered standard errors (at country level) are reported in parentheses. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

(positive) impact on the likelihood of setting positive CCyBs when the prudential regulator (the financial stability committee) decides.

As the independent variables measure systemic risk in different dimensions, it should be informative to inspect the co-movements of the explanatory variables when interpreting multivariate regression results.[9] Coefficients of correlation are reported for the continuous explanatory variables (Table 3). None of the bivariate correlations exceeds 0.6. In our baseline regressions (Table 5 and Table 7) in which we do not include the MFI credit growth, the highest bivariate correlation is below 0.5. We also calculated the centered variance

[9]We thank an anonymous referee for pointing out this aspect.

Table 15. Random-Effects Probit Regression

$CCyB^{>0}$	I	II	III	IV
Credit-to-GDP Gap	0.0393	0.0495	0.0446	0.0507
	(0.0336)	(0.0340)	(0.0342)	(0.0368)
Credit Growth (1Y)	–0.1222	–0.0928	–0.1171	–0.1368
	(0.0842)	(0.0735)	(0.0817)	(0.0921)
House Prices (5Y)	0.2136***	0.1762***	0.2011***	0.2294***
	(0.0277)	(0.0214)	(0.0331)	(0.0313)
Stock Index (1Y)	–0.0258	–0.0256	–0.0267	–0.0231
	(0.0200)	(0.0177)	(0.0197)	(0.0206)
Stock Index Volatility	0.6389	0.4689	0.6550	0.8075
	(0.7372)	(0.6626)	(0.7367)	(0.7723)
Current Account	–0.0040	–0.0068	–0.0029	–0.0015
	(0.0302)	(0.0265)	(0.0293)	(0.0317)
Regulatory Capital	0.1189	0.1415	0.1537	0.1220
	(0.1537)	(0.1423)	(0.1575)	(0.1509)
Non-performing Loans	–1.5564***	–1.2757***	–1.4997***	–1.7006***
	(0.2190)	(0.1808)	(0.2000)	(0.2960)
PR Sets CCyB		–5.5355***	–4.1937*	
		(1.4388)	(2.1658)	
CB Sets CCyB		–2.9510*		
		(1.6157)		
MF Sets CCyB		–2.2030		
		(2.6578)		
FSC Sets CCyB				5.2927***
				(2.0268)
Observations	493	493	493	493
Log-Likelihood	–78.09	–77.41	–77.92	–77.12
χ^2 (DF)	124.48 (8)	169.89 (11)	109.06 (9)	82.31 (9)

Note: The dependent variable is the binary CCyB decision. The models were estimated using a constant, which is not reported. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

inflation factors (VIFs) for all continuous variables included in the linear-level regression without unobserved effects (column 1 in the linear regression, Table 7). The resulting VIFs (not reported) are small and, as indicated by the bivariate correlation measures, do not show a severe multicollinearity problem.

We also performed univariate analyses by regressing the CCyB level and the binary CCyB indicator variable on all continuous variables separately.

Table 16. Binary Regression—Univariate

Dependent Variable	Independent Variable	Coefficient
$CCyB^{>0}$	Buffer Guide	–0.3611
		(0.5373)
$CCyB^{>0}$	Credit-to-GDP Gap	–0.0105
		(0.0194)
$CCyB^{>0}$	Credit Growth (1Y)	0.0306
		(0.0354)
$CCyB^{>0}$	House Prices (5Y)	0.2622***
		(0.0510)
$CCyB^{>0}$	Stock Index (1Y)	–0.0468***
		(0.0130)
$CCyB^{>0}$	Stock Index Volatility	–1.0410**
		(0.5128)
$CCyB^{>0}$	Current Account	0.0050
		(0.0220)
$CCyB^{>0}$	Regulatory Capital	0.1262
		(0.1062)
$CCyB^{>0}$	Non-performing Loans	–4.4152***
		(0.8738)
Observations		493

Note: The dependent variable is the binary CCyB decision. The models were estimated using a constant, which is not reported. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

Intuitively, if the "rules-based approach" was the main driver for CCyB decisions, we would expect a strong positive and significant relationship between the buffer guide and the CCyB. It may be helpful here to think of an "ideal world" in which the credit-to-GDP gap—and hence the buffer benchmark—is a measure accepted by all national designated authorities that properly reflects the risks in the financial sector. We, therefore, regressed CCyB decisions on the buffer guide (derived from the credit-to-GDP gap), which we took from the ESRB data set. For the linear case, the slope parameter should be approximately equal to one. As shown in Table 16 and Table 17, the buffer guide was neither significantly different from zero for the CCyB indicator variable nor the buffer level. Consistent with our previous regressions, we considered only countries that have used the macroprudential instrument at least once within the observation period in the latter case. The null hypothesis that the linear

