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Internal CNB methodology for the review and evaluation of sovereign exposure concentration risk

Contents

Abbreviations

AIRB	advanced internal ratings-based
CNB	Czech National Bank
CR	capital requirement
CRA	credit rating agency
CRD IV	Capital Requirements Directive (Directive 2013/36/EU of the European Parliament and of the Council on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC)
CRR	Capital Requirements Regulation (Regulation (EU) No 575/2013 of the European Parliament and of the Council on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012)
DSGE	dynamic stochastic general equilibrium
EBA	European Banking Authority
ECB	European Central Bank
ECB SDW	European Central Bank Statistical Data Warehouse
EGAP	Exportní garanční a pojišťovací společnost, a.s.
EIU	Economist Intelligence Unit
ESRB	European Systemic Risk Board
EU	European Union
EURIBOR	Euro Interbank Offered Rate
FIRB	foundation internal ratings-based
FNR	false negative rate
FPR	false positive rate
FSB	Financial Stability Board
FSR	Financial Stability Report
GB	government bond
GDP	gross domestic product
IMF GFS	International Monetary Fund Government Finance Statistics
IMF IFS	International Monetary Fund International Financial Statistics
IRB	internal ratings-based
ISR	sovereign risk indicator
LCR	liquidity coverage ratio
LGD	loss given default
MiFID II	Markets in Financial Instruments Directive (Directive 2014/65/EU of the European Parliament and of the Council on markets in financial instruments and amending Directive 2002/92/EC and Directive 2011/61/EU)
NiGEM	National Institute Global Econometric Model
QPSDS	Quarterly Public Sector Debt Statistics

| OECD | Organisation for Economic Co-operation and Development |
PD	probability of default
PRIBOR	Prague Interbank Offered Rate
SFA	stock-flow adjustment
SREP	Supervisory Review and Evaluation Process
STA	standardised approach
WB QEDS	World Bank Quarterly External Debt Statistics
WB QPSDS	World Bank Quarterly Public Sector Debt Statistics
WB WGI	World Bank Worldwide Governance Indicators

1 Executive summary

As a supervisory authority, the CNB constantly monitors and evaluates all potential financial risks in its prudential supervisory work. It cannot ignore systemic risk in the form of the downward liquidity spiral that might arise if the close relationship between the financial and sovereign sectors were to decouple suddenly. Where a sovereign exposure has a large share in credit institutions' balance sheet and continues to increase significantly, the same as general government debt, this potential risk becomes highly relevant and gradually nears materialisation. Given the nature of this feedback loop and of the sectors concerned, the supervisory authority must intervene in good times where such a scenario has a non-zero probability of occurring, as any delay will reduce the room for conducting proper prudential policy.

Concentration risk is regulated in Pillar 1 of CRD IV, but sovereign exposures are exempted from this regulation because of their specific character. However, this cannot be interpreted as meaning that credit institutions are not subject to concentration risk through such exposures. Credit institutions to which CRD IV and CRR apply are obliged, among other things, to systematically and effectively manage concentrations of exposures, including sovereign exposures. In its supervisory work, the CNB reviews and evaluates at least once a year whether the arrangements, strategies, processes and mechanisms implemented by credit institutions genuinely ensure safe and sound operation and proper management and coverage of this risk. The CNB is required to take appropriate action on the basis of the outcome of the review and evaluation. The internal CNB methodology described below – a new microprudential **Pillar 2 supervisory tool** – has been created for this purpose. Limiting exposure concentrations is also one of the intermediate macroprudential policy objectives recommended by the ESRB.

The supervisory tool presented below applies to sovereign exposures evaluated as having a systemically important share in the credit institutions sector. In simplified terms, sovereign exposure means exposure to individual government sectors and their agencies in EU countries in all currencies, to which exemptions are applied under Pillar 1. Government bonds are the dominant sovereign exposure item in banks' balance sheets. The main element of the tool is a percentage limit which divides a systemically important sovereign exposure into a below-limit and an **above-limit part** (see Figure 1). The limit is a decreasing function of the probability of default by the counterparty expressed using a sovereign risk indicator estimated by the CNB taking values within the range of 0%–100%. If this indicator rises, the limit gradually falls. As a result, the above-limit part increases while the below-limit part decreases.

Figure 1: Simplified diagram of the tool
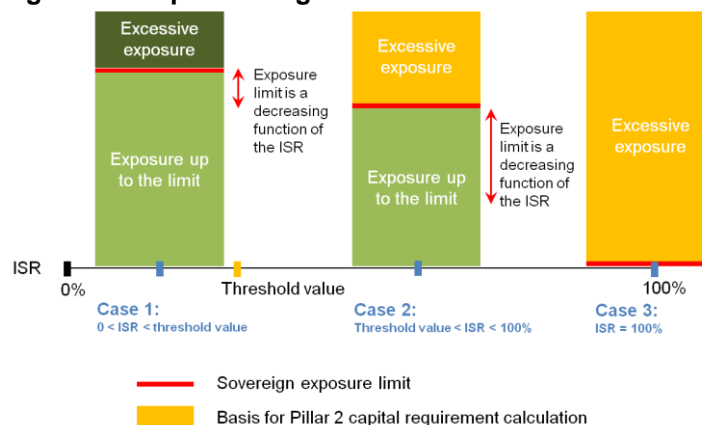
Source: CNB

The below-limit part of the sovereign exposure continues to be regulated under Pillar 1, i.e. it is exempted from the limit on large exposures and its risk weight is determined using the standardised or IRB approach. The credit institution will create an **additional capital requirement** for the above-limit part to cover excessive concentration risk. However, the credit institution will create this requirement at the earliest when the **three-year outlook** for the sovereign risk indicator exceeds a "**soft" threshold of 5%** and the results of an expert analysis confirm the need to create a capital requirement. If a "hard" threshold of 8% is exceeded, the institution will create an additional capital requirement automatically, i.e. without any further expert analysis. If a credit institution already creates a capital requirement to cover risk stemming from the sovereign exposures concerned, the capital already allocated will be subtracted from the additional capital requirement for the coverage of concentration risk arising from the above-limit sovereign exposure.

