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The CNB's approach to setting the countercyclical capital buffer

Contents

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Abbreviations

BCBS	Basel Committee on Banking Supervision
BIS	Bank for International Settlements
BLS	Bank Lending Survey
BPI	Banking Prudence Indicator
CCoB	capital conservation buffer
CCyB	countercyclical capital buffer
CISS	Composite Indicator of Systemic Stress
CNB	Czech National Bank
CRD	Capital Requirements Directive
CRR	Capital Requirements Regulation
CZ	Czech Republic
CZK	Czech koruna
CZSO	Czech Statistical Office
ECB	European Central Bank
ESRB	European Systemic Risk Board
EU	European Union
EWMA	exponentially weighted moving average
FCI	Financial Cycle Indicator
GBP	British pound
GDP	gross domestic product
HP	Hodrick-Prescott
IRB	Internal Rating Based Approach
IRS	interest rate swap
LGD	loss given default
LLP	loan loss provision
OIS	Overnight Indexed Swap
pp	percentage point
PRIBOR	Prague InterBank Offered Rate
PX INDEX	Prague Stock Exchange Index
S1, S2, S3	degrees of asset impairment according to IFRS 9
SRB	systemic risk buffer
STA	Standardised Approach
USD	American dollar

1. Foreword

The CNB is the designated macroprudential body for the Czech Republic[1] and is responsible for setting the CCyB rate for institutions'[2] exposures in the Czech Republic and in other countries. The CNB decides to set a CCyB rate in order to maintain the resilience of the Czech banking sector to negative impacts of potential impairment losses on loans provided in the upward phase of the financial cycle and to smooth lending to the real economy in the event of adverse developments.

The point of the CCyB macroprudential tool is to create a capital buffer when cyclical risks are accumulating in institutions' balance sheets and to release it when those risks are decreasing. In principle, therefore, it is a simple countercyclical tool. From the perspective of decision-making and communication, however, the specific CCyB rate must be backed up with an appropriate justification.

This paper aims to present key aspects of the CNB's approach to setting the CCyB rate, contribute to the formation of expectations about the future path of the rate, and thereby facilitate capital planning for credit institutions.

When deciding on the CCyB rate, the CNB follows the relevant national legislation and BCBS and ESRB methodologies and guidelines. Based on these methodologies and guidelines, the CNB calculates and publishes the credit-to-GDP gap and the corresponding benchmark CCyB rate. In light of the recommendation to consider the specificities of the Member State concerned, the CNB takes into account a number of other indicators. These are mainly macrofinancial indicators and indicators specific to the banking sector which the CNB uses to determine the position of the domestic economy in the financial cycle and to monitor institutions' vulnerability to cyclical risks. Based on a comprehensive assessment of the indicators, the CNB estimates the sufficiency of institutions' capital buffers to cover potential losses arising from cyclical risks and decides on the specific CCyB rate.

Considering the nature of systemic risks,[3] the CNB maintains some flexibility in its decision-making and is prepared to take into account new information leading to greater resilience of institutions in its approach to setting the CCyB rate. For this reason, this document may be revised and updated as needed with regard to (i) changes in statistical reporting and potential revisions of data entering the decision-making process on the setting and calculation of the CCyB rate, (ii) refinements of the CNB's modelling system, and (iii) changes in internationally agreed practices.

1 Act No. 6/1993 Coll., on the Czech National Bank, as amended, and other legal regulations.
2 Throughout this document, "institution" means banks and credit unions pursuant to Act No. 87/1995 Coll.
3 Frait, J., Komárková, Z. (2011): Financial stability, systemic risk and macroprudential policy, CNB thematic article.

2. Basic information on the setting of the CCyB rate

The CNB sets the CCyB rate for risk-weighted exposures[4] in the Czech Republic on **quarterly basis**. When deciding on the rate, it primarily takes into account:

a) a benchmark indicator based on the standardised deviation of the credit-to-GDP ratio from its long-term trend (the standardised credit-to-GDP gap) calculated in accordance with BCBS guidance[5] (see section 4 and Appendix 1),
b) another benchmark indicator based on the additional credit-to-GDP gap calculated in accordance with ESRB recommendations[6] (see section 4 and Appendix 1),
c) the CNB's main indicator helping to determine the position of the Czech Republic in the financial cycle, the FCI (see section 4 and Appendix 2),
d) macrofinancial indicators and indicators specific to the banking sector aimed at determining the level of cyclical risks in the Czech Republic and the domestic banking sector's level of vulnerability (see section 4),
e) calculated benchmark CCyB rates for risk-weighted exposures in the Czech Republic based on the standardised gap referred to in point a) and the additional gap referred to in point b) (see Appendix 1),
f) calculated CCyB guide rates for risk-weighted exposures in the Czech Republic based on CNB methods reflecting the macrofinancial specificities of the Czech Republic (see section 5).

In the course a comprehensive assessment encompassing the economic outlook and the configuration of economic policies in the Czech Republic and abroad, the CNB also takes into account risk-weighted exposures in the Czech Republic and the results of its macro-stress tests[7] when setting the CCyB rate.

The CNB sets the CCyB rate for risk-weighted exposures in the Czech **Republic between 0% and 2.5%**, calibrated **in multiples of 0.25 pp**. All institutions in EU Member States are required to use this rate in this case. In extraordinary cases also justified by items a) to f), **the CNB may set a rate in excess of 2.5%**. Institutions supervised by the CNB must abide by this rate, whereas institutions with exposures in the Czech Republic supervised by an authority of another EU Member State must in this case follow the instructions of their designated authority.

In the event of an **increase in the CCyB rate** (see section 5.1), institutions are obliged to start applying the new CCyB rate usually **one year after the date of issue of the decision** (see section 6). In exceptional cases, the CNB may shorten this period. In the event of a decision to **lower the CCyB rate** (see section 5.2), institutions may start to apply the new rate **on the date of**

4 For the calculation of the total risk exposure amount, see Article 92(3) of Directive (EU) No 575/2013 (CRR).
5 BCBS (2010): Basel III: A global regulatory framework for more resilient banks and banking systems, BCBS (2010): Guidance for national authorities operating the countercyclical capital buffer.
6 ESRB recommendation on guidance for setting countercyclical capital buffer rates (ESRB/2014/1), part B, paragraph 2.
7 https://www.cnb.cz/en/financial-stability/stress-testing/

issue of the decision. In the event of a decrease in the CCyB rate, the CNB will determine and state in its decision an indicative period during which no increase in the CCyB rate is expected.

The CNB decides on the recognition of a CCyB rate for risk-weighted exposures to EU Member States which has been set in excess of 2.5% by the designated macroprudential authority of that country for institutions supervised by the CNB.[8] In the event of a decision not to recognise a rate in excess of the limit, the CNB will set the CCyB rate at 2.5% (see section 6).

The CNB decides on the CCyB rate or on the recognition of the CCyB rate for risk-weighted exposures in a non-Member State of the EU which has been set by the designated macroprudential authority of that non-Member State for institutions supervised by the CNB. Where the relevant authority of the non-Member State of the EU has not set a CCyB rate, or has set it lower than 2.5%, and the CNB evaluates the amount of credit provided in that non-Member State by institutions supervised by the CNB as risky, it can set a CCyB rate of up to 2.5%. Where the relevant authority of a non-Member State of the EU has set a CCyB rate in excess of 2.5%, the CNB proceeds in the same way as it does with EU Member States.

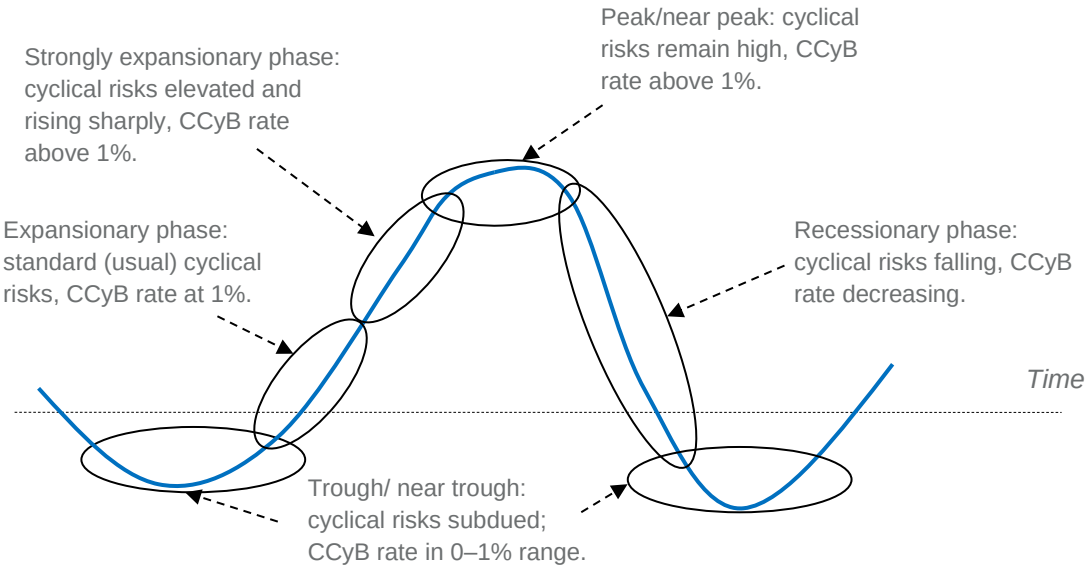
3. Evolution of cyclical risks over the financial cycle

For setting the CCyB rate for risk-weighted exposures in the Czech Republic, the CNB's basic starting point is to determine the current position of the Czech economy in the financial cycle. Similarly to the economic cycle, this cycle has an expansionary phase, a recessionary phase and turning points – a peak and a trough.[9] It is subsequently important to assign the expected evolution of cyclical risks to the identified position in the financial cycle and to estimate the size of those risks in institutions' balance sheets. In this sense, the size of cyclical risks can be described as subdued, standard, increased or decreasing (see Figure 1).

