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Analysis of the relationship between countercyclical capital buffer and performance and risk indicators of the banking sector[1]

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Abstract: This study aims to explain the association between the quarterly data obtained over the period 2007: Q2–2020: Q3 for Turkey and the countercyclical capital buffer (CCyB) proposed within the framework of Basel III with banking performance and risk indicators. For this purpose the association among the variables was analyzed using the ARDL model and by performing the Toda Yamamoto (T-Y) causality test. According to the analysis results, it was determined that the CCyB has a statistically significant and positive relationship with the capital adequacy indicators of the banks in the long-run, however, it has a statistically significant and negative relationship with the asset quality risk and currency risk indicators. In the short-run it was determined that the CCyB has a statistically significant and positive relationship with the capital adequacy, profitability and liquidity indicators and similar to the long-term relationship, it has a statistically significant and negative relationship with the asset quality risk and exchange rate risk indicators. According to the causality test results, a statistically significant and unilateral causality running from the indicators of capital adequacy, asset quality and exchange rate risk to the CCyB was detected. The obtained estimation results indicate that the CCyB can be increased by policymakers during the periods when the performance indicators of the banking sector rise, whereas can be decreased by policymakers during the periods when the risk indicators of the sector rise. Furthermore, the results of the study asserted that the CCyB was an appropriate instrument for mitigating the macroeconomic and systemic risks for Turkey.

Keywords: countercyclical capital buffer, performance indicators, risk indicators, ARDL model, Toda Yamamoto causality test.

JEL codes: G21, G32, G33.

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Introduction

Bank credits are among the most important factors that increase economic growth by generating resources for the consumption and investment behaviour of the private sector. While the expansion in the credit volume contributes to economic growth it leads to a rise in the risks regarding the financial sector. The fact that rapid credit growth periods are associated with banking crises in many countries renders it necessary to closely monitor credit growth to manage the increased financial risks more cautiously. The Basel Committee on Banking Supervision has developed the "countercyclical capital buffer" (CCyB) as a macroprudential policy instrument to prevent the potential risk caused by excessive credit growth in the financial system and the cyclicality that may occur in the Basel III standards (BIS, 2010). Since excessive credit growth is a source of systemic risk the CCyB protects the banking sector from excessive credit rise and aims to maintain a flexible structure for the financial system in the presence of positive or negative changes in indicators (Drehmann, Sorensen, & Stringa, 2010; Francis & Osborne, 2012; Shim, 2013). The CCyB prevents excessive risk-taking by mitigating excessive credit growth during economic growth periods. Nonetheless it reduces the sensitivity toward risk by providing the continuation of the normal flow of credit activities along with the change of the credit cycle during the economic contraction periods.

The Basel Committee recommends a ratio to be determined comprised of the core capital component of between 0%–2.5% of risk-weighted assets for the CCyB. Nevertheless countries can set a figure above these rates once they deem it necessary. The Banking Regulation and Supervision Agency of Turkey has imposed an obligation to hold additional core capital at rates ranging between 1%–3% for the additional capital buffer to be held for systemically important banks (D-SIBs) (BDDK, 2015). Although the credit growth in the Turkish credit market from low levels to a rapid increase within the last five years does not seem to be a problem in the short-run it is of great significance to control the increase since the rapid rise in the medium- and long-run poses a risk to the financial system's stability.

It has been seen that most of the studies regarding the CCyB in international literature have been conducted on the real sector. In these studies the impact of CCyB on credit expansion has been investigated. An absence of studies regarding indicators affecting the CCyB of countries has been observed in the literature. This study is conducted based on the problem of which banking performance and risk indicators would affect the determination of Turkey's CCyB ratio. The internal dynamic indicators of the countries are crucial in the calculation of the CCyB, which is a macroprudential tool. Therefore BIS has let the ratios be used in the calculation to the country's own structure. Since the CCyB rates tend to vary by country-specific policies only one country is included in the study and Turkey constitutes the main motivation of the study.

A high level of credit growth figures in Turkey as a developing country and clearly-stated calculation method of the CCyB in the regulation are the most important factors for its examination in the study. This study aims to figure out the association between the CCyB and the banking sector's performance as well as risk indicators. The Basel III Accord has mentioned the Credit/GDP gap as the variable to be referenced for determining the CCyB. The Credit/GDP gap indicates that the credits in the banking sector diverge from their own trend and risks accumulate. In this regard the aim is also to determine the banking indicators that may cause the credit gap in the study. In the study responses to certain questions are sought. The questions of the study involve whether long-term, short-term and causal relationships exist between the CCyB and: (1) the capital adequacy indicators of the banks; (2) the asset quality risk indicators of the banks; (3) the profitability indicators of the banks; (4) the liquidity indicators of the banks; (5) the foreign exchange risk indicators of the banks. To respond to these questions econometrically the association between the quarterly data and variables obtained between 2007: Q2–2020: Q3 is analyzed using the ARDL model and conducting the Toda-Yamamoto (T-Y) causality test. It is thought that the obtained findings would contribute to both the knowledge of the sector regulators and the literature.

In Section 1 a relevant literature review is introduced. In Section 2 the utilized data and methodology are explained. In Section 3 the findings obtained from the analyses are presented. In the last Section general results, discussions and limitations of the research study are given.