Given the preventive nature of the proposed tool, the **sovereign risk indicator** (ISR) is estimated using a public finance stress test and statistical models at the three-year horizon. The methodology for determining the sovereign exposure limit and how it is reduced takes into account the credit institution's ability to continuously fulfil the liquidity buffer requirement relating to the LCR and gives it sufficient room to respond in time by gradually reducing the sovereign exposure if a deterioration in public finances is indicated.

2 Prudential framework

From the perspective of the regulation of credit institutions, exposures to central governments of EU Member States or the government bonds issued by them are considered to be safe and highly liquid assets. There are undoubtedly good economic and practical reasons for this. The state has high credibility as an issuer thanks to its power to collect taxes. The government not only can time-shift its debt service costs, but also has some ability and flexibility to adjust the tax quota to its debt service needs. The intertemporal aspect of general government debt service helps maintain the value of government bonds. For these reasons, sovereign risk is also often regarded as the lowest risk in the economy (the floor). Government bonds are thus subject to the smallest haircuts when

used as collateral, and economic agents are motivated to hold them. The inclusion of government bonds among the collateral accepted by central banks often contributes to this. For the reasons given above, the government bond market is not only the largest in terms of issue volume, but also the most liquid.

The specific regulatory position of sovereign exposures relates mainly to the following areas (see Figure 2):

1. The capital requirements for the credit risk of sovereign exposures are minimal under Pillar 1. The requirement for credit institutions that apply the standardised approach is zero.[1] Credit institutions using the IRB approach do not automatically apply a zero risk weight, but, unlike for exposures to corporates, the PD for sovereign exposures entering the risk weight calculation is exempted from the minimum value of 0.03%.[2] Moreover, a credit institution may apply the IRB approach only partially and use the standardised approach with a zero risk weight for sovereign exposures ("permanent partial use").[3]

2. Sovereign exposures are exempted from the limits to large exposures that limit concentration risk under Pillar 1.[4]

3. For the purposes of the liquidity buffer relating to compliance with the liquidity coverage requirement (LCR), government bonds issued by EU sovereigns are level 1 assets. In other words, they are recommended for classification as assets of extremely high quality and liquidity, which are not subject to haircuts or size limits.[5]

4. In respect of market risk, a capital requirement is often created "only" to cover the general interest rate risk of sovereign exposures held in the trading book.

Figure 2: Approach to the regulation of credit institutions for sovereign exposures
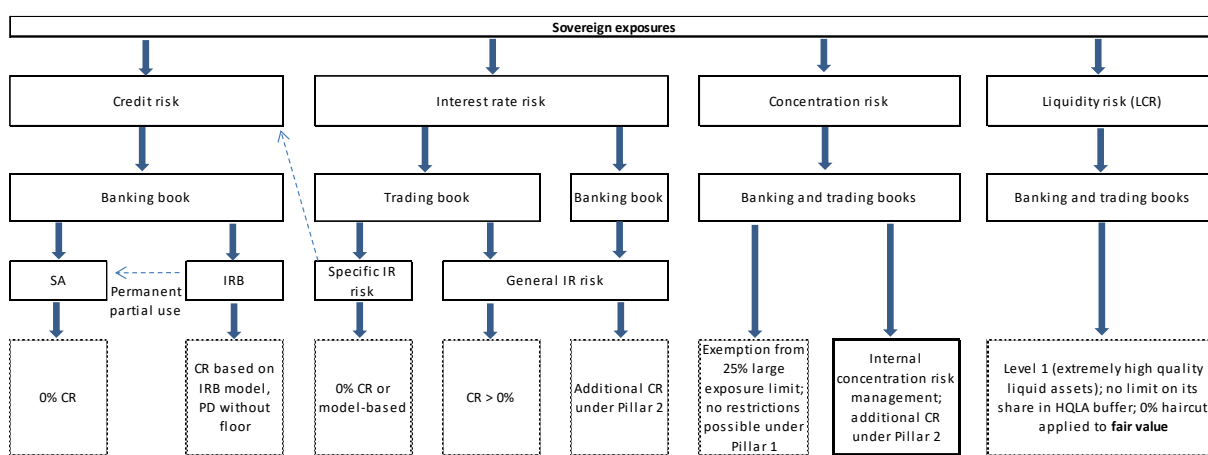
Source: CNB
Note: SA stands for standardised approach, IRB for internal ratings-based approach, CR for capital requirement and HQLA

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[1] CRR, Article 114(4)
[2] CRR, Article 160(1)
[3] CRR, Article 150(1)
[4] CRR, Article 400(1)
[5] Article 10 of Commission Delegated Regulation (EU) 2015/61 to supplement CRR with regard to liquidity coverage requirement for credit institutions.

The preferential treatment given to government bonds listed above implies that it is both desirable from the regulatory perspective and advantageous for credit institutions to hold such securities in their balance sheets. That said, credit institutions' portfolios should not be concentrated in a single asset even if the regulations allow it. Credit institutions should hold a diversified asset buffer composed of various categories, as it is impossible to predict which assets might be affected by potential shocks.

In the context of sovereign exposures, the CNB monitors sovereign credit risk and has the power under Pillar 1 to make credit institutions applying the IRB approach change the PD or LGD parameter. However, the Czech financial system also contains credit institutions that use the standardised approach and apply zero risk weights for this type of exposure. As regards supervision of sovereign credit risk, the CNB is thus left with Pillar 2 in this case, i.e. it monitors whether such risk is properly managed and covered in the review and evaluation process. Depending on the outcome, it may impose measures in the form of an increase in the capital requirement. Given the low frequency of default by the sovereign sector and the dependence of the sustainability of general government debt on market sentiment, the PD of a sovereign exposure is quite difficult to estimate. Based on historical experience, moreover, general government debt default can occur at various levels and in various conditions. The estimate of the PD of a sovereign exposure is therefore close to zero in the long term, and the capital requirement for such an exposure is also very low in the long run. What is more, above a certain accumulated sovereign exposure amount, the capital requirement is de facto ineffective in terms of its ability to absorb a loss given default, because the potential loss will always exceed the amount of capital available. In other words, this type of tool does not act sufficiently prudentially against excessive exposures of credit institutions to the sovereign sector.