Subdued cyclical risks, in the sense of newly assumed risks and risks of low magnitude in institutions' balance sheets, are typical of times when the financial cycle is at or **close to its trough**. The relevant indicators (see section 4, Table 1) are below their long-term levels. The manifestations of recession/crisis are still visible, and credit demand and investors' appetite for financial risk remain very subdued. Prices of financial assets and property are no longer falling significantly and institutions' credit losses[10] are no longer rising sharply. Risk weights of exposures and the cost of capital[11] remain elevated and credit standards stringent. In this phase, the CNB expects **CCyB rates to be in the range of 0–1%.**

8 Up to a rate of 2.5%, reciprocity is automatic. Simply put, this means that up to this level, institutions supervised by the CNB automatically apply the CCyB rate for risk-weighted exposures in other EU Member States set by the designated authority of that Member State.
9 The financial cycle may at times follow an atypical course, with some of these phases either not occurring at all or lasting an unusually short or long time.
10 Credit losses are a cost item in the profit and loss account.
11 In the sense of market conditions affecting the costs of increasing capital in the form of retaining earnings, issuing new shares or changing the structure of portfolios.

Figure 1: Evolution of cyclical risks over the financial cycle



The standard (usual) amount of newly assumed **cyclical risks** and their size in institutions' balance sheets is typical of times when investment optimism is recovering and indicators are pointing to a clear shift of the **financial cycle into the expansionary phase**. Lending activity and prices of financial assets and property are increasing modestly, credit losses are usually no longer rising, credit standards are being relaxed slightly and institutions are generating reasonable profits. Risk weights of exposures and the cost of capital are no longer increasing and, given the falling probability of a renewed recession, may start to decline gradually. However, it may be hard for the CNB to assess the real level of growth in new cyclical risks and their size in the financial system in real time, as in this phase of the cycle the indicators (see section 4) or models may provide insufficiently robust or mixed signals of this growth. To ensure timely creation of the CCyB, and to avoid the need to make sharp changes to it in the future, the CNB applies the concept of the **standard CCyB rate**, which it has estimated at **1%** (see section 5.1).

The **strongly expansionary phase** of the financial cycle is characterised by an **elevated** amount of newly assumed **cyclical risks** and rapid accumulation of those risks in institutions' balance sheets. The financial cycle is heading steeply towards its peak. The relevant indicators are at above-average levels. In this phase, credit growth and prices of financial assets and property are rising sharply against a backdrop of very relaxed financial conditions. Investors have a very optimistic view of the amount of risk being taken. Credit losses, risk weights of exposures and the cost of capital are declining steadily, nearing or reaching long-term lows. In this phase, the CNB expects to **raise the CCyB rate above 1%, to as high as 2.5**% (see section 5.1) or even higher in exceptional cases.

At or around the peak, the amount of newly assumed cyclical risks stagnates or gradually decreases and their growth in institutions' balance sheets gradually slows or stops. Some forward-looking indicators (such as credit growth, asset/property prices and risk weights of some types of exposures) may be signalling a turnaround in the financial cycle. However, the **size of cyclical risks** in balance sheets **remains elevated**. In this situation, the CNB does not expect to change the CCyB rate.

The recessionary phase of the financial cycle is typified by a **decrease in cyclical risks** previously assumed in institutions' balance sheets**.** The first signs of a turnaround in the financial cycle are apparent primarily in market indicators (see Appendix 4). In the recessionary phase of the financial cycle, prices of financial assets and property tend to stagnate or fall, financial conditions become tighter, investors are pessimistic about the level of risk, credit growth slows, and cyclical risk materialisation, loan defaults and institutions' losses increase gradually. Risk weights of exposures and the cost of capital stop falling sharply and, given the growing probability of a recession, may start increasing gradually. In this phase, CNB expects to **lower the CCyB rate**. Depending on the depth of the economic slowdown, **the buffer may be released completely and the rate set at 0%** (see section 5.2). This decision requires signals of **materialisation of previously assumed cyclical risks** directly affecting the **supply of credit to the real economy.**

4. Indicators used to determine cyclical risks and the resilience of the financial system

When deciding on the CCyB rate, the CNB assesses a series of indicators that should provide a guide to when the CCyB rate should be raised, maintained or lowered, or the buffer fully released. These are mostly macro-financial indicators used to determine the position of the Czech Republic in the phase of the financial cycle (see section 3) so that systemic cyclical risks can be estimated, and banking sector-specific indicators used to monitor the sector's vulnerability/resilience. These indicators help estimate whether the capital buffers are sufficient to cover losses stemming from the materialisation of cyclical risks.

The CNB selects suitable indicators in accordance with ESRB recommendations,[12] among other things. The ESRB recommends calculating for each quarter the credit-to-GDP gap estimated using the HP filter based on the BCBS/ESRB methodology. The Czech Republic, however, is a country where the calculated gap does not provide a reliable signal for identifying the emergence of systemic cyclical risks (see Appendix 1). For these reasons, the CNB, in accordance with ESRB guidance, calculates the gap using an alternative method (the expansionary credit gap[13]). The signalling potential of the alternative gap is higher, but it still does not sufficiently reflect the credit cycle and the risks of excessive credit expansion in the Czech Republic. Based on empirical

12 ESRB recommendation on guidance for setting countercyclical capital buffer rates (ESRB/2014/1).
13 Hájek, J., Frait, J., Plašil, M. (2017): The countercyclical capital buffer in the Czech Republic, CNB thematic article.

findings and ESRB recommendations, the CNB uses additional indicators (see Table 1) that complement the above-mentioned gaps and have a greater ability to track the evolution of cyclical risks in the Czech Republic.

Table 1: Main indicators/tools used by the CNB in setting the CCyB rate

Type	Indicators	Note	Data frequency
Macrofinancial indicators	Financial Cycle Indicator (FCI)	Composite indicator: evolution of new loans, changes in property price index, debt sustainability, lending conditions, PX stock index, adjusted current account to GDP ratio; see Appendix 2	Q
	Credit growth	Growth in loan stock and new loans	M
	Financial conditions	Difference between interest rates on new loans and inflation/nominal income growth	M and Q
	Default rates for households and non-financial corporations	Newly defaulted exposures in next 12 months/non-default loans	M and Q
	Property price overvaluation	The CNB estimates overvaluation using two approaches: prudential and valuation-based; see Plašil, M., Andrle, M. (2018): Assessing house price sustainability	Q
	Composite Indicator of Systemic Stress CISS	Market data: money market, equity market, government bond market, foreign exchange market, financial intermediation; see Appendix 4	D
Banking sector-specific indicators	Capital structure and capital ratio	Classed into Pillar 1 and Pillar 2, SRB, CCoB, CCyB, voluntary surplus	Q
	Evolution of capital ratio	Sensitivity analysis of change in demand/capital ratio to capital given use of standardised approach (STA) and internal ratings based (IRB) approach by banks	Q
	IRB risk weights and their evolution		Q
	Margins on loan stock/provisions per unit of credit	Vulnerability indicator indicating evolution of cyclical risks in banking sector; see Banking Prudence Indicators (BPI), Pfeifer, L., Hodula, M.: A profit-to-provisioning approach to setting the countercyclical capital buffer: The Czech example	M
	(Margins on loan stock/provisions per credit unit)*(credit/capital excluding CCyB)	Banking sector vulnerability indicator additionally taking into account financial leverage and CCyB rate; see: Banking Prudence Indicators (BPI), Pfeifer, L., Hodula, M.: A profit-to-provisioning approach to setting the countercyclical capital buffer: The Czech example	Q
	Evolution of provisioning	Ratio of provisions to stock of loans, expected credit losses	M
	Asset quality	Banking sector credit losses, shares of S1, S2, S3 assets in credit portfolio, change in asset structure over time	M
	Prudential estimate of unexpected credit losses	Model approach, see Appendix 3	Q
	Structure and evolution of profit	Net interest income excluding income on excess liquidity, return on assets, after-tax profit in absolute terms	M
	Capital capacity for lending	Credit to private non-financial sector potentially provided from difference between total capital and capital requirement	Q
	Indication of demand and supply constraints according to BLS		Q
Others	Stress test results	Stress tests of banks, households, non-financial corporations, insurance companies, pension companies, investment funds, public finances	H (banks, households, non-financial corporations), Y (others)
	Other policy tools		

Source: CNB
Note: D daily, M monthly, Q quarterly, H half-yearly, Y yearly

The **composite financial cycle indicator (FCI) plays an important role** in determining the position of the Czech economy in the financial cycle. The FCI was created in order to measure the accumulation of risks in the financial sector and to provide an early warning (6–8 quarters ahead) signal of the potential materialisation of such risks. The FCI includes subindicators covering a wide range of demand and supply factors which, according to earlier studies and the CNB's expert judgement, well characterise the cyclical swings in financial risk perceptions. Decomposing the FCI into individual factors allows the CNB to identify the determinants of the current evolution of the composite indicator (see Appendix 2).