1. Literature review

The CCyB is accumulated at the beginning of the systemic risk indicated by excessive credit growth, whereas it prevents excessive credit growth by being used without limitations during the periods of risk occurrence. The first study in the literature to investigate the association between the CCyB and the banking sector was Buser, Chen and Kane (1981). The study stated that banks maintained a large amount of capital buffer to avoid the additional burdens placed by policymakers and it affected their profit margins. Berger (1995) investigated the association between the performance of banks and the capital buffer. In his study a positive association was detected between the CCyB and the return on equity. Nevertheless, Jokipii and Milne (2008) concluded that the CCyB negatively affected profitability within the framework of the association between the banking performance and the CCyB. The authors analyzed the impacts of the cyclical behaviour of the European Union banking system on the profitability, size, risk factor and net loans in the sector utilizing the data obtained over the period 1997–2004, employing the two-step GMM estimation method. They concluded that cyclical behaviour in capital buffers generates adverse impacts on banks' profitability, size and net credits while increasing the risk factor. In particular the authors pointed out that the cyclicality policy of the Basel accord would worsen the sector's performance.

Flannery and Rangan (2008) investigated the impact of capital accumulations on banking indicators by utilizing the annual data obtained over the period 1986–2001. According to the panel data analysis results they concluded that capital accumulation positively affected the profitability of the banking sector but negatively affected the asset quality. Shim (2013) examined the influence of the CCyB on the portfolio risk of banks by utilizing the quarterly data obtained over the period 1992: Q1–2011: Q3. The three-stage least squares (3SLS) method was employed in the study. As a result of the findings it was asserted that the CCyB had a positive effect on the profitability and liquidity of the banks, whereas it negatively affected the asset quality risk. Guidara, Soumaré and Tchana (2013) investigated the association between the CCyB and business cycles of Canadian banks utilizing the quarterly data obtained over the period 1982–2010. A two-step GMM regression method was employed in the study. The study concluded that the rise in the performance of the banks has a positive effect on the CCyB and reduces the risk in the sector. Moreover, they stated that there was no decrease in the capital of Canadian banks due to the buffer effect throughout the recessionary periods.

Drehmann and Gambacorta (2012) investigated the impacts of the CCyB on bank credits of the banking sector in Spain utilizing the quarterly data obtained over the period 1999–2009. In the study the GMM was employed. According to the results of the analysis it was concluded that the CCyB and the liquidity indicator and the capital adequacy indicators were in a positive relationship and that an adverse relationship existed with the risk indicators. Besides it was concluded that the CCyB could lower credit growth throughout the excessive credit expansion and might reduce credit contraction once the buffer was released. Huang and Xiong (2015) investigated the association between bank capital buffers and macroeconomic variables utilizing the data of 45 commercial banks which operated in China between the years 2000–2010. The one-step GMM method was used in the study. According to the analysis results they concluded that an adverse association existed between the CCyB and the total assets of the banks, their profitability indicators and the non-performing loan ratio. They also concluded that the buffer significantly reduced deposits in the Chinese banking sector.

Giesse and others (2014) analyzed the performance of the CCyB against credit expansion for the UK utilizing the quarterly data obtained over the period 1969–2009. They concluded that the CCyB performed well against excessive credit expansion. Pramono, Hafidz, Adamanti, Muhajir and Alim (2015) explained the impacts of the CCyB on credit growth in Indonesia using the GMM method utilizing the data obtained over the period 2005: Q1–2015: Q2. According to the results of the analysis, a rise in the capital adequacy ratio increased the CCyB. In other words the decline of the capital requirements of banks increased the CCyB. They also concluded that the CCyB and the return on the assets' ratio and total assets were positively related. Jiang and Zhang (2017) investigated the association between bank capital buffers, franchise value and risk heterogeneity utilizing the data obtained from 141 commercial banks operating in China over the period 2004–2015. According to the panel data analysis results they concluded that an adverse relationship existed between the risk-taking features of banks and the CCyB.

Antoun, Coskun and Youssef (2021), utilizing the data obtained over the period 2009–2014, examined the association between the capital buffer of the Southeast European banking sector and the indicators explaining the risk regulations. According to the results of the three-stage least squares method they employed in their studies, they concluded that the capital buffer and the return on assets' ratio as well as the liquidity ratio were positively related, however, total assets were adversely connected.

Upon examining the literature it is seen that studies were conducted on the CCyB in the banking sector as well as the impacts of capital buffer on credit expansion. In these studies indicators based on macroeconomic variables and financial structures of the banking sector were utilized. Micro-level studies in the literature seem to attribute the impacts of the cyclical capital buffer in a given country to the performance of local banks. Unlike other studies this study would contribute to micro-level studies in terms of utilizing the CCyB, indicators explaining the performance of banks and risk regulations for the sector in general. Furthermore usage of the ARDL Bounds test and T-Y causality test analyses, unlike many other studies, for evaluating the relationship between the CCyB and the banking performances and risks would make another contribution to the literature.

2. Empirical issues

2.1. Methodology and model specification

The most frequently used cointegration tests in the literature include the two-step Engle-Granger (1987) method and the Johansen (1988) as well as Johansen and Jesulius (1990) methods. In order to employ these methods all variables in the model must not be stationary at the level I (0) and must be stationary upon taking the first differences (Pesaran, Shin, & Smith, 2001, s. 289–290). The bounds test approach, also referred to as the ARDL approach, eliminates the problem of not employing the cointegration method toward the series with different orders of cointegration. The advantage of this approach is that it investigates whether or not a cointegration exists among the variables regardless of the variable's order of cointegration. However, the application of this method is considered appropriate due to three reasons. Firstly, it is simple, and unlike multivariate cointegration techniques, the presence of a cointegration is detected after the lag length of the model is determined with the OLS. Secondly, the bounds test procedure unlike the Johansen and Juselius (1990) cointegration techniques, does not require preliminary testing. The bounds test may be carried out regardless of whether being all I (0) and I (1) or being all cointegrated I (1), besides the series in the model are I (2). Thirdly, the bounds test is quite effective for restricted sample sets.