Exposure to the sovereign sector is not limited directly in EU legislation, and in the case of Pillar 1 it cannot be limited directly. Again the CNB is left solely with Pillar 2 for managing such exposures in the supervision of a specific institution or group of institutions (SREP). The CNB monitors concentration risk primarily by means of large exposure reports. On the basis of a review and evaluation of sovereign exposure concentration risk, the CNB then determines whether credit institutions are managing such risk properly and whether they are covering it sufficiently with capital and liquidity buffers. Depending on the outcome, the CNB may impose remedial measures. For example, it may require a credit institution to reduce concentration risk vis-à-vis the sovereign sector. In terms of efficiency and effectiveness, the CNB has quite a lot of scope to apply an active and preventive prudential approach in this area.

For this purpose, the CNB has created an internal methodology, i.e. a new microprudential Pillar 2 supervisory tool, to evaluate the risk of systemic concentration of sovereign exposures. The supervisory tool is based on the fact that credit institutions are obliged under CRD IV to ensure, among other things, systematic and effective management of concentration risk in their risk management systems. The same applies to concentrated sovereign exposures.[6] According to EBA

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[6] Articles 30 and 42 of Decree No. 163/2014 Coll., on the performance of the activity of banks, credit unions and investment firms.

guidelines, national supervisory authorities should assess concentration risk management.[7] In its supervisory work, the CNB will therefore at least once a year review and evaluate – from now on using the methodology described below – whether the arrangements, strategies, processes and mechanisms implemented by credit institutions genuinely ensure proper management and coverage of this risk.[8] One of the intermediate macroprudential policy objectives recommended by the ESRB also focuses on exposure concentrations.[9]

3 Basic information about the tool

The CNB's motivation to introduce the tool was prudential in nature. The tool is primarily intended to stimulate credit institutions to make timely changes to their behaviour and not to resolve crises. When creating it, the CNB took into account the initial structural conditions in the Czech Republic, where sovereign risk has already accumulated significantly in the balance sheets of Czech financial institutions, and the existence of a close two-way relationship between the domestic financial sector and sovereign sector. The measure is therefore designed so as to gradually break the existing close relationship and prevent it from re-emerging in the future and so as not to cause a sudden adjustment of market prices.

The supervisory tool/methodology consists essentially of a sequence of related activities:

1. identification of a systemically important sovereign exposure (see 3.1 Definitions, points b-e),

2. estimation of the sovereign risk indicator for the systemically important sovereign exposure (see 3.4 Sovereign risk indicator and Appendices 1 and 2),

3. identification of the above-limit part of the systemically important sovereign exposure for the specific credit institution (see 3.2 Sovereign exposure limit),

4. determination of the size of the additional capital requirement for the systemically important sovereign exposure (see 3.3 Loss given default, 3.4 Sovereign risk indicator and 4 Procedure for introducing a capital requirement).

The size of the additional capital requirement in point 4 is compared in the concentration risk management review process with the capital already allocated by individual credit institutions for covering risks associated with sovereign exposures and its current sufficiency is evaluated (see 4 Procedure for introducing a capital requirement).

3.1 Definitions

For the purposes of this methodology:

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[7] According to Article 154 of the EBA *Guidelines on common procedures and methodologies for the supervisory review and evaluation process*, supervisory authorities should assess concentration of exposures to individual countries, including sovereign exposures, in the Pillar 2 supervisory process.
[8] Article 25c of Act No. 21/1992 Coll., on banks, Article 21a of Act No. 87/1995 Coll., on credit unions, Article 135b of Act No. 256/2004 Coll., on capital market undertakings.
[9] Recommendation of the ESRB (ESRB/2013/1) on intermediate objectives and instruments of macro-prudential policy, p. 9, para. 2: *"…to limit direct and indirect exposure concentrations, taking into account their degree of riskiness. Direct concentration risk arises from large exposures to the non-financial sector (e.g. the housing market, general government)…"*.

a) **credit institution** means a bank pursuant to the Act on Banks or a credit union pursuant to the Act on Credit Unions,

b) **exposure** pursuant to Article 389 of the CRR means any asset or off-balance sheet item referred to in Part Three, Title II, Chapter 2, without applying the risk weights or degrees of risk, the value of which exposure is calculated in accordance with Article 390 of the CRR,

c) **sovereign exposure**[10] means an exposure to the Union and the European Investment Bank, a Member State, including a government department, a government organisation or a special purpose vehicle of the Member State, in the case of a federal Member State, a member of the Federation, a special purpose vehicle for several Member States, or an international financial institution established by two or more Member States which has the purpose of mobilising funding and providing financial assistance to the benefit of its members that are experiencing or threatened by severe financing problems,[11]

d) **important sovereign exposure** means a sovereign exposure held by a credit institution with a minimum ratio to its eligible capital of 100%,

e) **systemically important sovereign exposure** means an important sovereign exposure held by credit institutions whose total asset share exceeds 5% of the total assets of all credit institutions,[12]

f) **sovereign risk** means the risk of potential loss arising from a sovereign exposure caused by the counterparty defaulting on its debt or failing meet other contractual covenants whose legal enforcement may be ineffective given the sovereignty of the counterparty; counterparty credit risk is the main component of sovereign risk,

g) **concentration risk** means the risk arising from a concentration of exposures to persons, groups of economically or otherwise connected persons, or to persons in the same economic sector or geographic region, from a concentration of exposures arising from the same activity or traded commodity or underlying asset of securitised exposures, from exposures to central counterparties, collective investment funds or other exposures, or from another significant concentration with a common risk factor, or the risk arising from a concentration in the application of credit risk mitigation techniques, in particular in the case of large indirect exposures such as a single issuer of securities accepted as collateral,[13]

h) **eligible capital** means the sum of Tier 1 capital as referred to in Article 25 of the CRR and Tier 2 capital as referred to in Article 71 of the CRR, which is equal to a maximum of 50% of Tier 1 capital at most during the period from 1 January 2016 to 31 December 2016 and a maximum of one-third of Tier 1 capital as from 1 January 2017.

3.2 Sovereign exposure limit

A key element of the measure presented here is the identification of a percentage limit dividing the sovereign exposure into a below-limit and an above-limit part (see Figure 1). The limit is a decreasing function of the ISR derived by the CNB (see 3.4 Sovereign risk indicator and

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[10] The methodology does not apply to exposures guaranteed by state agencies (such as corporate exposures guaranteed by EGAP).

[11] Article 4(61) of Directive 2014/65/EU on markets in financial instruments (MiFID II) gives a similar definition ("sovereign debt").