Table 17. Linear Regression—Univariate

Dependent Variable	Independent Variable	I	II	III
CCyB	Buffer Guide	0.1669	–0.3945	–0.1702
		(0.2675)	(0.2339)	(0.1155)
CCyB	Credit-to-GDP Gap	0.0055	–0.0090	–0.0021
		(0.0057)	(0.0096)	(0.0044)
CCyB	Credit Growth (1Y)	0.0231	0.0068	0.0066
		(0.0194)	(0.0098)	(0.0041)
CCyB	House Prices (5Y)	0.0243**	0.0296***	0.0098
		(0.0106)	(0.0084)	(0.0071)
CCyB	Stock Index (1Y)	–0.0057	–0.0079	0.0003
		(0.0035)	(0.0049)	(0.0038)
CCyB	Stock Index Volatility	–0.1354	–0.3853**	–0.0460
		(0.1487)	(0.1382)	(0.0485)
CCyB	Current Account	–0.0010	0.0006	0.0010
		(0.0075)	(0.0034)	(0.0024)
CCyB	Regulatory Capital	0.0502	0.0515	0.0168
		(0.0665)	(0.0670)	(0.0172)
CCyB	Non-performing Loans	–0.0651*	–0.1851***	–0.0421*
		(0.0351)	(0.0566)	(0.0213)
Country FE		No	Yes	Yes
Year Effects		No	No	Yes
Observations		229	229	229

Note: The dependent variable is the announced CCyB level. All observations of countries were used which have announced positive CCyB rates at least once within the observation period. The models were estimated using a constant, which is not reported. Clustered standard errors (at country level) are reported in parentheses. Significance levels: ***1 percent, **5 percent, *10 percent. Data sources are provided in Table 1.

coefficient of the credit-to-GDP gap equals 0.3125 and that of the buffer guide equals 1 is clearly rejected on conventional levels (Table 8). The univariate results in Table 16 support the positive impact of house price inflation and the negative influence of non-performing loans on the likelihood of using the buffer. Both variables also seem relevant for buffer calibration (Table 17), at least when we do not control for the country and time effects. In univariate approaches, the stock market variables seem to be more relevant.

6. Conclusions

Based on its "guided discretion" approach, the European Systemic Risk Board recommends a prominent role of the credit-to-GDP

gap and the related benchmark buffer rate. However, our empirical analysis indicates that the credit-to-GDP gap, as the rule-based element, seems to be only of a minor, if any, relevance for national macroprudential policies.

Interestingly, that does not mean that national authorities act in a downright discretionary way only. We find that policymakers systematically take into account some of the other risk indicators related to the financial cycle as suggested by the ESRB (2014). In particular, they seem to react to house price inflation when setting the countercyclical buffer rate for domestic exposure. This is likely to reflect concerns about potential overvaluations in real estate markets, the subsequent risk of bursting housing bubbles, and distress in the banking sector. As pointed out by Borio and Lowe (2002b) and Borio (2014) among others, real estate prices are a key driver of the financial cycle. Also, credit quality, as measured by the nonperforming loans ratio, appears to play an important role in setting the countercyclical capital buffer.

Our empirical results are related to a conflict that has been discussed at great length in the field of monetary policy. In choosing their policy framework, policymakers not only have the choice between (pure) rules versus (pure) discretion; they can also choose to constrain discretion by implementing *rule-like* features (Mishkin 2017). A similar logic might hold in the field of macroprudential policy. By strengthening rule-like elements in their policy decisions, authorities could possibly improve the efficiency of their policies. Rule-based components enhance the comparability of macroprudential policy among different countries and should make decisions more comprehensible to financial markets. Transparent communication of indicators and their consistent application could improve the predictability of capital buffer decisions and reduce adaption costs for financial institutions.

Unsurprisingly, some caveats should be kept in mind. Since the CCyB is a relatively novel instrument, our analysis does not cover policy decisions for the entire financial cycle. Moreover, the reporting of consistent data (e.g., credit-to-GDP gaps, credit-to-GDP ratios) on the European level is still in its infancy. Consistently calculated and published indicators would help to improve the analysis of European CCyB decisions.

Finally, it is puzzling that national authorities do not stick more closely to the buffer guide rule they have agreed to as ESRB members. Apparently, they are not at odds with a systematic CCyB policy, at least when it is based on indicators such as house price inflation and credit quality. By not following the officially agreed-upon credit-to-GDP rule while concentrating on complementary variables, they pursue rather non-transparent and inconsistent policies. They neglect the potentially relevant information channel of their policies and forgo the benefits of a time-consistent policy. In this situation, the following two options seem available. Either the ESRB recommendations are brought in line with the current CCyB policies on the national level, or else national buffer decisions should be more closely linked to the single quantitative rule.

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