Models have been established to examine the association between the CCyB and the banking sector performance and risk indicators in line with studies such as Jokipii and Milne (2008), Ayuso, Pérez and Saurina (2004), Shim (2013) and Guidara and others (2013). Indicators of the banking sector have a crucial place in the literature. In this regard the model of the study is preferred to merely include variables relevant to the banking sector. In this model an attempt is made to evaluate the extent to which banking sector variables are associated with the CCyB. The ARDL model and its stages established for the bounds test regarding the model with eight independent variables are presented below.

$$CAPBU\ f\ (CAR, TIER, NPCR, NPTC, ROA, ROE, LAR, PRD) \tag{1}$$

$$\begin{aligned} CAPBUF = \beta_0 + \beta_1\ CAR_t + \beta_2\ TIER_t + \beta_3\ NPCR_t + \\ + \beta_4\ NPTC_t + \beta_5\ ROA_t + \beta_6\ ROE_t + \beta_7\ LAR_t + \beta_8\ PRD_t \end{aligned} \tag{2}$$

The econometric models that include the error term are as follows:

$$\begin{aligned} CAPBUF = \beta_0 + \beta_1\ CAR_t + \beta_2\ TIER_t + \beta_3\ NPCR_t + \beta_4\ NPTC_t + \\ + \beta_5\ ROA_t + \beta_6\ ROE_t + \beta_7\ LAR_t + \beta_8\ PRD_t + \mu_t \end{aligned} \tag{3}$$

$$\begin{aligned} \Delta CARBUF_t = \alpha 0 &+ \sum_{i=1}^{m} \beta_{1i} \Delta CARBUF_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta CAR_{t-i} + \sum_{i=0}^{p} \beta_{3i} \Delta TIER_{t-i} + \\ &+ \sum_{i=0}^{r} \beta_{4i} \Delta NPCR_{t-i} + \sum_{i=0}^{h} \beta_{5i} \Delta NPTC_{t-i} + \sum_{i=0}^{w} \beta_{6i} \Delta ROA_{t-i} + \\ &+ \sum_{i=0}^{x} \beta_{7i} \Delta ROE_{t-i} + \sum_{i=0}^{y} \beta_{8i} \Delta LAR_{t-i} + \sum_{i=0}^{z} \beta_{9i} \Delta PRD_{t-i} + \\ &+ S_1 CARBUF_{t-1} + S_2 CAR_{t-1} + S_3 TIER_{t-1} + S_4 NPCR_{t-1} \\ &+ S_5 NPTC_{t-1} + S_6 ROA_{t-1} + S_7 ROE_{t-1} + S_8 LAR_{t-1} + \\ &+ S_9 PRD_{t-1} + \mu_t \end{aligned} \tag{4}$$

$$\Delta CARBUF_t = \alpha 0 + \sum_{i=1}^{m} F_{1i} \Delta CARBUF_{t-i} + \sum_{i=0}^{n} F_{2i} \Delta CAR_{t-i} + \sum_{i=0}^{p} F_{3i} \Delta TIER_{t-i} + \\ + \sum_{i=0}^{r} F_{4i} \Delta NPCR_{t-i} + \sum_{i=0}^{h} F_{5i} \Delta NPTC_{t-i} + \sum_{i=0}^{w} F_{6i} \Delta ROA_{t-i} + \\ + \sum_{i=0}^{x} F_{7i} \Delta ROE_{t-i} + \sum_{i=0}^{y} F_{8i} \Delta LAR_{t-i} + \sum_{i=0}^{z} F_{9i} \Delta PRD_{t-i} + \\ + \gamma ECT_{t-1} + \mu_t \quad (5)$$

$$ECT_t = CARBUF_t - \sum_{i=1}^{m} F_{1i} \Delta CARBUF_{t-i} - \sum_{i=0}^{n} F_{2i} \Delta CAR_{t-i} - \sum_{i=0}^{p} F_{3i} \Delta TIER_{t-i} - \\ + \sum_{i=0}^{r} F_{4i} \Delta NPCR_{t-i} - \sum_{i=0}^{h} F_{5i} \Delta NPTC_{t-i} - \sum_{i=0}^{w} F_{6i} \Delta ROA_{t-i} - \\ + \sum_{i=0}^{x} F_{7i} \Delta ROE_{t-i} - \sum_{i=0}^{y} F_{8i} \Delta LAR_{t-i} - \sum_{i=0}^{z} F_{9i} \Delta PRD_{t-i} \quad (6)$$

In this equation α denotes the constant term; Δ represents the difference of the variables; S1, S2, S3, S4 stand for the long-term coefficients; and μ_t denotes the error term. In the model established for the performance of the bounds test the coefficients *m*, *n*, *p*, *r*, *h*, *w*, *x*, *y*, and *z* denote the lag length of the relevant variables and the appropriate lag value is determined according to the results of several information criteria. By estimating the lag length with a model that maintains the lowest critical value it is investigated whether or not the model contains autocorrelation problem. The *F*-statistic test hypothesis is as follows;

$$H_0: S_1 = S_2 = S_3 = S_4 = 0 \\ H_1: S_1 \neq S_2 \neq S_3 \neq S_4 \neq 0 \quad (7)$$

The H_0 hypothesis implies that a cointegration exists whereas the H_1 hypothesis claims that no cointegration exists among the variables. The null hypothesis would be not be accepted once the estimated *F*-statistic value exceeds the upper bound whereas it would be asserted that cointegration exists between the dependent variable and the estimators. The null hypothesis implying that no cointegration exists would not be rejected once the estimated *F*-statistic value is lower than the lower bound. Nonetheless if the calculated *F*-statistic value is between the upper and lower bounds no accurate interpretation cannot be made, therefore, other cointegration testing approaches should be considered.