[12] See the definition of important market position in Decree No. 163/2014, Annex 1.

[13] Article 42 of Decree No. 163/2014 Coll., on the pursuit of business of banks, credit unions and investment firms.

Appendix 2). Simply put, the ISR is a variable taking values within the range of 0%–100% indicating the risk of default on a monitored exposure. This means that the below-limit part gradually decreases and the above-limit part increases as the riskiness of the sovereign exposure increases.

For the minimum ISR of 0%, the part of the sovereign exposure for which the eligible capital would no longer be sufficient to cover the loss in the event of unexpected counterparty default, lies above the limit. Assuming an expected loss given default on the sovereign exposure of 45% (see 3.3 Loss given default), the maximum value of the below-limit part of the sovereign exposure is thus 222% of the eligible capital ($= \frac{1}{0.45} \cdot eligible\ capital$).[14] A capital requirement to cover the excessive concentration, equal to the expected loss assuming an LGD of 45%, is then applied to the part of the sovereign exposure exceeding that limit (for more details on the capital requirement, see 4 *Procedure for introducing a capital requirement*).

For the maximum ISR of 100%, counterparty default is considered so likely that the entire expected loss on the sovereign exposure should be covered by eligible capital. For this reason, the lowest value of the below-limit part of the sovereign exposure is set at 0%. The entire sovereign exposure is thus treated as above the limit and the expected loss given default by the counterparty of 45% is covered by capital.

As the limit decreases linearly between the two ISR bounds, its level can be expressed for any value as $\frac{(1-ISR)}{0.45} \cdot eligible\ capital$.

The main reasons for linking the limit to the sovereign risk indicator itself include the financial market's tendency to be mechanically reliant on external ratings, which in certain circumstances can have destabilising knock-on effects on the financial sector and in particular on the sovereign sector. This is because the external ratings of the sovereign sector are relatively stable over time. When producing ratings, credit rating agencies do not focus on borrowers' absolute creditworthiness at a given moment ("point in time ratings"), but instead try to avoid excessive rating volatility over the cycle and smooth ratings over time ("through the cycle ratings"). However, such smoothing can postpone a downgrading reflecting the borrower's true creditworthiness. When a downgrading becomes inevitable, the reduction can be all the more extreme (with multiple reductions occurring over a short period of time). Linking the limit too closely to such ratings could lead to fire sales associated with spillovers of stress from one market to another.[15]

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[14] At 286% on average (and 196% in aggregate terms), this level was near the average (aggregate) ratio of sovereign exposures to eligible capital in the Czech banking sector in mid-2014 (the year when the methodology was introduced).

[15] This was also one of the main reasons why the FSB recommended that policy makers work to reduce reliance on external ratings in laws and regulations and in central bank collateral policy. See, for example, FSB (2014): Thematic Review of the FSB Principles for Reducing Reliance on CRA Ratings – Final Report.

3.3 Loss given default

The loss given default (LGD) value is based on Article 161 of the CRR, which stipulates an LGD value of 45% for non-subordinated unsecured exposures for institutions that apply the FIRB approach. With reference to the same article, the Bank of England, for example, in 2013 introduced a sovereign LGD floor of 45% for British banks applying the AIRB approach.[16] There were two main reasons for this: a single approach to a sovereign borrower across the sector, and the low reliability of LGD value estimates in the case of sovereign exposures. An ECB study confirms that an LGD value of 45% is realistic.[17] This study states that the average LGD of all sovereign debt restructurings in the world between 1970 and 2010 was 50%. It also asserts that LGD does not exceed 40% outside turbulent crisis periods and that it amounted to 60% in the empirical case of Greece.

3.4 Sovereign risk indicator

The ISR is a key indicator for determining the below-limit and above-limit parts of a systemically important sovereign exposure and for creating and calculating the capital requirement. It is intended solely for the CNB's supervisory needs and, given how it is calculated, cannot be unconditionally substituted for the PD of a sovereign exposure computed using other methods.

Simply put, the ISR is a variable taking values within the range of 0%–100% which is used to classify, on the basis of input data, whether default on a monitored sovereign exposure will occur in a given period (see Appendix 2). For the purposes of estimating the ISR, sovereign exposure default means a write-off of part of the exposure, general government debt restructuring, hyperinflation or the launch of an international economic aid programme for the country concerned by, for example, the International Monetary Fund.

The ISR is constructed on the basis of a statistical analysis of historical observations of debt crises and selected explanatory variables from the public finance performance category, macrofinancial variables and indicators reflecting the soundness of the financial system, quality of governance and political stability. The noise-to-signal method used, for example, by the European Commission to construct public debt crisis early-warning indicators was chosen for modelling the relationships between sovereign exposure default and the explanatory variables.[18] Projections of the main ISR input variables are obtained using a public finance stress test (see Appendix 1).

Data as of the end of the previous year on economic developments in the country issuing sovereign exposures identified by the CNB as systemically important in the Czech credit

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[16] Bank of England (2013): Internal Ratings Based approaches, p. 15, changed in Bank of England (2014): CRD IV: updates for credit risk mitigation, credit risk, governance and market risk, p. 21.
[17] Camba-Méndez, G. and Serwa, D. (2014): Market perception of sovereign credit risk in the euro area during the financial crisis, ECB.
[18] Berti, K., Salto, M. and Lequien, M. (2012): An early-detection index of fiscal stress for EU countries, European Economy, Economics Papers 475, December 2012.

institutions sector are the starting point for the stress test.[19] Subsequent developments over the three-year horizon are derived from a stress scenario that contains assumptions about adverse shocks to the main macroeconomic variables and other additional shocks reflecting currently perceived risks, especially market risk. Some of those macroeconomic variables directly enter the calculation of the ISR. The general government finance projection is calculated on the basis of these assumptions and initial data.

4 Procedure for implementing a capital requirement

The CNB will require credit institutions to create an additional capital requirement for the above-limit part of a sovereign exposure. However, this will apply only where it finds in a concentration risk management review conducted in individual credit institutions that the coverage is insufficient with regard to the riskiness of the sovereign exposure.