Another indicator monitored is the dynamics of bank loans with respect to both the stock (overall amounts) and flows (new business) of credit. The **dynamics of the stock of loans** provide information on the evolution of overall leverage, while the **dynamics of new loans** indicate current tendencies in risk-taking by households and non-financial corporations. Long-term averages and past values from periods assessed in retrospect as upper limits are used as benchmarks for evaluating whether credit growth is excessive. To assess the dynamics of the stock of loans, the year-on-year rate of growth is complemented by the year-on-year changes in absolute amounts in order to eliminate the low base effect. Absolute amounts are used in particular when assessing new bank loans.

In addition to credit dynamics, the CNB pays attention to **property market indicators**. Besides the annual rate of growth of property prices, it estimates their over/under-valuation and sustainability relative to economic fundamentals.[14] Furthermore, the CNB focuses on **indicators of indebtedness of economic sectors, external imbalances** and lending conditions and credit standards.[15]

Another accompanying feature of the different phases of the financial cycle is the evolution of the banking sector's vulnerability due to procyclical **provisioning** (expected losses, ratio of provisions to stock of loans, BPI) and the procyclical behaviour of **risk weights**.[16] The CNB also uses other primary indicators to decide on whether to maintain or lower the CCyB rate. Empirical findings indicate that market indicators have some forward-looking ability to signal the future materialisation of risks in a timely fashion. As representative of this category (and based on ESRB recommendations), the CNB uses the **Composite Indicator of Systemic Stress – CISS** (see Appendix 4). When deciding on the level and rate of release of the CCyB, the CNB monitors the materialisation of cyclical risks (in particular credit risk, i.e. asset quality and in particular **credit losses**, which feeds through to the mechanism for absorbing credit losses through **profit** and **capital**). To indicate the possible constraint on the supply of credit by the capital requirement in the recessionary phase of the financial cycle, the CNB uses the **Capital Lending Capacity Indicator** (see section 5.2) and supplementary information on the evolution of lending conditions and credit standards.

14 The CNB uses two model-based approaches to assess house price sustainability; see Plašil, M., Andrle, M. (2018): Assessing house price sustainability, CNB thematic article.
15 More information in this area is provided by the BLS: https://www.cnb.cz/en/statistics/bank-lending-survey/.
16 Risk-weighted portfolios under the IRB approach. At the aggregate level, the CNB typically registers a decrease (increase) in risk weights and a resulting lower (higher) amount of risk-weighted assets during the expansionary (recessionary) phase of the financial cycle.

The CNB regularly evaluates the predictive ability of the above indicators and recalibrates the relationships in the models it uses. The option of creating new indicators or refining the models themselves is not neglected either.

5. Calibration of the CCyB rate for risk-weighted exposures in the Czech Republic

The methodology for setting the CCyB rate was formulated by the BCBS and subsequently introduced into EU regulatory practice through the CRD IV directive and its transposition into Czech law. The framework was further developed by the ESRB. Under this methodology, a **benchmark CCyB rate** is set using the deviation of the credit-to-GDP ratio from its long-term trend (the credit-to-GDP gap) based on the HP filter (see section 4). The benchmark CCyB rate calculated in accordance with this methodology is not suitable for the Czech Republic (see Appendix 1) and for the CNB it represents merely a starting point for a more comprehensive evaluation. The alternative gap (see section 4) also does not imply a CCyB rate taking sufficient account of the manifestations of cyclical risks in the Czech Republic. The CNB therefore likewise considers the rate based on the alternative gap as only a very rough guide. **The CNB sets the CCyB rate using its own approach (see Figure 1)** taking into account a **series of indicators** reflecting the specificities of the Czech Republic in the area of systemic cyclical risks, in accordance with ESRB recommendations (see section 4).

5.1 The CCyB rate-increasing process

The CNB increases the CCyB rate in the expansionary phase of the financial cycle.

The standard CCyB rate[17]

In deciding on the CCyB rate in the expansionary phase of the financial cycle when the amount of new cyclical risks and their size in institutions' balance sheets are at standard levels, CNB uses **the standard rate concept.** Under this concept, the CNB gives greater weight to historical experience and patterns observed in the past. The application of this concept has no direct effect on the CCyB rate attained at the peak of the financial cycle; it merely represents a different **distribution of the creation of the buffer over time.**

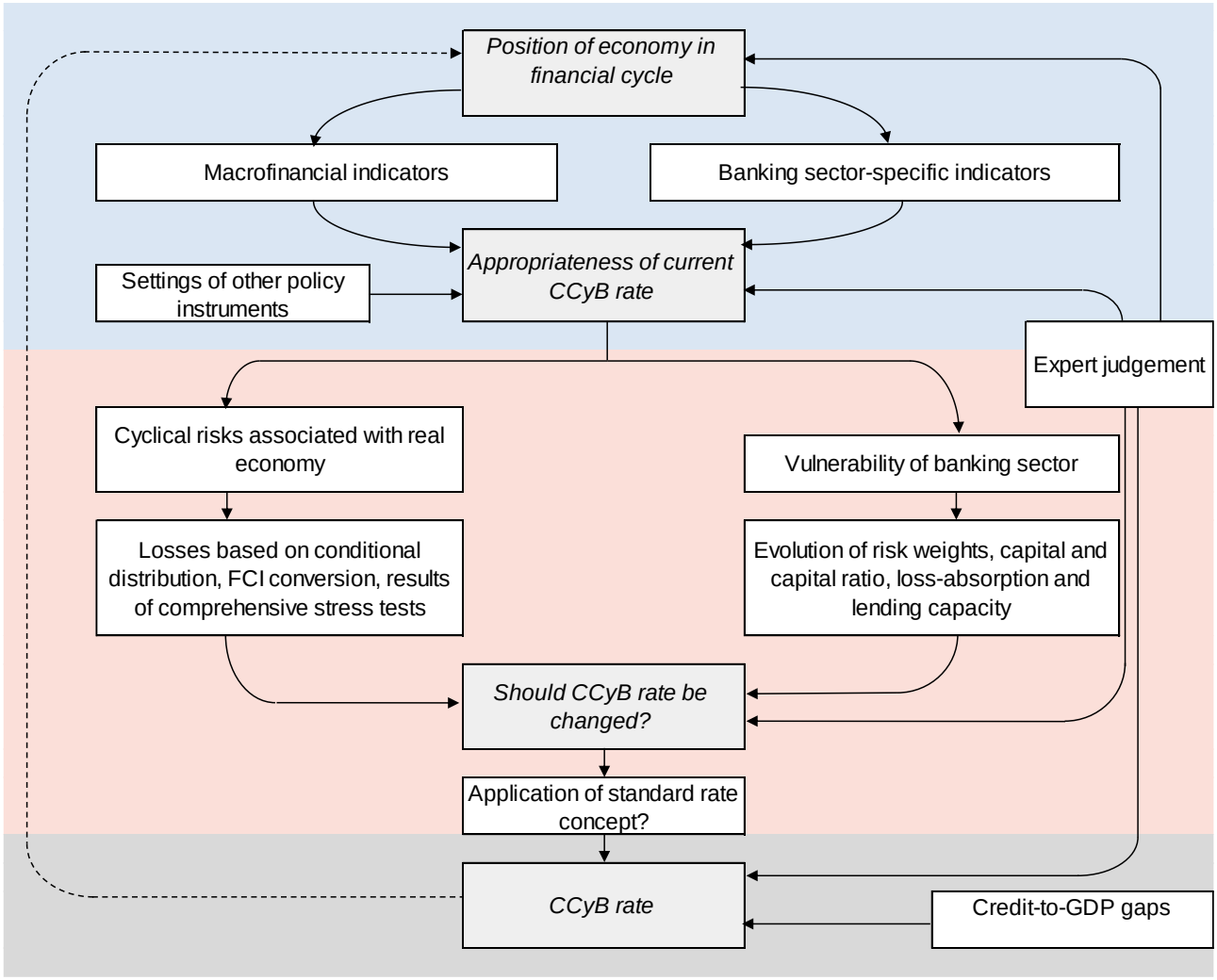
The CNB uses two approaches to calibrate the optimum CCyB rate. The first is based on the sustainable rate of credit growth in the Czech Republic and the second on the conversion of FCI values (see section 4 and Appendix 2). The results of both approaches indicate a need to set the **standard CCyB rate in the Czech Republic at 1%.**

The first approach helps the CNB to **decide when to start creating the CCyB.** Under this approach, a situation where growth in ratio of the stock of credit to nominal GDP is around 4% – assuming a long-term annual nominal GDP growth rate of 4.5% – is identified as the usual level of cyclical risks in institutions' balance sheets (this rate of growth corresponds to a situation where the Czech economy

17 Plašil, M. (2019): The countercyclical capital buffer rate for covering the usual level of cyclical risks in the Czech Republic, CNB thematic article.

is operating close to its potential). The CNB expects to start considering raising the CCyB rate to 1% when growth in the stock of loans nears this level.[18]

Diagram 1: The CNB's approach to setting the CCyB rate



Source: CNB

The second approach helps the CNB **decide on the pace of increase of the CCyB rate** in this period. It is based on the method used as a tentative guide to setting the CCyB rate based on the values of the composite FCI (see section 4 and Appendix 2). In this method, the CNB assumes that the usual level of cyclical risks in balance sheets corresponds to the historical median of the sub-indicators entering the composite FCI calculation. The CNB regularly evaluates the **relationship between the FCI values and the CCyB rate** and publishes a **conversion table** semi-annually (see

18 In 2018, the rate of growth in the ratio of the stock of loans provided to the private, non-financial sector to nominal GDP of 4% corresponded to roughly CZK 40–50 billion.