In the causality test based on the VAR system cointegration of the series is not essential. The most crucial advantage of this assumption involves the minimization of the risks that would arise if the order of cointegration of the series cannot be determined accurately. The T-Y tests are valid for integrated and cointegrated variables (Toda & Yamamoto, 1995). According to the relevant method, even if the series is not stationary, a VAR system containing the level values of the series is established and the system is calculated using the seemingly unrelated regression (SUR) method. According to the T-Y approach, the bivariate model, which includes the level values of the data of both Y and X variables is as follows.

$$Y_t = \lambda_1 + \sum_{i=1}^{k} \alpha_{1i} Y_{t-i} + \sum_{j=k+1}^{d_{\max}} \alpha_{2j} Y_{t-j} + \sum_{i=1}^{k} \beta_{1i} X_{t-i} + \sum_{j=k+1}^{d_{\max}} \beta_{2j} X_{t-j} + e_{1t} \tag{8}$$

$$X_t = \lambda_2 + \sum_{i=1}^{k} \alpha_{2i} Y_{t-i} + \sum_{j=k+1}^{d_{\max}} \alpha_{2j} Y_{t-j} + \sum_{i=1}^{k} \beta_{2i} X_{t-i} + \sum_{j=k+1}^{d_{\max}} \beta_{2i} X_{t-j} + e_{2t} \tag{9}$$

The T-Y method is performed in two phases. In the first phase it is essential to detect the maximum integration level (d_{max}) of the variables in the system. It is determined by unit root tests (d_{max}). In the Var(k) model the lag lengths of the variables are determined according to the Akaike (AIC) Schwartz (SIC), Sequential Modified LR test and Hannan-Quinn (HQIN) information criteria. Following the detection of the optimal lag length (k) and (d_{max}); autocorrelation, heteroscedasticity, normality tests and VAR stability tests are conducted for the diagnostic test controls of the VAR model. In the next phase the Granger causality results are obtained by performing the Wald tests to the first VAR (k) coefficient matrixes. It ensures the asymptotic distribution of the VAR ($k+d_{max}$) for the estimated Wald statistic.

2.2. Data and descriptive statistics

In the study the relationship between the CCyB and the banking sector performance and risk indicators for Turkey is investigated. For banking performance and risk indicators a model is established based on liquidity, profitability, capital adequacy, asset quality risk and currency risk indicators. The variables used in the study include the quarterly data obtained over the period 2007: Q2–2020: Q3. The variables of banking sector performance used in the study consist of eight variables such as the ratio of risk-weighted assets to capital, the ratio of capital to risk-weighted assets, the ratio of non-performing loan provisions to capital, the ratio of non-performing loans to total credits, return on assets ratio, return on equity ratio, the ratio of liquid assets to total assets and the ratio of net open position in foreign exchange to capital. For the calculation of the CCyB, the [Credit/GDP-Trend (Credit/GDP)] difference, in other words, the Credit/GDP gap is taken as an indicator. The sub-indicators and acronyms of the variables are shown in Table 1.

The Credit/GDP gap indicator was developed by the International Settlement Bank (BIS) as part of the Basel III regulations that define standards for bank-

Table 1. Sub-indicators, acronyms, and definitions of the variables

Sub-indicators	Acronym	Definition
Countercyclical Capital Buffer	CAPBUFF	Min(2.5%×Max(Credit/GDP gap −3%) / 12%, 2.5%)
Capital Adequacy	CAR TIER	Statutory equity / risk-weighted assets ratio Statutory capital / risk-weighted assets ratio
Asset Quality Risk	NPCR NPTC	Non-performing loan provisions / capital ratio Non-performing loans / total credits ratio
Profitability Ratio	ROA ROE	Return on assets Return on equity
Liquidity Ratio	LAR	Liquid assets to total assets
Foreign Exchange Rate Risk	NOP	Net open position in foreign exchange to capital

Source: (International Monetary Fund and Bank for International Settlements, 2021).

ing. In determining the CCyB the Credit/GDP gap is taken into account by the Basel Committee as the main reference indicator (BDDK, 2015). The Credit/GDP gap is the indicator used to measure the accumulation of risks in the banking system. The case of a positive and growing gap indicates that the credits diverge from their own trend and the risks accumulate. The formula CCyB = Min(2.5% · Max(Credit/GDP gap −3%) / 12%, 2.5%) is used to calculate the CCyB. This formula was put into effect as of 2015 by the Turkish banking regulatory and supervisory board to calculate the CCyB. BDDK (2015) set the CCyB as 0% if the credit gap falls below 3%. If the credit gap exceeds 15% the maximum CCyB ratio, 2.5%, is used. If the credit gap ranges between 3%–15%, a CCyB ratio that is lower than 2.5% would be used. The long-term trend value in the Credit/GDP gap is calculated with the HP filter as in Drehmann and Gambacorta (2012), Pramono and others (2015), and Drehmann and Yetman (2018). It is disputable in the literature what the smoothing parameter of the HP filter would be. The parameter value of the HP filter suggested by BIS in the calculation should be determined according to country-specific dynamics. BIS recommends the smoothing parameter (λ) of the HP filter as 400,000. In the study upon considering the parameter value as 400,000 the credit gap criterion has higher positive values and inconsistencies are observed over the periods. Therefore the optimal smoothing parameter (λ) suggested by Pramono and others (2015) is accepted as 25,000 since it is thought that Turkey's central bank economic bulletins better reflect the credit gap periods.