The key indicator for the creation and calculation of the capital requirement is the ISR (see 3.4 Sovereign risk indicator and Appendices 1 and 2). The CNB will indicate the setting of additional capital requirements for institutions at the three-year horizon at the earliest when the ISR outlook at this horizon exceeds a "soft" threshold of 5% and the results of an expert analysis confirm that a capital requirement is necessary. The expert analysis will include an assessment of the contributions of individual variables to the excess over the "soft" threshold (see Appendix 2) and an evaluation of other macroeconomic conditions that cannot be modelled. If the expert analysis does not confirm that an additional capital requirement is necessary, the CNB will step up its monitoring. Institutions will have the duty to manage risks with increased prudence. If a "hard" ISR threshold of 8% is exceeded, it will be indicated that an additional capital requirement must be met unconditionally at the three-year horizon.

The upper threshold value is based on the level used for sovereign exposures in the European stress test conducted by the EBA in 2011 and on the Basel II/III regulatory standards for sovereign exposures held in the banking book.[20] The EBA set PDs for sovereign exposures based on external ratings. In the EBA test, a PD of 9.7% was assigned to a B rating (high speculative grade). A sharp increase in PD is apparent at this rating (see Table 1). Given the CNB's conservative approach, a lower value – 8% – was used as the upper ISR threshold.

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[19] In FSR 2019/2020, the CNB identified government bonds issued by the Czech government as systemically important sovereign exposures.
[20] Hannoun, H. (2011): Sovereign risk in bank regulation and supervision: Where do we stand? http://www.bis.org/speeches/sp111026.pdf.

Table 1: PD used in the EBA stress test for sovereign exposures

S&P rating	Average 2-year PD derived from external rating (%)
AAA	0,03
AA	0,03
A	0,26
BBB	0,64
BB	2,67
B	9,71
CCC–C	36,15

Source: EBA, Hannoun, H. (2011) - footnote 22.
Note: Methodology for stress tests applied in 2011.

The ISR outlook is monitored within a fluctuation band of 5%–8% because of its potential to oscillate around the upper threshold value of 8%. Such oscillation may be caused by either the data level or model level of the outlook calculation. At the data level, the input variables may be subject to short-term fluctuations, there may be changes in statistical reporting (the material content of statistical indicators) and historical values may be subject to revision. At the model level, the individual relationships are regularly updated and subsequently recalibrated, and the estimation method may itself be gradually refined. However, oscillations around the upper threshold value would lead to undesirable and/or unjustified re-evaluations of the requirement to create additional capital. The lower threshold of the band is set at 5%. This is because the critical limit at which the ISR most accurately divides the observations into safe countries and countries with imminent default lies within the range of 5%–10%.

The CNB will set the above-limit part of the sovereign exposure for individual institutions for three years after the capital requirement is indicated. A potential additional capital requirement will be applied for the above-limit part of the exposure. The risk weight will be derived from the standard formula set out in Article 153 of the CRR. The PD parameter will be replaced by the current ISR value (not the original ISR outlook obtained from the stress test).[21] Furthermore, an LGD of 45% and a maturity of 2.5 years will be applied.[22] The current ISR value is not disclosed. This is because the ISR is intended solely for the CNB's stress tests and supervisory needs and cannot be unconditionally substituted for the PD of a sovereign exposure computed using other methods. The following figure contains an illustrative example of the timeline of application of the tool.

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[21] The actual values of the explanatory variables for the previous year, known as of the end of March, will be used to calculate the current ISR value. Where final data are not available, preliminary data will be used.
[22] Consistently with Article 162(1) of the CRR.

Figure 3: Illustrative example of activation of the tool
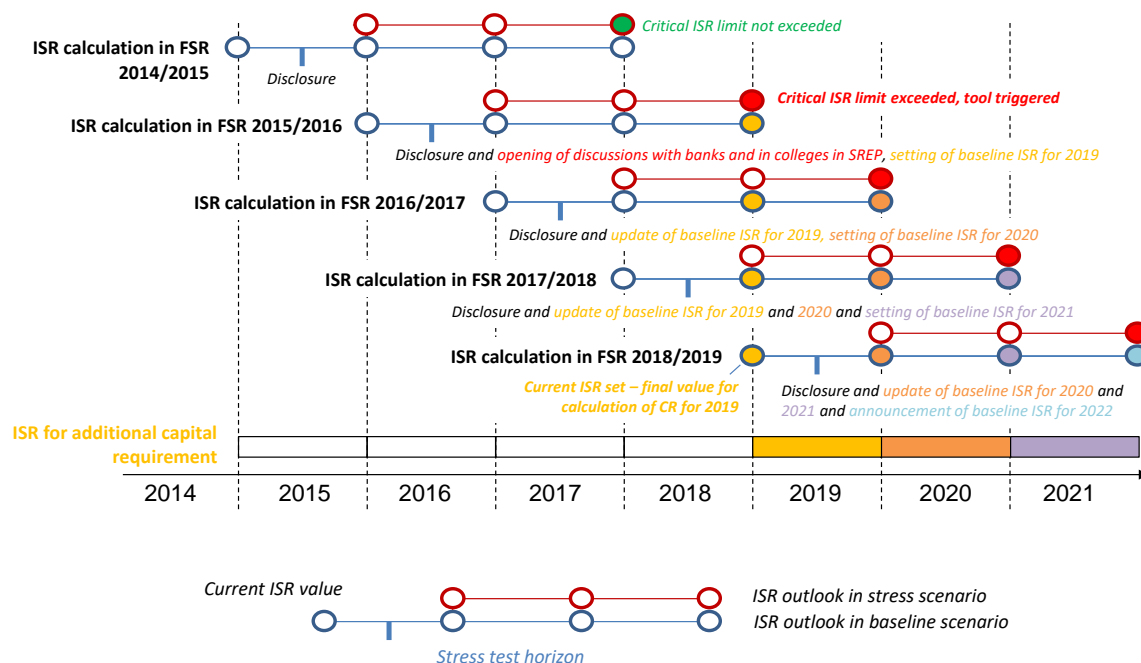
Source: CNB
Note: The illustration assumes a situation where the public sector stress test published in Financial Stability Report 2015/2016 first identifies a breach of the ISR critical limit which causes the tool to be triggered. Subsequently, it is assumed that the tool remains active in the following years. The choice of years in which the critical limit is exceeded should not in any way be associated with the CNB's expectations about future developments.