Appendix 2 and section 6). In the conversion table, a CCyB rate close to 1% corresponds to the situation where cyclical risks are at their usual levels. Experience from the previous two financial cycles shows that the period between starting to create the CCyB and reaching the FCI values corresponding to a standard rate of 1% lasts around eight quarters. This corresponds to a **pace of increase of the CCyB rate of 0.5 pp a year.**

The CCyB rate in the strongly expansionary phase

The CNB uses two approaches to setting the CCyB rate during the strongly expansionary phase of the financial cycle.

The first approach to setting the CCyB rate – used as a guide – is based on the **FCI** (see section 4), and specifically on the conversion table between FCI values and CCyB rates (see Appendix 2). The conversion is non-linear, so the bands of FCI values are not necessarily of the same width for all the rates, and it does not hold that an increase in the FCI values leads to a proportional change in the CCyB rate. As a result of changes in the overall range of the FCI values, the CNB recalibrates the intervals implying a specific CCyB rate every quarter. The CNB publishes the current conversion table semi-annually (see section 6).

The CNB's second, formal, approach to setting the CCyB rate is based on the premise that the CCyB level should cover potential unexpected credit losses related to the cyclical risks the banking sector may face in the event of a future shock. As the probability of occurrence and severity of a shock varies over the financial cycle, **the CNB uses a conditional probability distribution to estimate potential unexpected losses**.[19] In the case of the conditional distribution, the risk of a crisis – and hence also the probability of greater cumulative losses in future – steadily increases as the economy moves into the strongly expansionary phase of the cycle. To estimate the size of the cumulative credit losses over a two-year time period, the CNB applies the principles of macro-stress testing. A large number of alternative paths (scenarios) are simulated for the stress test input variables, and the corresponding cumulative credit loss is calculated for each path. An empirical estimate of the probability distribution is then obtained by summarising these losses. The distribution is constructed in such a way that the expected size of the losses (the median of the distribution) always matches the losses in the most likely economic scenario (the CNB's forecast). Based on the distribution obtained, the CNB determines the size of the potential unexpected losses as the difference between the 99% quantile and the median. It then compares this difference with the currently applicable CCyB rate. This choice reflects the CNB's preference to cover even relatively unlikely losses with the countercyclical buffer (see Appendix 3).

The conditional loss distribution and FCI conversion approach primarily provides information on the absolute size of the institution's potential credit losses, but **does not cover** aspects of the financial cycle related to change in **institutions' vulnerability**. These aspects include cyclically

19 This estimate relates to loan impairment losses.

low provisioning and declining risk weights. When deciding on the CCyB rate, it is necessary to take into account both the potential size of credit losses and institutions' vulnerability. The CNB determines the need to raise the CCyB rate due to cyclically lowered risk weights based on the model-implied evolution of non-financial private sector risk weights in a strongly adverse economic scenario. This method uses simulated PD and LGD values obtained from the calculation of the conditional probability distribution of credit losses (the 99% quantile of the probability distribution) and substitutes them into the regulatory formulas for the derivation of risk weights. Using the risks weights obtained in this way, a hypothetical risk-weighted exposure corresponding to the developments in the simulated adverse scenario is calculated. **The need to raise the CCyB rate** associated with the cyclical decline in risk weights is then derived from the difference between the actual capital requirement and the capital requirement calculated from the hypothetical risk exposure. The difference between these two capital requirements is expressed in relation to the current level of risk-weighted assets. This gives us the CCyB which should cover the decrease in the capital requirement as the risk weights cyclically increase in an extremely adverse scenario.

The resulting CCyB rate is then equal to the simple sum of the estimated unexpected losses from the conditional distribution and the possible increase in risk weights.

5.2 The CCyB rate-reducing process[20]

The CNB begins to consider lowering the CCyB rate when the Czech economy is in the recessionary phase of the financial cycle.[21] This position of the economy is a necessary but not sufficient condition for starting to lower the CCyB rate. The process of **lowering the CCyB rate** is linked with a **decline in the size of cyclical risks in institutions' balance sheets.** When deciding whether to lower the CCyB rate, the CNB primarily assesses if and how **cyclical risks (mainly credit risks) are decreasing** in institutions' balance sheets. While doing so, it **continuously** evaluates the impacts of the decline on **capital** and the intensity of their materialisation. The speed, extent and timing of lowering the CCyB rate is based on this evaluation.

The CNB regards a clear decrease in the amount of cyclical risks (in particular credit risks) in institutions' balance sheets as representing the **occurrence of systemic losses**,[22] which will be manifested in a decrease in capitalisation. In addition to an absolute decrease in institutions' capital, a decrease in the capital ratio is interpreted as a decrease in capitalisation. This situation usually corresponds to a severe recession (or even a financial crisis), with economic sentiment deteriorating sharply in both the real economy and the financial sector. The increasing default rate, loss realisation and overly pessimistic expectations of institutions are reflected, with a lag, in **growth in risk weights** and risk-weighted assets. In this case, the release of the CCyB is intended

20 Brož, V., Holub, L., Konečný, T. a Pfeifer, L. (2020): The CNB's approach to releasing the countercyclical capital buffer, thematic article (forthcoming).
21 This phase usually includes the period of stress referred to in EU legislation in connection with the CCyB.
22 For the purposes of setting of the CCyB rate, the CNB regards losses of at least 0.25% of the total risk-weighted exposures of institutions as being systemic losses. Under the legislation, this is the smallest part of the CCyB the CNB can release.

to absorb the observed losses.[23] Depending on the amount of those losses, the **CCyB rate** can be lowered all the way to **0%.**

A decline in the capital ratio causes banks' **capital capacity for lending** to the sound part of the real economy to fall. This is undesirable from an economic policy point of view, especially in the recessionary phase of the business cycle, as it may also give rise a long-term shortfall in the supply of credit to viable projects. The CNB measures the adequacy of the capital capacity for lending using the amount of additional credit that can be provided from capital in excess of the capital requirements. The CNB finds the **capital capacity** for lending to be sufficient if it **covers at least an annual rate of growth in the credit to nominal GDP ratio of around 4%** (see section 5.1, The standard CCyB rate). If the CNB evaluates the capacity as insufficient, it is prepared to release the CCyB so that the credit supply does not become constrained.

The CNB may also lower the CCyB rate even in cases where cyclical risks are disappearing naturally from balance sheets and systemic losses are not occurring and/or the available lending capacity is sufficient. This situation may arise during a shallow recession or economic slowdown when the accumulation of cyclical risks slows or stops and the observed macro-financial situation is indicating a significant decrease in the probability of another sudden and significant economic downturn. In most cases, the non-financial sector is able to continue servicing its loans thanks to its financial reserves and relatively low stress levels. This naturally reduces the cyclical risk in institutions' balance sheets and the need for CCyB coverage. The observed credit losses are relatively low and are usually absorbed to a sufficient degree by institutions' profits. The CNB does not expect the CCyB rate-reducing process to be dramatic and rapid in cases where cyclical risks are disappearing naturally from institutions' balance sheets. It also does not expect the CCyB buffer to be released in full. The CCyB rate is likely to be lowered gradually to its standard level of 1% (see section 5.1).[24]

As regards timing, in the absence of a clear signal to lower the CCyB rate in the form of systemic credit losses, there is a need to be cautious and to rely more on comprehensive evaluations and analyses when making decisions. For these reasons, when deciding whether to lower the CCyB rate, the CNB will take into account the following in its quantitative approaches:

a) the evolution of the FCI (see sections 4 and 5.1) and the conversion table between FCI bands and the CCyB rate (see Appendix 2),
b) the formal approach based on estimating potential unexpected losses conditional on the probability distribution (see section 5.1 and Appendix 3),
c) macro-stress test results.