The CAR and TIER ratios indicate whether the banking system has sufficient capital level. Indicators provide information on the sector's ability to pay. The NPCR ratio measures the possible impact of non-performing loans on capital. This ratio also indicates the ability of the sector to cover the losses arising from its receivables (IMF, 2006, p. 78). The NPTC ratio provides information on the quality of credits which constitute a large part of the assets in the balance sheet of banks. ROA and ROE are measures of the efficiency level of the banks' activities. The LAR ratio indicates the ability of banks to meet their liquid demands. Liquidity is one of the crucial endogenous determinants of bank performances (IMF, 2006, p. 187). The NOP ratio indicates the ability of the sector to manage currency risk. This ratio was used to indicate exchange rate risk in the banking performance index created by the BRSA as of 2004.

According to Table 2, the median and mean of the variables are, in general, convergent. Upon examining the standard deviation values, it is seen that the highest value belongs to the CAPBUF variable. This indicates that the CAPBUF variable has the furthest distribution.

Table 2. Descriptive statistics of the variables

Variables	Mean	Median	Standard deviation	Skewness	Kurtosis
CAPBUF	8.485185	10.15000	5.473208	−1.527822	4.655500
CAR	17.29422	17.01006	1.463782	0.399123	2.148883
TIER	15.12854	14.69225	1.758780	0.516587	2.032648
NPCR	3.650540	3.222316	1.476146	1.324665	4.528284
NPTC	3.329297	3.019854	0.733327	1.021110	2.774795
ROA	2.327452	2.211828	0.712121	0.585506	2.106387
ROE	19.77080	19.34866	5.047280	0.529987	2.275194
LAR	51.05660	50.66649	4.290837	0.100917	2.533225
NOP	−0.901638	−0.754294	1.667695	−0.105482	2.457718

Source: Own calculations using EViews 10.

As can be seen in Table 2 the kurtosis of the distribution ranges between 2.03–4.65, indicating that the distribution has an asymmetrical feature. In the skewness values the negative / positive cases indicate that the distributions are skewed to the right / left respectively. The skewness values of the variables are, in general, positive.

3. Empirical results

In the first stage of the study the presence of an association between the independent variables used in the model and the CCyB is investigated. In the second stage the presence of a causal association among the variables is analyzed.

3.1. Unit root result

In the analyses conducted on time-series the non-stationarity of the series causes unreliable outcomes among the variables. Thus it is essential to examine the stationarity features of the series prior to model estimation. The Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) unit root tests are conducted to estimate the relationships between the CCyB and banking sector performance. With these tests a hypothesis is formed regarding whether or not the time-series contain unit roots. In this context, if there is a unit root, it is interpreted as non-stationary and if there is no unit root it is interpreted as stationary.

H_0: The series contain unit roots.

H_1: The series does not contain unit roots.

Table 3 indicates the ADF and PP unit root test results.

Table 3. The ADF and PP unit root test results

Variables		ADF-t Statistic (at level)	ADF-t Statistic (1st difference)	PP-t Statistic (at level)	PP-t Statistic (1st difference)
CAPBUF		−2.769260 (0)	−6.779608 (0)***	−2.769260 (0)	−6.768840 (3)***
CAR		−1.327185 (0)	−6.062392 (0)***	−1.356656 (2)	−6.754506 (5)***
TIER		−0.914626 (0)	−7.259490 (0)***	−0.774011 (4)	−7.400966 (6)***
NPCR		−2.866397 (1)	−4.304295 (0)***	−2.340260 (3)	−4.281954 (1)***
NPTC		−2.894588 (1)	−3.406818 (0)*	−1.996349 (4)	−3.378627 (1)*
ROA		−2.428357 (0)	−6.658747 (0)***	−2.493721 (2)	−6.637237 (2)***
ROE		−2.656017 (0)	−6.930687 (0)***	−2.680331 (2)	−6.930093 (1)***
LAR		−5.365513(0)***	−11.58569 (0)***	−5.317939(1)***	−13.80571(6)***
NOP		−3.969866(0)**	−10.88394 (0)***	−4.029989(4)**	−10.88394 (0)***
Significance level	1%	−4.140858	−4.144584	−4.140858	−4.144584
	5%	−3.496960	−3.498692	−3.496960	−3.498692
	10%	−3.177579	−3.178578	−3.177579	−3.178578

Note: Values in parentheses indicate the lag lengths according to the AIC. ***, **, and * indicate the significance at 1%, 5%, and 10% levels of significance, respectively.

Source: Own calculations using EViews 10.

According to the ADF and PP unit root test results presented in Table 3, it is seen that the H_0 hypothesis is not rejected since the t statistical values of the CAPBUF, CAR, TIER, NPCR, NPTC, ROA and ROE variables are lower than the critical value level, in other words, the series contain unit roots. Upon taking the first difference of the series it is seen that they are stationary and the H_0 hypothesis is rejected. Since the t statistical values of LAR and NOP variables are higher than the critical value it is seen that the H_0 hypothesis is rejected, hence, it is stationary at the level.