If a credit institution already creates a capital requirement to cover risk stemming from the sovereign exposures concerned on the basis of the IRB approach under Pillar 1 or on the basis of its own risk management system under Pillar 2, the CNB will take this into account. The already allocated capital will be subtracted from the additional capital requirement for the coverage of concentration risk arising from above-limit sovereign exposures.

The CNB might revise a previously adopted measure if the ISR were to decline as a result favourable public finance developments. As the public finance stress test takes into account all currently approved future changes in the institutional set-up (tax changes etc.), it can be expected that the stress test will not be sharply revised in any subsequent update without the approval of new measures by the government, and hence that the measure itself will not be revised in terms of a reduction of the additional capital requirement. Consequently, there is no danger of an institution unnecessarily reducing an exposure in advance. The first indication of any revision of the capital requirement will occur when the three-year ISR outlook falls below 5% and the results of an expert analysis confirm the need for such a revision.

5 Communication

Starting in 2015, the CNB every year projects the ISR at the three-year horizon for systemically important sovereign exposures using a public finance stress test (see Appendix 1) and statistical models (see Appendix 2). The estimated ISR values, the public finance stress test results and the proposed stress scenario will be published in the Financial Stability Report (FSR).

The FSR will thus be used to inform credit institutions whether the CNB has identified a systemically important sovereign exposure in the credit institutions sector and whether the ISR outlook thresholds have been crossed in either direction for that exposure. The CNB will address the level of the above-limit sovereign exposure in respect of which an additional capital requirement should be created or revised with each relevant credit institution individually.

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Appendix 1: Czech public finance stress test methodology[23]

Public finance stress tests are used at the CNB as a supportive tool for internally determining the riskiness of sovereign exposures in the supervision of management of the risk of excessive sovereign exposure concentration in credit institutions' portfolios. Data on the economic situation in the country issuing the relevant sovereign exposures as of the end of the previous year are the starting point for the stress test. Subsequent developments over the three-year horizon are derived from a stress scenario that contains assumptions about adverse shocks to the main macroeconomic variables. Adverse economic developments are associated with lower tax collection, a rise in some primary government expenditures and rising general government debt service costs. The resilience of public finances to these effects is then assessed in the stress test.

The objective of the stress test is to generate three-year outlooks for the ISR input variables for sovereign exposures held in the Czech credit institutions sector which have been identified as systemically important (see 3.1 Definitions, 3.4 Sovereign risk indicator and Appendix 2). These variables can be divided into three categories according to how their outlooks are determined: (1) variables assumed directly in the macroeconomic scenario, (2) variables obtained from the fiscal forecast drawn up for the adverse macroeconomic scenario, and (3) variables set at the level of the last known value (see Table 2).

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[23] By definition (see 3.1 Definitions), only exposures to the Czech general government were identified at present as systemically important sovereign exposures, so the presented methodology relates to the stress test of Czech government finances.

Table 2: How the outlooks for the variables are determined

ISR variable	How the three-year outlook is determined
Macroeconomic variables	
Real GDP growth (%)	Macroeconomic scenario
Current account balance (% of GDP)	Macroeconomic scenario
Gross national savings (% of GDP)	Value as of end of year preceding start of test
External debt (% of GDP)	Value as of end of year preceding start of test
Difference between real GB yield and real GDP growth (pp)	Macroeconomic scenario linked with yield curve decomposition
Fiscal variables	
General government debt (% of GDP)	Macroeconomic scenario and fiscal forecast
General government structural balance (% of GDP)	Macroeconomic scenario and fiscal forecast
10Y government bond yield (%)	Macroeconomic scenario linked with yield curve decomposition
General government debt maturing within one year (% of GDP)	Macroeconomic scenario and fiscal forecast
Share of general government debt maturing within one year (%)	Macroeconomic scenario and fiscal forecast
Share of foreign currency debt (%)	Macroeconomic scenario and fiscal forecast
Share of non-residents in debt holdings (%)	Value as of end of year preceding start of test
Institutional variables	
Government effectiveness (WB WGI score)	Value as of end of year preceding start of test
Political stability (WB WGI score)	Value as of end of year preceding start of test
Rule of law (WB WGI score)	Value as of end of year preceding start of test
Banking crisis	Value as of end of year preceding start of test
Past sovereign defaults	Value as of end of year preceding start of test

Source: CNB

The starting assumption for the Czech public finance stress test is an adverse macroeconomic scenario. This scenario is identical to that used in stress tests of the banking sector, insurance companies and pension management companies. The CNB's official forecasting model, coupled with estimates of the future evolution of certain additional variables not generated directly by the model, is used to prepare the scenario (see Figure 4). The scenario is drawn up by identifying typical and/or impending risks to the Czech economy.

The first step in modelling the evolution of general government finances over the three-year period of the stress test is the primary balance forecast. Subsequently, the general government borrowing requirement is derived. It affects the size of the general government debt and the interest costs at which new debt is issued. The overall general government balance is given by the sum of the primary balance and total interest costs after the shock has been applied. The size of the general government debt at the end of the relevant year is equal to the debt at the start of the year minus the overall general government balance plus stock-flow adjustment (SFA) items.[24]

The primary balance outlook is based on the forecast of the individual general government revenue and primary expenditure items under ESA 2010 methodology in the adverse macroeconomic scenario. The individual tax revenue items are modelled on the basis of the evolution of the

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[24] For a more detailed specification of SFA items, see for example CNB (2011): Inflation Report I/2011, Box 1.

relevant tax bases and estimated elasticities thereof. Other current revenue and capital revenue are, given their nature,[25] relatively little affected by the drop in economic activity and are therefore similar in amount as in the baseline scenario.[26]