23 Provided that institutions' capitalisation for the intended purposes is maintained, the CNB is also ready to release the CCyB in cases where systemic losses have not occurred but are highly likely to occur in the near future.
24 It is appropriate to maintain a certain buffer in case the remaining credit risks in institutions' balance sheets materialise or the economic conditions change unexpectedly. Another reason is some caution on the part of the CNB to avoid undesirable fluctuations in institutions' capital. For each CCyB rate reduction, the CNB is obliged to give a guide period during which it expects no increase in the rate (see section 2).

6. Communications

The CNB sets the CCyB rate for risk-weighted exposures in the Czech Republic on a quarterly basis and discloses the rate in a **press release.** The rate becomes legally binding on institutions on the publication of a Provision of a general nature on setting the countercyclical capital buffer rate, which the CNB announces in a manner enabling remote access. At the same time, for easier traceability of past decisions and their justifications, the history of provisions issued is available on the CNB website under Financial stability – Macroprudential policy – Countercyclical capital buffer. The text of the provision contains an evaluation of the current situation and the values of the key indicators used in making the decision. The CNB publishes more detailed analyses underlying its CCyB rate decisions semi-annually in its financial stability publications.

The CNB's decision on the level or recognition of the CCyB rate for risk-weighted exposures in other countries for institutions supervised by the CNB is issued by means of provisions of a general nature published on the CNB website, again under Financial stability – Macroprudential policy – Countercyclical capital buffer.

Appendix 1: Credit-to-GDP gap

The deviation of the credit-to-GDP ratio from its long-term trend – the credit-to-GDP gap – is the most widely used indicator for determining the position of the economy in the financial cycle. An increasing positive gap indicates excessively rapid credit growth with respect to the potential of the economy and the accumulation of systemic cyclical risks. Empirical studies[25] show that, for many countries, this gap has good signalling properties for identifying an impending financial crisis. For this reason, the size of the gap was chosen by the BCBS[26] as the starting point for determining the optimal CCyB rate and subsequently became part of European law (Article 136(2) CRD). The ESRB also assessed the credit-to-GDP gap as an appropriate indicator of the financial cycle and, in a 2014 recommendation,[27] required Member States to publish its value quarterly. In its financial stability publications, the CNB regularly emphasises that this approach does not provide a suitable guide to determining the position of the Czech economy in the financial cycle or the optimal CCyB rate. Recent ESRB documents have also pointed out some of its shortcomings,[28] in particular the insufficient ability of the basic methodology to indicate the true level of cyclical risks after a long period of credit expansion or in converging economies. The following paragraphs of this appendix summarise the key weaknesses of this indicator.

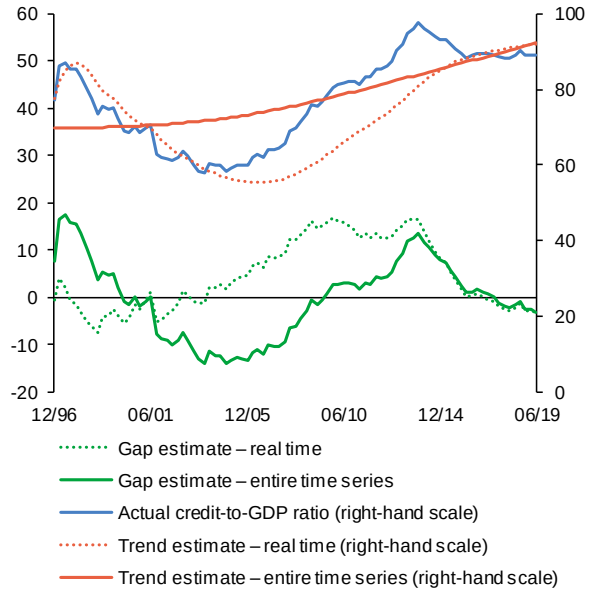
In the basic methodology, the trend of the credit-to-GDP ratio is estimated using an HP filter with a smoothing parameter (lambda) of 400,000. The advantage of this approach is that it is easy to apply. However, the weak link of the HP filter to economic theory and the excessive construction simplicity give rise to both statistical and economic issues.

From the statistical perspective, the significant revisions that are made to the estimate of the credit-to-GDP gap at the end of the time series as new observations arise are particularly problematic in practice. The size of the deviation from the estimated trend in real time is thus subject to significant uncertainty.[29] The behaviour of the gap calculated according to the BCBS methodology based on the available data sample is illustrated for the Czech case in Chart 1.[30] It shows the trend estimate made with knowledge of the entire time series and the trend estimate based solely on the data available up to the given quarter (in real time). Estimated in real time, the gap implying the level of the rate was positive from the start of 2004 until the end of 2016, despite the occurrence of recessions in 2009 and 2013–2014 and an observed credit contraction. The real-time gap would

25 See, for example, Drehmann, M., Juselius, J. (2014): Evaluating early warning indicators of banking crises: Satisfying policy requirements, International Journal of Forecasting, 30(3), pp. 759–780, and Drehmann, M., Yetman, J. (2018): Why you should use the Hodrick-Prescott filter – at least to generate credit gaps, BIS WP 744.
26 BCBS (2010): Countercyclical capital buffer proposal, consultative document.
27 ESRB (2014): Recommendation on guidance for setting countercyclical buffer rates.
28 Buch, C., Vogel, E., Weigert, B. (2018): Evaluating macroprudential policies, ESRB WP Series 76.
29 The HP filter can be expressed in state-space form, which implies specific structural assumptions for the trend and cyclical components of the time series (see, for example, Harvey, A., Trimburt, T. (2008): Trend estimation and the Hodrick-Prescott filter, Journal of Japan Statistic Society, 38(1), pp. 41–49, and Harvey, A. (1989): Forecasting, structural time series models and the Kalman filter, Cambridge University Press), assumptions which are not met for typical macroeconomic series. The reasons for the significant revisions are also clear from the implied weights assigned to the individual observations at the end of the time series.
30 Data for previous periods may also revised as new observations arrive. These revisions also have an effect on the estimated gap. In the illustrative example, however, we abstract from them and use the currently available revised data for the calculation.

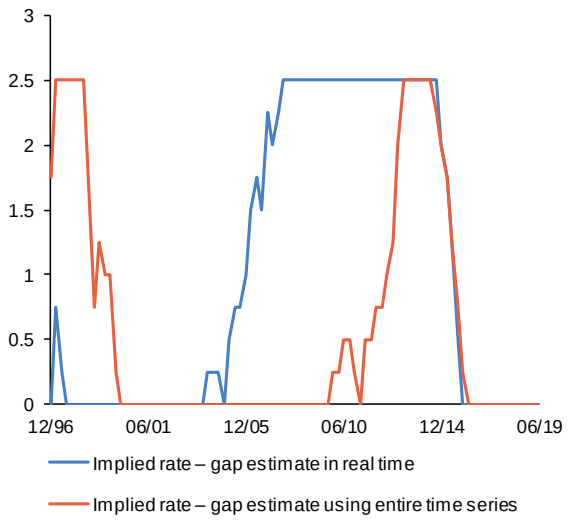
have implied a CCyB rate of 2.5% for most of the period. The gap obtained with knowledge of the entire time series, however, also fails to provide intuitive and economically plausible results.

Chart 1: Comparison of the trend and gap estimated on the basis of the entire time series with the estimate made in real time
(% of GDP)



Source: CNB, CZSO
Note: The estimate does not take into account data revisions over time, and the latest available time series is used.

Chart 2: Comparison of the CCyB rate implied by the credit gap using calculations based on the entire time series and in real time
(% of total risk-weighted exposure)

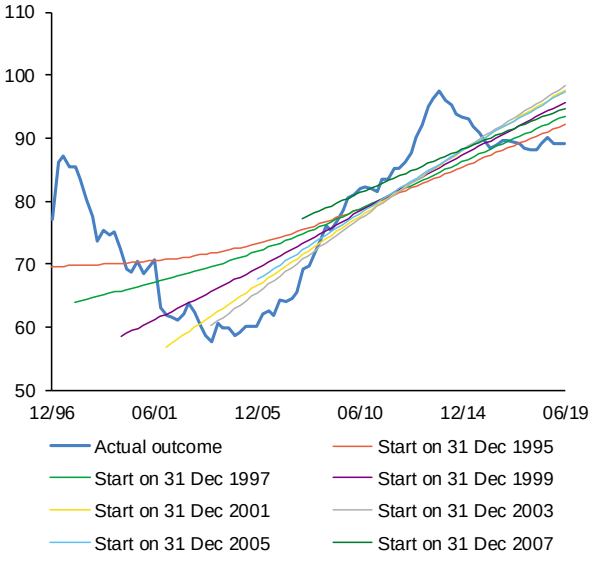


Source: CNB
Note: The implied rate does not take into account data revisions over time, and the latest available time series is used.