3.2. Cointegration analysis: The ARDL bounds test

Following the determination of the stationarity levels of the variables the cointegration analysis for detecting the presence of a long-term association. Since the variables are non-stationary at the same level and the model is not at the I(2) stationarity level the cointegration relationship is analyzed by performing the ARDL Bounds Test. The appropriate lag length in the model is determined as a maximum of 8 according to the AIC. The F statistical value regarding the existence of a cointegration relationship is taken into account. The statistical value results are given in Table 4.

Table 4. The ARDL bounds test for cointegration

Model Estimation	**CAPBUF = *f* (CAR, TIER, NPCR, NPTC, ROA, ROE, LAR, NOP)**	
Lag Structure	2, 4, 4, 4, 4, 4, 4, 3, 4	
***F*-statistics**	8.010783	
k*	8	
Level of significance	**Critical bounds levels**	
	I0 Bound	**I1 Bound**
10%	1.85	2.85
5%	2.11	3.15
2.5%	2.33	3.42
1%	2.62	3.77

Note: *(k) denotes the number of independent variables that include in the model and explains the dependent variable.

Source: Own calculations using EViews 10.

The *F* statistical value of the model is calculated as 8.010783 and it is higher than the upper bound at the 1% level (see Table 4). Thus a cointegration exists among the variables and allows for the establishment of a long- and short-term ARDL model.

3.3. The ARDL long- and short-term results

The long-term coefficient results of the ARDL (2,4,4,4,4,4,3.4) obtained by determining the appropriate lag values for the variables in the model are given in Table 5.

Table 5. Long-term coefficients

Variable	Coefficient	Probability
CAR	0.771751	0.0470**
TIER	1.189986	0.0159**
NPCR	–0.004010	0.9989
NPTC	–3.323211	0.0930*
ROA	4.896120	0.5688
ROE	0.340888	0.2683
LAR	0.391194	0.3125
NOP	–2.327434	0.0040***
C	3.002297	0.0249**

Note: ***, **, and * indicate the significance at 1%, 5%, and 10% levels of significance, respectively.

Source: Own calculations using EViews 10.

Upon considering the long-term coefficient results the NOP ratio is at a 1% significance level, while the CAR and TIER ratios indicate a long-term relationship at the 5% significance level. Moreover, it is seen in Table 5 that the NPTC ratio is in a long-term association with the CCyB at a 10% significance level. The CAR and TIER ratios have positive impacts on the CCyB. In other words a positive association exists between CCyB and capital adequacy indicators. The NPTC ratio and the NOP ratio have a negative impact on the CCyB in the long-run.

Table 6. Short-run estimation-error correction model test results

Variables	Coefficient	Probability
ΔCAR	4.172484	0.0001***
ΔTIER	6.727575	0.0000***
Δ NPCR	–6.534456	0.0000***
Δ NPTC	–10.724801	0.0000***
ΔROA	13.741211	0.0025***
ΔROE	2.048271	0.0009***
ΔLAR	0.360001	0.0001***
ΔNOP	–0.367025	0.0505*
ECT (–1)	–1.082516	0.0000***

Note: ***, **, and * indicate the significance at 1%, 5%, and 10% levels of significance, respectively.

Source: Own calculations using EViews 10.

The ECT coefficient is statistically significant and negative at the 1% significance level (see Table 6). The variable ECT (–1) stands for one period lagged value of the series of error terms obtained from the long-run association. The coefficient of this variable indicates the extent to which the disequilibrium in the short-run would be corrected in the long-run. The fact that the coefficient is higher than 1 in the model explains that an unusual situation occurring in the short-run would quickly adapt in the next year.

According to the short-term coefficient results presented in Table 6, it is seen that the CCyB is positively affected by capital adequacy, profitability and liquidity ratios. Asset quality and exchange rate risk ratios seem to adversely affect the CCyB in the short-run.

Rise in assets and willingness to offer credits increase the capital buffer during the expansionary periods of banks. In recessionary periods, however, the willingness to extend credits declines and banks have a cyclical bias. Since capital adequacy ratios indicate the capability of the banking sector to withstand sudden losses and shocks a rise in these ratios increases the CCyB. The rise in these ratios increases the CCyB as profitability ratios indicate the capability of banks to absorb losses without affecting their capital. Similarly the liquidity indicator indicates the ability of banks to withstand cash shocks and a rise in the indicator increases the CCyB. The inequality in the net foreign currency positions, regardless of being in favor of debits or receivables, generates exchange rate risk in both cases. If the total of foreign currency holdings and foreign currency receivables cannot meet the foreign exchange commitments and foreign exchange debts there is an open position in favour of the debts and this situation is called a "short position". The NOP in favour of debts reduces the CCyB. The asset quality indicator shows the potential risks that may affect the solvency of banks and increases in this indicator lead to a decline in the CCyB.

According to the diagnostic test results in Table 7 it is seen that no results that violate the reliability of the model exist. No problems are detected in the model regarding autocorrelation, heteroscedasticity and normality of the error distribution. Figures 1 and 2 illustrate the CUSUM and CUSUM-SQ test results of the model.

Table 7. Diagnostic tests for the ARDL model

Tests	*F*-statistic	*P*-Value
J–B normality test	0.148284	0.9285
Breusch-Godfrey LM test	0.216154	0.8116
Heteroscedasticity Test Breusch-Pagan	1.420542	0.3138
Ramsey RESET	0.157114	0.7223

Source: Own calculations using EViews 10.