Figure 4: Czech public finance stress test diagram
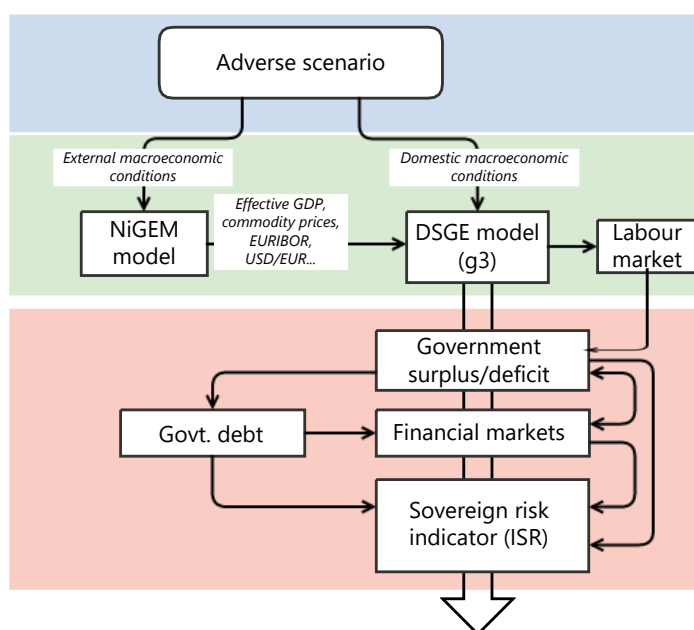
In the case of primary expenditure, it is assumed that there will be no change in the government's spending policy irrespective of the adverse economic developments, and that most primary expenditure will be drawn to the extent assumed in the baseline scenario of the CNB's fiscal forecast published in the Monetary Policy Report over the entire stress test horizon.[27] The exceptions are expenditure on unemployment benefits, which will increase significantly over the entire stress test horizon owing to the adverse economic developments.

The forecast for interest payments, i.e. general government debt service costs, is based on the structure of the debt portfolio and reflects expected financial market developments. Specifically, the amount and maturity structure of the debt and the yield at which it is issued are derived.

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[25] In the case of capital revenue, it mainly comprises revenue from the EU to finance investment under the EU economic and social cohesion policy (structural operations). Revenue from the EU for non-investment projects is included in other current revenue, which also include e.g. property income etc.

[26] The baseline scenario of the fiscal forecast corresponds to the most likely path of the economy in the period under review and is independent of the stress test. See the relevant Monetary Policy Report, CNB.

[27] See, for example, CNB (2022): Monetary Policy Report – Spring 2022.

The amount of the debt is equal to the sum of the outstanding part of previously issued debt and the debt issued in the year of interest. The amount of debt issued in the year of interest must cover the borrowing requirement, i.e. the debt maturing in the given year that needs to be refinanced, and any budget deficit arising in the year of interest, with regard to SFA items.

The maturity structure of the debt at the start of the test is obtained from the Debt Statistics by the Czech Ministry of Finance (MF). That structure determines which part of the debt will mature in which year. Fifteen annual maturity baskets are considered. Debt with maturity of longer than 15 years is treated as 15-year debt. The maturity structure of new issues, i.e. issues made in each year of the three-year stress test period, is based on the issuance history in the last years and takes into account the issuance strategy for the next years published by the MF. The total amount and structure of the debt is given by the amount and structure of old and newly issued debt.

The yield on debt issued before the start of the test is computed as the implicit rate, which is equal to the ratio of total interest expense in the last year to the amount of debt at the start of the test.

The yield on new debt reflects the market conditions in the adverse scenario under which new general government debt will be issued. The evolution of yield curves is based on their decomposition as in the stress tests of the banking sector, insurance companies and pension management companies.[28]

Foreign currency debt is affected by the exchange rate. Consistent with the stress scenario – assuming an adverse impact on the domestic economy – is a weakening of the Czech koruna leading to growth in the koruna cost of servicing foreign currency debt. Moreover, revaluation of the outstanding part of the foreign currency debt at the weaker exchange rate increases the koruna size of the debt. The stress test assumes no new issues of foreign currency debt.

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[28] Decomposition of yield curves is performed in accordance with Kučera et al. (2017): Longer-term Yield Decomposition: An Analysis of the Czech Government Yield Curve.

Appendix 2: Method for deriving and calibrating the sovereign risk indicator

The ISR is a variable taking values within the range of 0%–100% which aims to assess the risk of sovereign exposure default for the purposes of evaluating sovereign exposure concentration risk. For the needs of the methodology presented here, sovereign exposure default means a write-off of part of the exposure, general government debt restructuring or the launch of an international economic aid programme, for example by the International Monetary Fund. The ISR is constructed on the basis of a statistical analysis of historical observations of debt crises and selected variables in such a way as to meet the following main requirements:

a) high resolution,
b) interconnectedness with the public finance stress test,
c) simplicity and ease of interpretation,
d) compatibility with the current CRR/CRD IV.

The ISR must enable us to distinguish as precisely as possible between default observations and normal observations on the basis of observed or projected data. As sovereign risk is assessed in the form of a stress test, the ISR input variables must overlap as much as possible with the public finance stress test output variables (see Table 2). The ISR calculation must be transparent and allow for easy decomposition of the effect of each indicator. In addition, the statistical properties of the ISR must enable the capital requirement to be calculated in accordance with the current regulations (the ISR substitutes for PD in the equation for calculating the capital requirement for the above-limit part of the exposure).

The explanatory variables can be divided into three categories. The first category is made up of fiscal variables describing the performance of public finances – the general government structural balance and general government debt and its maturity, currency and territorial structure. The second category comprises macroeconomic variables affecting public finances – real economic growth, the current account balance and the government bond yield. The last category contains additional indicators reflecting the soundness of the financial system (a binary variable indicating whether the economy is going through a financial sector crisis), the external debt of the economy, past debt defaults[29] and indicators of government effectiveness, political stability and rule of law.

The statistical method used by the European Commission to construct general government debt crisis early-warning indicators was chosen for modelling the relationships between sovereign exposure default and the explanatory variables.[30] Using historical data, a critical limit is found for each variable monitored. This limit divides default and non-default observations in such a way that

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[29] Past debt defaults are represented by a binary variable indicating whether the issuer has defaulted in the past ten years.
[30] For more details, see, for example, Berti, K., Salto, M. and Lequien, M. (2012): An early-detection index of fiscal stress for EU countries, European Economy, Economics Papers 475, December 2012.

it minimises the sum of the false positive rate (*fpr*) and the false negative rate (*fnr*).[31] Exceeding the critical limit can be regarded as a warning signal. A higher number of warning signals for a higher number of variables means a higher risk of default.

A composite indicator *CI* is constructed from all the observed signals using a weighted average, where each signal is weighted by its ability to distinguish between default and non-default observations (*1 – fpr – fnr*). The composite indicator *CI* is highly non-linear and its numerical values do not directly provide an estimate of the probably of default. It is therefore recalibrated to the resulting ISR, which does not suffer from these deficiencies, using logistic function (see *Sequence for calculating the ISR*).