Long time series are needed in order to obtain economically meaningful results using the HP filter. Given the chosen smoothing parameter, it is recommended to completely drop from the assessment the size of the estimated gap in the first at least 15–20 years, as the results strongly depend on the cyclical position of the economy at the starting point of the time series.[31] In the case of short time series, the method gives a completely different picture of the cyclical risks observed above depending on the chosen starting date of the analysis. Given that data for the Czech Republic are only available from 1995 and that structural breaks are present in the first half of the time series, increased variability in the results continues to be observed depending on the specific choice of starting date (see Chart 3).[32]

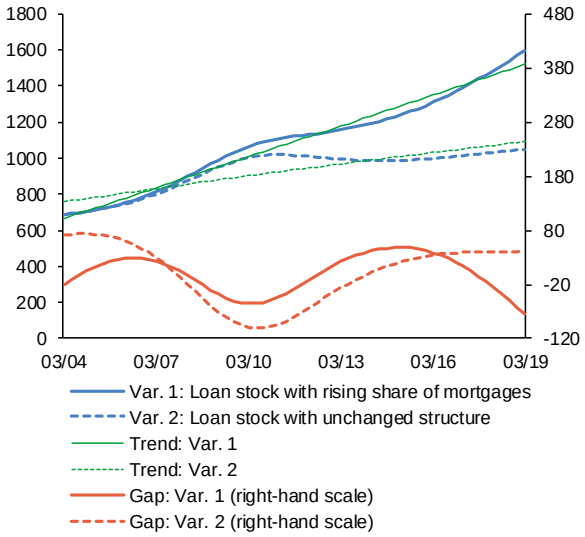
31 See, for example, Drehmann, M., Tsatsaronis, K. (2014): The credit-to-GDP gap and countercyclical capital buffers: Questions and answers, BIS Quarterly Review, and Plašil, M., Seidler, J., Hlaváč, P. (2016): A new measure of the financial cycle: Application to the Czech Republic, Eastern European Economics, 54(4), pp. 296–318.
32 The structural breaks are related, among other things, to the 1997 currency and banking crisis, when bad loans were transferred from the banking sector's balance sheets to the Czech Consolidation Agency until 2004. The clean-up of banking sector balance sheets caused a significant decrease that did not reflect a credit contraction.

Chart 3: Effect of the choice of starting date on the trend component estimate
(% of GDP)



Source: CNB
Note: Estimate using the entire time series.

Chart 4: Effect of changes in loan portfolio structure on the stock of loans and the size of the corresponding gap
(CZK billions)



Source: CNB
Note: The illustrative example assumes the same initial loan stock and the same amount of new loans in all quarters for both variants, but a gradual change in loan portfolio structure towards long-term debt (mortgage loans). The loan structure at the start and end of the time series corresponds to the actual ratio of corporate to household debt. The same fixed interest rate is used for loans to corporations and households over the entire time series.

The structural breaks in the Czech Republic are accompanied by a natural process of financial deepening, an increase in the share of economic agents with credit and, for example, by an overall change in the loan portfolio towards mortgage loans.[33] Because of its simplicity of construction, the HP filter does not distinguish between the effects of these changes and excessive lending and may misinterpret the natural part of the credit growth as being a result of the financial cycle (see Chart 4). The implicit property of the HP filter whereby its application to typical macroeconomic time series leads to a stationary deviation from the trend component is also problematic for convergence economies. This assumption may not be met, at least for converging economies, and the sustainable level of debt may be above the default level of private non-financial sector debt for an extended period in the initial years of convergence.[34]

The outcomes of the recommended methodology are also difficult to defend in some phases of the financial cycle. The time series of debt is a stock variable and changes only slowly over time. It

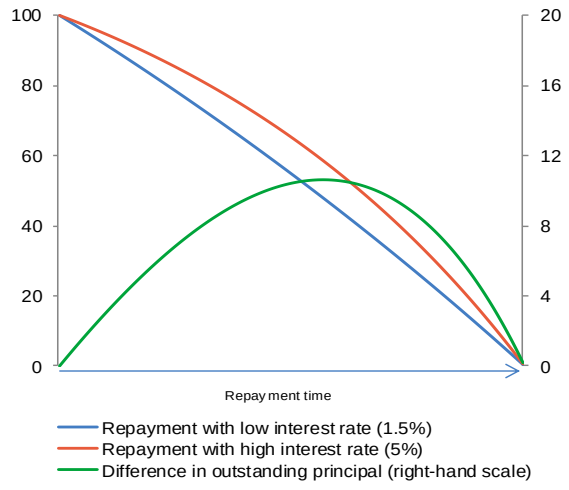
33 Mortgages are of a long-term nature and stay in banking sector balance sheets for longer. All other things being equal (with equally large volumes of new business), the pace of growth of the stock of credit/debt rises as the weight of mortgages in banks' loan portfolios increases.
34 Geršl, A., Seidler, J. (2011): Credit growth and capital buffers: Empirical evidence from Central and Eastern European countries, Research and Policy Note, CNB.

therefore takes quite some time for either a positive or negative gap to close, regardless of the current level of financial risks. As a result, the size of the gap cannot describe the cyclical risks immediately after the peak of the expansionary phase of the financial cycle occurs or after a deep recession has faded away, when new cyclical risks are already emerging, while the gap remains highly negative.

Besides the statistical shortcomings, one also needs to take into consideration the fact that the trend component estimated on the basis of the HP filter has no direct economic interpretation and does not take sufficient account of the structural characteristics of the economy. In the estimate of the long-term trend, it thus overlooks the effect of demographic factors, interest rates and the fact that the current level of debt is affected by the repayment of old debt in addition to new loans. The repayment profile and thus the evolution of the stock of loans in institutions' balance sheets is influenced both by past interest rates (see Chart 5) and by the specific path of loans granted in the past (see Chart 6). Abstracting from this effect may significantly distort the level of real cyclical risks in real time. The interest rate path not only affects debt repayment, but also has a direct impact on the evolution of sustainable debt over time. If nominal interest rates have been declining in the long term and their return to the former average is not guaranteed, this has an impact on the safe level of the debt that the private non-financial sector is able to service at a given level of income. A decrease in interest rates at a constant level of debt implies a lower ratio of debt servicing costs to income and hence generally more safely repayable debt.

Chart 5: Effect of different interest rate levels on the outstanding amount of loans over time

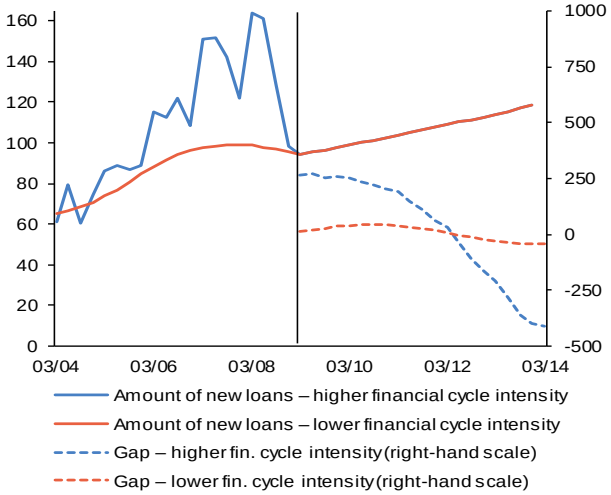
(%; right-hand scale: pp)



Source: CNB

Chart 6: Alternative path of new loans in the past and its effect on the size of the current gap

(three-month totals in CZK billions; right-hand scale: CZK billions)



Source: CNB

Note: In both variants, the stock of loans is the same at the moment when new loans continue along an identical path (separated by the vertical line).

Appendix 2: Financial Cycle Indicator

The composite financial cycle indicator (FCI) was designed to determine the extent of new cyclical risks, encompassing both supply and demand factors. The construction method is based on Holló et al. (2012).[35] The components of the indicator were selected on the basis of the results of empirical studies and expert judgement[36] and should cover the widest possible range of financial risks in the real economy. The FCI is composed of the following sub-indicators:

Credit growth: Excessive credit growth is one of the best explanatory variables for future problems in the financial sector.[37] In the expansionary phase of the financial cycle, the general optimism of consumers and firms is often accompanied by high quantities of lending. Lenders who are willing to lend to riskier clients may also suffer from short sightedness (Brandão–Marques et al., 2019[38]). Credit growth is represented in the FCI by the 12-month moving sum of new loans for the household sector and the non-financial corporations sector separately.

Property prices: The onset of financial crises is usually associated with sharp growth in property prices and the formation of a property market bubble.[39] High optimism and cheap financing can lead to property prices becoming overvalued and create a spiral between property prices and house purchase loans. The rapid return to equilibrium usually has a negative impact on banking sector balance sheets. The year-on-year change in the property price index published by the CZSO is used to capture the dynamics of the property market.

Debt sustainability: The ratio of household and corporate debt to disposable income/gross operating surplus has a tendency to grow in the expansionary phase of the financial cycle. In this phase, economic agents may incorrectly assess their future income situation and take on too much debt. If borrowers' income situation turns out worse than they expected, they will often become insolvent. In converging economies, including the Czech Republic, the relative debt level of the private sector is constantly rising, so falling risk aversion is measured using year-on-year changes, i.e. using the rate of growth of debt relative to income. Owing to the short time series available, total debt is proxied for now by bank loans only (which are currently the main source of external financing in the Czech Republic).