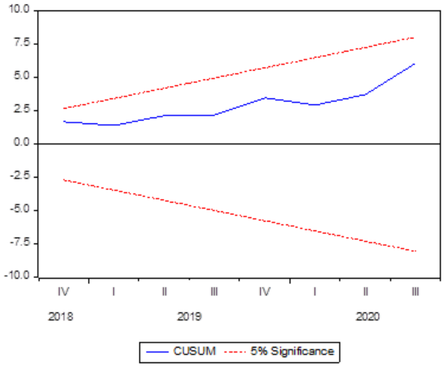

Figure 1. CUSUM
Source: Own work.

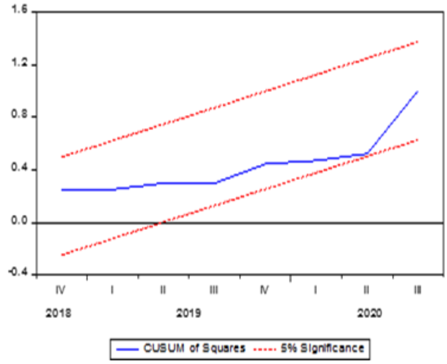

Figure 2. CUSUM-SQ
Source: Own work.

The CUSUM and CUSUM-SQ tests which are performed on consecutive error terms and squares of consecutive error terms help to determine whether or not the coefficients estimated in the models are stable. As illustrated in Figures 1 and 2 the coefficients obtained from the model are stable since they are within the 5% confidence interval.

3.4. Toda Yamamoto (T-Y) causality test

The unit root test results presented in Table 3 reveal that the maximum degrees of cointegration of the variables (d) are not higher than one, that is (d_{max}=1). This result should appear in the T-Y causality analysis. Five different information criteria are taken into account in determining the optimum lag length for VAR. Table 8 presents the optimal lag lengths.

Table 8. Determining the optimum lag length for VAR

Lag	LogL	LR	FPE	AIC	SC	HQ
0	–579.8552	NA	0.137156	23.55421	23.89837	23.68527
1	–267.1666	500.3018	1.36e–05	14.28666	17.72830*	15.59726
2	–162.5550	129.7184	7.23e–06	13.34220	19.88132	15.83233
3	–71.90065	79.77580	1.27e–05	12.95603	22.59262	16.62570
4	194.7314	138.6487*	9.02e–08*	5.530743*	18.26482	10.37995*

Note: * denotes the appropriate lag length according to the relevant information criteria; LR (the Likelihood-ratio test); FPE (Final prediction error); AIC (Akaike information criterion); SC (Schwarz information criterion); HQ (Hannan-Quinn information criterion).

Source: Own calculations using EViews 10.

According to Table 8, the optimum lag length for VAR is 4 according to the HQ, LR, FPE, and AIC criteria; whereas is 1 according to the SC criterion. All lag lengths need to be checked to decide which lag length is the most appropriate for the T-Y causality test. Since the order of cointegration (d_{max}) of the variables is 1, the estimated level for the T-Y causality test is VAR ($k + d_{max}$), and it is VAR (5) ($k + d_{max} = 5$) for the HQ, LR, FPE, and AIC criteria. For the SC criterion it is VAR (2) ($k+ d_{max} =2$). Nonetheless, it is concluded that the calculated VAR (2) test result is not stable and only the VAR (5) result is stable.

The T-Y test results indicate that only 5 out of the 16 causal relationships can be accepted (see Table 9).

As Table 9 depicts the first causal relationship emerges at the 1% statistical significance level and supports a unilateral causality running from the CAR ratio to the CCyB. The second causal relationship is unilateral from the TIER ratio to the CCyB at the 1% significance level. In the study it is seen that a unilateral causality exists between the two ratios representing capital adequacy and CCyB. The third causal relationship is unilateral running from the NPCR ratio, which represents the asset quality at the 1% significance level, to the CCyB. The fourth causal relationship is unilateral causality running from the NPTC ratio which is another variable representing asset quality at the 10% significance level to the CCyB. The final relationship is the unilateral causality running from the NOP ratio which represents the exchange rate risk to the CCyB. The significant results obtained due to the short- and long-term information with the ARDL model are also supported by the causality test.

Conclusions and discussions

Along with the increase in financial integration which is an important outcome of globalization, countries tend to attach more importance to financial stability. Therefore regulations that protect and prevent financial stability are important. The Basel III Accord has implemented the CCyB practice in order to prevent the financial stress that may occur following excessive credit growth of banks and to prevent an additional downturn in credit conditions during periods of unfavorable economic conditions. The main reason for the practice is that if the rapid credit growth is not kept under control it assumes a risk factor for the banking sector.

In the study the association between the CCyB and banking performance and risk indicators over the period 2007: 02–2020: 03 is investigated by employing the ARDL model and performing the T-Y causality test. While the performed tests verify the presence of cointegration the error correction term is detected to be negative and significant with a high compliance rate in the error correction model. The obtained estimation results asserted that capital adequacy indicators have a positive and significant association with the CCyB in