Sequence for calculating the ISR

1. Obtain currently available data for each variable.
2. Compare the value of each variable with the assigned threshold value.
3. Calculate the auxiliary composite indicator CI as the sum of the weights of the k variables out of the total of 17 that are above their thresholds.

$$CI = \sum_{i=1}^{k} weight_i$$

4. Calculate the ISR as

$$\text{ISR} = \frac{e^{(-8.1\,+\,10.1\text{CI})}}{1\,+\,e^{(-8.1\,+\,10.1\text{CI})}}$$

The data sample used to calibrate the ISR comprises observations for more than 50 countries between 1980 and 2018 and consists primarily of EU and OECD member countries. Countries with a high proportion of official creditors (the USA, Japan, the UK and Switzerland) were left out of the sample, as their government bonds are of specific importance in financial markets. Retaining the observations from those countries could thus bias the ISR estimates for other countries.

Table 5 provides an overview of the sources of historical data used to calibrate the ISR. Where more than one data source is available for a variable, the sources are ordered from highest to lowest priority. Where the values differed, priority was given to the value from the highest-priority source. There are observations missing from the historical time series of the individual variables. The frequency of missing observations may be relatively high at the start of the period under review.

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[31] The false positive (negative) rate is the ratio of the number of false positive (negative) signals to the number of all actual negative (positive) observations. In this case, a default observation/signal is regarded as "positive". It is considered an error if the variable exceeds (does not exceed) the critical limit when default subsequently did not (did) occur.

Table 5: Data sources for input indicators

Sub-indicator (variable)	Data source (abbreviation)
Macroeconomic variables	
Real GDP growth (%)	EIU country data
Current account balance (% of GDP)	EIU country data
Gross national savings (% of GDP)	EIU country data
External debt (% of GDP)	WB QEDS, EIU country data
Difference between real 10Y GB yield and real GDP growth (pp)	EIU country data, IMF IFS, CNB calculations
Fiscal variables	
General government debt (% of GDP)	ECB SDW, EIU country data, Abbas, et. al. (2010)[32]
General government structural balance (% of GDP)	AMECO database and IMF
10Y government bond yield (%)	IMF IFS, EIU country data
General government debt maturing within one year (% of GDP)	ECB SDW, OECD QPSDS, WB QPSDS, CNB calculations
Share of general government debt maturing within one year (%)	ECB SDW, OECD QPSDS, WB QPSDS, WB QEDS, EIU country data, CNB calculations
Share of foreign currency debt (%)	ECB SDW, OECD QPSDS, WB QPSDS, WB QEDS, EIU country data, CNB calculations
Share of non-residents in debt holdings (%)	ECB SDW, OECD QPSDS, WB QPSDS, WB QEDS, EIU country data, CNB calculations
Institutional variables	
Government effectiveness (WB WGI score)	WB WGI
Political stability (WB WGI score)	WB WGI
Rule of law (WB WGI score)	WB WGI
Banking crisis	Leauven and Valencia (2018)[33]
Past sovereign defaults	Moody's (2014), Emanuele et al. (2011), Cruces and Trebesch (2013), Reinhart et al. (2003), CNB calculations[34]

Source: CNB

Table 6 provides the detailed results of the calibration of the individual input indicators. The results reveal that each category of variables has a weight of approximately one-third in the calculation of the resulting ISR value. As a result of this even weight distribution, it is necessary to have a signal from several different sub-indicators (variables) simultaneously in order to reach the critical value of the resulting ISR. So if, for example, a signal is being sent out solely by variables reflecting the state of the economy, but the issuer's debt structure is sound, the ISR cannot attain the critical

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[32] Abbas, Belhocine, ElGanainy and Horton (2010): A Historical Public Debt Database, IMF WP

[33] Leauven and Valencia (2018): Systemic Banking Crises Revisited

[34] Moody's Sovereign Default and Recovery Rates (2018), Emanuele, et al. (2011): Assessing fiscal stress, IMF Working Papers, Cruces, J. J., and Trebesch, C. (2013): Sovereign Defaults: The Price of Haircuts, American Economic Journal: Macroeconomics 5(3), Reinhart, C. M., Rogoff, K. S., and Savastano, M. A. (2003): Debt Intolerance, Brookings Papers on Economic Activity 34

level. This prevents the ISR from reaching its critical limit due to the stress scenario alone, which usually assigns values primarily to macroeconomic variables.

Table 6: Parameters of the sovereign risk indicator

Sub-indicator (variable)	Critical limit		fpr (%)	fnr (%)	Weight (%)
Macroeconomic variables					
Year-on-year difference in real GDP growth (pp)	<	-1.0	29.0	47.4	4.8
Current account balance (% of GDP)	<	-1.4	47.8	10.0	8.6
Gross national savings (% of GDP)*	<	19.3	23.7	38.9	7.6
External debt (% of GDP)*	>	113.5	6.2	66.7	5.6
Difference between real 10Y GB yield and real GDP growth (pp)	>	6.4	6.3	69.2	5.0
Fiscal variables					
General government debt (% of GDP)	>	61.4	32.8	60.0	1.5
General government structural balance (% of GDP)	<	-3.1	37.8	27.2	7.2
Year-on-year difference in 10Y government bond yield (pp)	>	0.5	14.7	38.5	9.6
General government debt maturing within one year (% of GDP)	>	15.1	21.7	42.9	7.3
Share of general government debt maturing within one year (%)	>	33.2	16.5	57.1	5.4
Share of foreign currency debt (%)	>	29.0	19.8	77.8	0.5
Share of non-residents in debt holdings (%)*	>	25.9	62.8	0.0	7.0
Institutional variables					
Government effectiveness (WGI score)*	<	0.7	23.8	41.7	7.2
Political stability (WGI score)*	<	0.8	41.4	16.7	9.2
Rule of law (WGI score)*	<	1.2	50.2	16.7	6.5
Banking crisis	>	0.0	5.8	75.0	4.0
Past sovereign defaults	>	0.0	22.2	65.0	3.0

Source: CNB, other sources see Table 5
Note: fpr (fnr) stands for false positive (negative) rate. The symbol > (<) denotes that a higher (lower) variable means the critical limit has been exceeded and increased risk is indicated. Higher WGI scores mean higher institutional quality.