35 Holló, D., Kreimer, M., Lo Duca, M. (2012): CISS – A composite indicator of systemic stress in the financial system, ECB WP Series 1426
36 For more on the motivation for the selection of each indicator, see Plašil, M., Seidler, J., Hlaváč, P. (2016): A new measure of the financial cycle: Application to the Czech Republic, Eastern European Economics, 54(4), pp. 296–318.
37 See Drehmann, M., Borio, C., Tsatsaronis, K. (2012): Characterising the financial cycle: Don't lose sight of the medium term!, BIS WP 380, and Babecký, J., Havránek, T., Matějů, J., Rusnák, M., Šmídková, K., Vašíček, B. (2013): Indicators of crisis incidence: Evidence from developed countries, Journal of International Money and Finance 35(C), pp. 1–19.
38 Brandão-Marques, L., Chen, Q., Raddatz, C., Vandenbussche, J., Xie, P. (2019): The riskiness of credit allocation and financial stability, IMF WP.
39 This relationship is described in more detail by, for example, Giese, J., Andersen, H., Bush, O., Castro, C., Farag, M., Kapadia, S. (2013): The credit-to-GDP gap and complementary indicators for macroprudential policy: Evidence from the UK, mimeo, Drehmann, M., Borio, C., Tsatsaronis, K. (2012): Characterising the financial cycle: Don't lose sight of the medium term! BIS WP 380, and Rünstler, G., Vlekke, M. (2016): Business, housing and credit cycles, ECB WP Series 1915.

Lending conditions: Lending conditions characterise financial risk perceptions on the credit supply side. At times of heightened market optimism, banks encourage less creditworthy clients to borrow by relaxing their lending conditions through lower risk mark-ups on interest rates. At times of high risk aversion, by contrast, banks have a tendency to tighten their lending conditions too much and restrict the supply of credit to the sound part of the real economy. As the bank lending survey in the Czech Republic has too short a history,[40] the lending conditions are approximated using the difference between the interest rate on client loans (separately for households and non-financial corporations) and the three-month PRIBOR. This approximation relatively reliably reproduces the results of the euro area survey.[41]

Stock index: The stock index provides an overall picture of the current investment sentiment among market participants, although its evolution is linked primarily with the economic cycle.[42] The value of the PX stock index is included in the FCI.

Adjusted current account deficit-to-GDP ratio: The current account deficit indicates how much more is saved than invested in the economy. A negative current account thus implies imports of capital from abroad and may be a source of growth in imbalances and future problems repaying loans.[43] The current account deficit sub-indicator is further adjusted for the balance of reinvested earnings.[44]

To ensure that the input time series are mutually comparable, the components are first transformed into the interval (0, 1) using the kernel estimate of the distribution function,[45] where zero corresponds to the trough of the financial cycle and one to the peak. The aggregation of the sub-indicators into the FCI captures both the time dimension of risk and the cross-sectional dimension of risk (the correlations between all the sub-indicators). The time dimension of risk is given by the magnitude of the sub-indicators themselves. The time series have differing importance for the final FCI value. The weights of the sub-indicators were calibrated to best predict credit losses six quarters ahead (see Table 2[49]).

The evolution of the cross-sectional dimension of risk is represented by the time-varying correlations between the FCI input variables. The stronger are the correlations between them, the higher is the FCI and the stronger is the signal sent out about the overall nature of the observed cyclical risks.[46] This implies that the sub-indicators that show a strong positive correlation with each other have the strongest upward effect on the FCI. In the case of perfect correlation between all the input variables, the FCI would attain its highest possible value with respect to the values of the sub-indicators.

40 https://www.cnb.cz/en/statistics/bank-lending-survey/
41 Plašil, M., Radkovský, Š., Řežábek, P. (2013): Modelling bank loans to non-financial corporations, CNB thematic article.
42 Borio, C. (2012): The financial cycle and macroeconomics: What have we learnt? BIS WP 395.
43 Especially when the investment is financed by portfolio investment of a short-term, speculative nature.
44 Plašil, M., Seidler, J., Hlaváč, P. (2016): A new measure of the financial cycle: Application to the Czech Republic, Eastern European Economics, 54(4), p. 296–318.
45 The source method described in Holló, D., Kremer, M., Duca, M. L. (2012). CISS – A composite indicator of systemic stress in the financial system, ECB WP No. 1426, works with a simple estimate of the empirical distribution function.
46 This property is useful for setting the CCyB, which is a broad tool and should respond to general growth in optimism and risk-taking in the economy.

Table 2: FCI input variables

Variable name	Weights in FCI	Data source
12-month moving sum of loans to households	35%	CNB
12-month moving sum of loans to non-financial corporations	27%	CNB
Property price inflation	9%	CZSO
Debt growth/disposable income of households	8%	CNB, CZSO
Debt growth/operating surplus of firms	7%	CNB, CZSO
Interest rate spread for households	5%	CNB
Interest rate spread for firms	5%	CNB
PX index	2%	PSE
Adjusted current account deficit/GDP	2%	CNB, CZSO

Source: CNB

The CNB uses the FCI when considering the level of the CCyB rate. Table 3 shows the indicative relationship between the FCI values and the CCyB rate. The presented relationship can be formally derived by adopting a set of assumptions, two of which exert a decisive influence on it. The first is that the maximum observed FCI value from the peak of the previous cycle in mid-2008 corresponds to a rate of 2.5%.[47] The second is that the median of the sub-indicators entering the FCI calculation corresponds to a kind of "equilibrium" situation where the financial cycle is not significantly subdued and significant cyclical risks are not being taken. The FCI is constructed using a quadratic system of weights,[48] so the conversion between FCI values and the CCyB rate is non-linear. A consequence of this property is that the bands of FCI values are not necessarily of the same width for all the rates, and it does not hold that an increase in the FCI values leads to a proportional change in the rate. The conversion of the FCI value into the CCyB rate should be taken as a guide, and other aspects of the economic environment should also be taken into account in setting the rate itself. As of the second quarter of 2019, for example, an FCI of 0.15 implied a CCyB rate of 1% using the conversion table (see Table 3).

Table 3: Conversion table between FCI values and the CCyB rate

Range of FCI values		CCyB rate
from	to	
0	0.09	0.00%
0.09	0.11	0.25%
0.11	0.12	0.50%
0.12	0.15	0.75%
0.15	0.17	1.00%
0.17	0.19	1.25%
0.19	0.22	1.50%
0.22	0.26	1.75%
0.26	0.29	2.00%
0.29	0.33	2.25%
0.33	1	2.50%

47 With the benefit of hindsight, it can be said that in the Czech economy, as in many other developed countries, the financial expansion that occurred just before the start of the global financial crisis was so strong that if the CCyB had been available as a macroprudential policy instrument, it would have required the setting of the "upper-bound" rate of 2.5% at least.

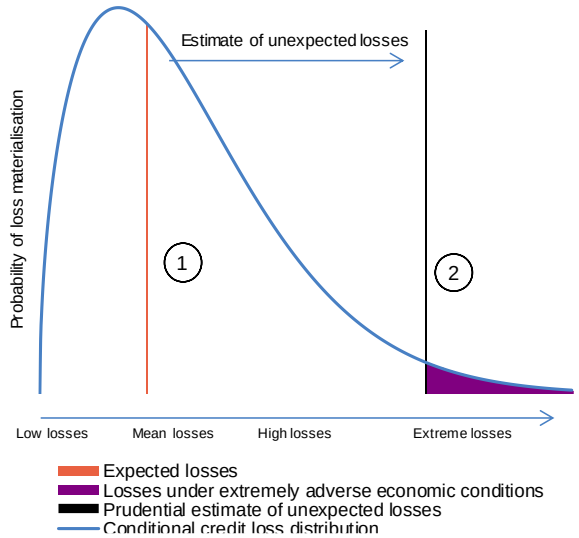
48 Hájek, J., Frait, J., Plašil, M. (2017): The countercyclical capital buffer in the Czech Republic, CNB thematic article.

Source: CNB

Appendix 3: Conditional credit loss distribution[49]

The construction of the conditional credit loss probability distribution is based on banking sector stress testing. The purpose of stress testing is to verify the resilience and quantify the credit losses of the banking sector in the chosen stress scenario. The CCyB rate should cover the unexpected credit losses associated with the materialisation of less likely, less favourable scenarios (see Chart 7). The conditional distribution takes into account the fact that the probability of scenarios implying higher credit losses changes over the financial cycle.

Chart 7: Conditional credit loss distribution



Source: CNB
Note: (1) expected losses (losses realised in baseline Scenario);
(2) 99% quantile of loss probability distribution.

The main credit segments of the private non-financial sector (loans to non-financial corporations, loans to households for house purchase and loans to households for consumption) enter the calculation of credit losses, which form the basis for the construction of the conditional distribution. The size of the losses in the scenario are obtained on the basis of the projected growth of the said credit aggregates, the default rate and the average loss given default (LGD) for each credit segment.