Table 9. Toda-Yamamoto causality test

Direction of causality	Null hypothesis (H0)	Chi-square probability value	Results
CAPBUF→CAR	CAPBUF does not Granger cause CAR	0.9531	H0 cannot be rejected
CAR→CAPBUF	CAR does not Granger cause CAPBUF	0.0000***	H0 can be rejected
CAPBUF→TIER	CAPBUF does not Granger cause TIER	0.7973	H0 cannot be rejected
TIER→CAPBUF	TIER does not Granger cause CAPBUF	0.0000***	H0 can be rejected
CAPBUF→ NPCR	CAPBUF does not Granger cause NPCR	0.5812	H0 cannot be rejected
NPCR →CAPBUF	NPCR does not Granger cause CAPBUF	0.0000***	H0 can be rejected
CAPBUF→ NPTC	CAPBUF does not Granger cause NPTC	0.9758	H0 cannot be rejected
NPTC →CARBUF	NPTC does not Granger cause CAPBUF	0.0959*	H0 can be rejected
CAPBUF→ROA	CAPBUF does not Granger cause ROA	0.9809	H0 cannot be rejected
ROA→CAPBUF	ROA does not Granger cause CAPBUF	0.4781	H0 cannot be rejected
CAPBUF→ROE	CAPBUF does not Granger cause ROE	0.9853	H0 cannot be rejected
ROE→ CAPBUF	ROE does not Granger cause CAPBUF	0.3225	H0 cannot be rejected
CAPBUF→LAR	CAPBUF does not Granger cause LAR	0.8822	H0 cannot be rejected
LAR→ CAPBUF	LAR does not Granger cause CAPBUF	0.2502	H0 cannot be rejected
CAPBUF→NOP	CAPBUF does not Granger cause NOP	0.8092	H0 cannot be rejected
NOP→ CAPBUF	NOP does not Granger cause CAPBUF	0.0058***	H0 can be rejected

Note: → indicates the direction of causality. ***, **, and * indicate the significance at 1%, 5%, and 10% levels of significance, respectively.

Source: Own calculations using EViews 10.

the long-run. It is determined that asset quality risk indicators and exchange rate risk indicators have an adverse and significant association with the CCyB in the long-run. There have been various studies conducted on the fact that banks' capital adequacy ratios and credits tend to increase under sound and stable conditions. This may lead to excessive credit growth and generate a rise in the CCyB. Asset quality risk indicators exhibit potential risks that may affect banks' solvency. The increase in this indicator negatively affects the robustness of the banking sector. Therefore the rise in the asset quality indicator negatively affects the CCyB. The currency risk indicator denotes the ability of the sector to manage currency risk. Rises in the net open position in foreign exchange are generally observed during recessionary periods of the economy and the banks' willingness to extend credits declines during those periods. Therefore increases in currency risk are negatively related to the CCyB.

According to the error correction model results obtained from the study, it is observed that a positive association exists between the CCyB and capital adequacy, profitability and liquidity indicators in the short-run. In compliance with the long-term relationship exchange rate risk and asset quality risk indicators are detected to be inversely related to the CCyB in the short-run. According to the results of the T-Y causality test performed to detect the causal relationship it is concluded that a unilateral causality from the indicators of capital adequacy, asset quality and exchange rate risk to the CCyB exists. This result confirms the bounds test results which reveal the long-term associations among the variables. The results of the short-term relationship and causality relationship indicate that the CCyB can be increased by policymakers during the periods when the performance indicators of the banks increase and the CCyB can be decreased by policymakers during the periods when the risk indicators increase. During the periods when the performance indicators of the banking sector increase the increase in the willingness to extend credit causes excessive credit expansion in the economy and a rise in systemic risk. The CCyB can be increased by policymakers in order to reduce excessive credit growth and systemic risk. During periods when the risk indicators of the banking sector increase the decline in banks' willingness to extend credit may cause the economy to contract. The continuous increase in the share of non-performing loans in total loans within the banking sector and the exchange rate risk cause a deterioration in the quality of the banks' credit portfolio, a decline in the performance indicators of the sector, and a cyclical bias. The CCyB ratio can be decreased by policymakers to help the economy recover from the cyclical bias of banks.

The results obtained from the study have similarities with the findings of several previously conducted studies such as Berger (1995), Shim (2013), Guidara and others (2013), Drehmann and Gambacorta (2012), Pramono and others (2015); except for Jokipii and Milne (2008) and Huang and Xiong (2015). The findings of conducted studies, in general, indicate that the CCyB published by the Basel Committee can be utilized by banks as an effective risk management instrument and that the CCyB may contribute to financial stability by reducing the systemic risk in the economy. Another result of the studies is that the CCyB rises during the growth periods of the economy and declines during the recessionary periods. According to the results obtained from the study it is of great importance that the regulation and supervision of capital adequacy be effective since the amount of additional capital held by banks has a key role in the credit supply. According to the regulation issued by Turkey regarding the CCyB additional core, capital obligation has been imposed on banks. Banks would fulfill the additional capital amount with the directive of the regulatory agency within the framework of a certain harmonization process. This situation has resulted in the banks' decision on profit distribution according to the situation of the additional core capital amount determined by the policymakers. Moreover, banks' actions according to the risk perception and credit policy of policymakers may cause a rise in systemic risk in the country. Therefore it is recommended that policy regulators use a simple, clear and rule-based indicator that may accurately measure the stress in the industry and can be implemented internationally in the selection of the indicator to be used upon determining the CCyB ratio. Appropriate indicator selection is essential for the effectiveness and credibility of the implementation. Moreover the results of the study indicate that the CCyB that is put into practice can be effectively implemented in Turkey.

The indicators on which the study is based are obtained from the official website of the IMF and BIS starting from the second quarter of 2007. Therefore it can be claimed that there is a time constraint on the variables. Since the variables used in the study are utilized merely for Turkey, hence, there is a country-specific limitation. Furthermore, another limitation of the study involves the fact that BIS is regarded as a basis for the CCyB variable in the study and merely the HP filter suggested by BIS is utilized in the calculation of the credit gap. In future studies it may be recommended to compare different countries by conducting studies on the CCyB.

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