A large number of alternative projections are simulated using the maximum entropy bootstrap method,[50] and the range of the cumulative losses is quantified for each path. The expected losses (the losses realised in the baseline scenario; see Chart 7, (1)) represent the median of the

49 This entire appendix relates to loan impairment losses.
50 Vinod, H. D. (2006): Maximum entropy ensembles for time series inference in economics, Journal of Asian Economics, 17(6), pp. 955–978.

distribution so obtained. The difference between the unlikely scenario (a high quantile of the conditional distribution) and the mean credit loss represents the unexpected losses for which the CCyB should be created. The specific shape and variance of the distribution is influenced by the current phase of the financial cycle (defined in the model by the last eight known FCI values). Put simply, the further along the economy is in the financial cycle, the greater is the likelihood of higher losses due to an increase in the probability of default, the LGD and the absolute size of the credit exposures.

The estimation of the average LGD from the individual credit segments takes place outside the main model and depends on the current position in the credit cycle and on a set of explanatory variables for each credit segment (for example, the overvaluation of house prices is the key explanatory variable for the LGD for loans to households for house purchase). The upper bound on the LGD value is then the estimate from the adverse scenario of the macroprudential test.

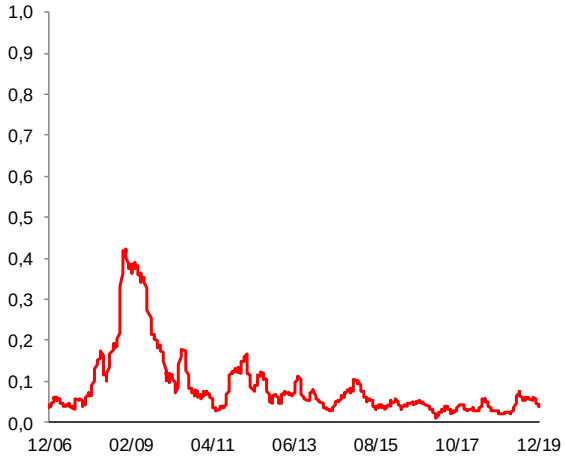
When deciding on the CCyB rate, the macroprudential authority has a preferred level of prudence. The CNB applies a cautious approach in an effort to cover even unlikely credit losses. It therefore sets the size of the potential unexpected losses as the difference between the 99% quantile of the probability distribution (see Chart 7, (2)) and the median of the same (the expected losses). The CCyB rate covering the unexpected losses resulting from the current phase of the financial cycle then corresponds to the estimated size of the unexpected losses relative to risk-weighted assets. When actually setting the CCyB rate, however, it is vital to consider all aspects of the economic situation rather than applying a mechanistic approach.

Appendix 4: Composite Indicator of Systemic Stress

The Composite Indicator of Systemic Stress (CISS) for the Czech Republic (see Chart 8) is compiled by aggregating financial data for the money market, the government bond market, the equity market, the foreign exchange market and financial intermediaries (see Figure 2).

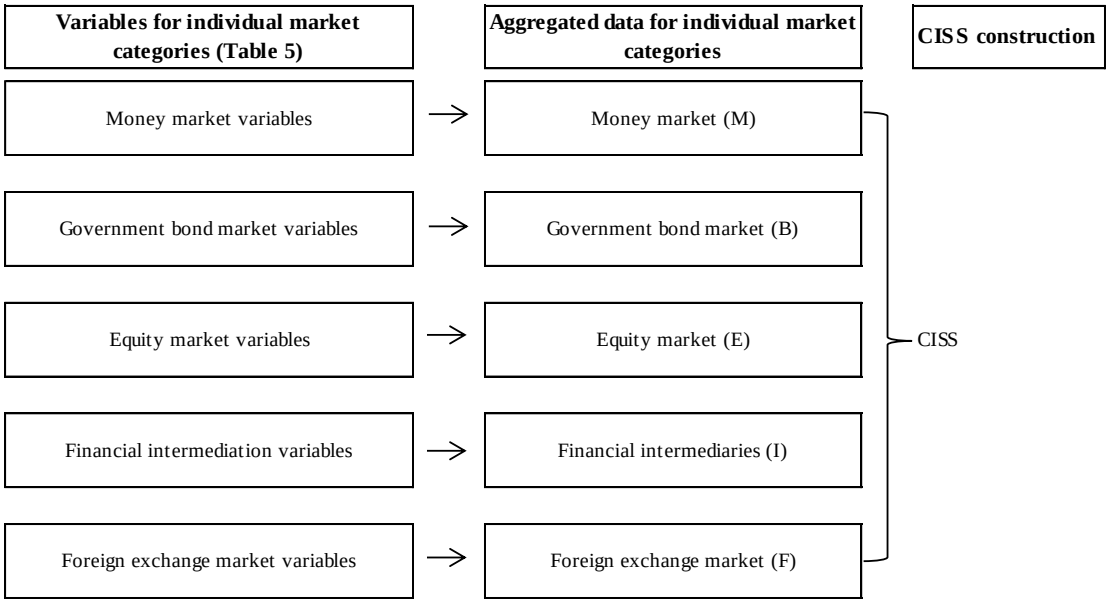
Chart 8: CISS for the Czech Republic

(0 minimum, 1 maximum; a higher value means greater stress)



Source: CNB
Note: Smoothed eight-week moving average (i.e. the average of the current value and seven lagged values).

Figure 2: Procedure for calculating the CISS for the Czech Republic



Source: CNB

The CISS for the Czech Republic is calculated using daily data (see Table 4) since 1 January 1999, from which weekly variables are compiled for each financial market category (see Table 5). To obtain the aggregate index value, the arithmetic mean of the individual variables for each market category is calculated (see Figure 2). The construction of the CISS is based on Holló et al. (2012)[51] and Adam and Benecká (2013).[52] The weights for the market categories are set as identical, and the EWMA method with a smoothing parameter of 0.93 is used to obtain the correlations between the market categories.

Table 4: Data sources

Category	Data by source	Ticker	Source
M	3M PRIBOR	PRIB03M Index	Bloomberg
	EONIA Index	CZEOINDX Index	Bloomberg
B	10Y GBOND	CZBRYLD(RY)	Refinitiv
	10Y IRS	TRCZ610	Refinitiv
E	CZECH REP.-DS NON-FINANCIAL - TOT RETURN IND	TOTLICZ(RI)	Refinitiv
	CZECH REP.-DS NON-FINANCIAL - TOT RETURN IND	TOTMKCZ(RI)	Refinitiv
	CZ BENCHMARK 10 YEAR DS GOVT. INDEX - TOT RETURN IND	BMCZ10Y(RI)	Refinitiv
I	CZECH REP.-DS Banks - TOT RETURN IND	BANKSCZ(RI)	Refinitiv
	CZECH REP.-DS Financials - TOT RETURN IND	FINANCZ(RI)	Refinitiv
FM	CZK/USD	PRUSDSP	Refinitiv
	3M PRIBOR	PRIB03M Index	Bloomberg
	EONIA Index	CZEOINDX Index	Bloomberg

Source: CNB

51 Holló, D., Kremer, M., Duca, M. L. (2012): CISS – A composite indicator of systemic stress in the financial system, ECB Working Paper Series, No. 1426.
52 Adam, T., Benecká, S. (2013): Financial stress spillover and financial linkages between the euro area and the Czech Republic, Finance a úvěr – Czech Journal of Economics and Finance 63(1), pp. 46–64.

Table 5: Variables for each market category

Category	Variable name	Description
M	Volatility of 3M interbank rate	Absolute daily rate changes, weekly average of daily data
	Spread between 3M interbank rate and OIS	3M – OIS, weekly average of daily data on spreads
B	Volatility of 10Y government bond yield	Absolute daily yield changes, weekly average of daily data
	Spread between 10Y koruna swap and 10Y government bond	IRS – bond, weekly average of daily data
E	Volatility of non-financial sector stock market index	Absolute daily log changes in total-return index (i.e. log (It/It–1)), weekly average of daily data
	Cumulative loss for non-financial sector total-return index	Average weekly total-return index values; indicator = 1 – value for reference week/maximum for past 105 weeks (including current one)
	Increase in correlation between stock market index and government securities index	Difference in correlation between log changes in total-return stock market and 10Y government securities indices for past 20 and 522 days (including current one); weekly average of daily correlation differences. If the weekly average is negative, a value of 0 is used. Measures the increase in correlation relative to the long-term trend)
I	Volatility of return of banking sector stock market index over total stock market index	Residual from regression of banking sector total-return index = a0 + a1*overall total-return index; past 522 observations of log return (i.e. log (It/It–1)) including value for current day. Absolute residual value for current day used; weekly average of daily residual values
	Cumulative loss for non-financial sector total-return index	Average weekly total-return index values; indicator = 1 – value for reference week/maximum for past 105 weeks (including current one)
F	Volatility of CZK/USD exchange rate	Absolute daily log changes in exchange rate (i.e. log (It/It–1)), weekly average of daily data
	Volatility of CZK/EUR exchange rate	Absolute daily log changes in exchange rate (i.e. log (It/It–1)), weekly average of daily data
	Volatility of CZK/GBP exchange rate	Absolute daily log changes in exchange rate (i.e. log (It/It–1)), weekly average of daily data

Source: CNB
Note: Y year, M month