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Solvency macro stress test of the domestic banking sector

Contents

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Abbreviations

A-IRB	Advanced Internal Ratings-Based Approach
AT1	Additional Tier 1 capital
BRRD2	Bank Recovery and Resolution Directive 2
CBR	Combined Buffer Requirement
CCoB	Capital Conservation Buffer
CCyB	Countercyclical Capital Buffer
CET1	Common Equity Tier 1
CNB	Czech National Bank
COREP	Common Reporting Framework
CRR2	Capital Requirements Regulation 2
DSGE	Dynamic stochastic general equilibrium model
EA	Exposure amount
EAD	Exposure at default
ECL	Expected credit loss
EP	Eligible profit
FINREP	Financial Reporting
F-IRB	Foundation Internal Ratings-Based Approach
FVPL	Fair value through profit or loss
GDP	Gross domestic product
IFRS 9	International Financial Reporting Standard 9
IRB	Internal Ratings-Based Approach
LGD	Loss given default
LR	Loss rate
MREL	Minimum requirement for own funds and eligible liabilities
NFCI	Net fee and commission income
NII	Net interest income
OCI	Other comprehensive income
OCR	Overall capital requirement
O-SII	Other systemically important institution
P2G	Pillar 2 Guidance
PAT	Profit after tax
PBT	Profit before tax
PCL	Profit for covering losses
PD	Probability of default
PiT	Point-in-time
P/L	Profit and loss statement
RW	Risk weight
SMEs	Small and medium-sized enterprises
SMST	Solvency macro stress test of the domestic banking sector

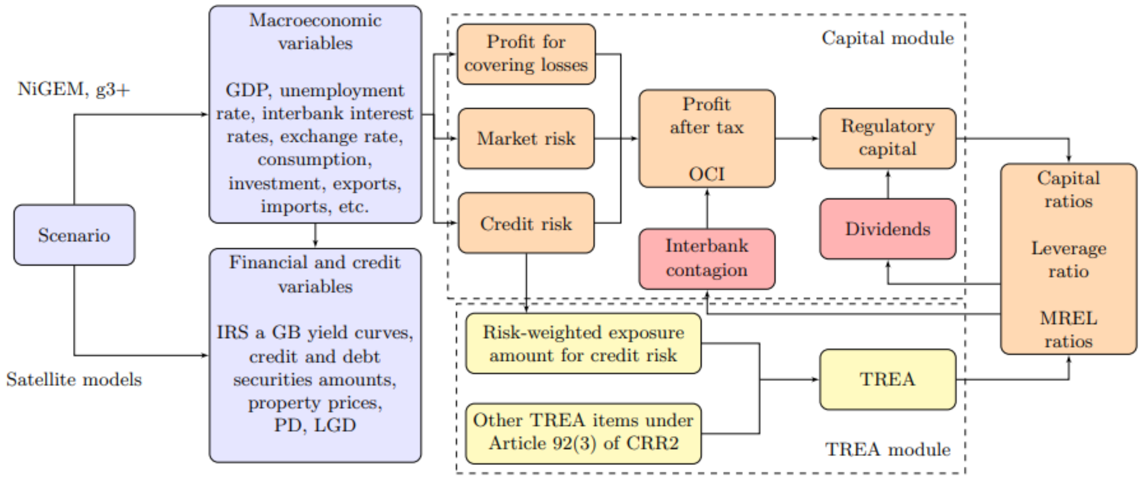
SREP	Supervisory Review and Evaluation Process
STA	Standardized Approach
SyRB	Systemic Risk Buffer
TEM	Total exposure measure
TREA	Total risk exposure amount
TSCR	Total SREP capital requirement
TTC	Through-the-cycle

1 Introduction to banking sector solvency stress testing

Solvency stress tests are a traditional tool for assessing the banking sector's capital resilience (solvency) to potential risks to its stability in a situation of expected and hypothetical future adverse macroeconomic developments (a *Baseline Scenario* and an *Adverse Scenario*). From the microprudential perspective, they make it possible to assess whether individual banks have sufficient capital resilience in relation to the regulatory capital requirements (see section 3). From the macroprudential perspective, they help supervisors assess whether the sector's capital level gives rise to systemic risks to financial stability (Frait and Komárková, 2011) and provide information for the configuration of macroprudential capital tools (Andersen et al., 2019).[1]

The solvency macro stress test of the domestic banking sector (SMST) can be characterised as a dynamic top-down stress test conducted by the Czech National Bank at a time horizon of 12 to 20 quarters. The SMST covers all domestic banks and branches of non-EU domiciled foreign banks in the Czech Republic subject to CNB supervision.[2]

Figure 1: SMST process diagram



Note: The other TREA items under Article 92(3) of CRR2 are not modelled and are left constant in the stress test. MREL ratios = ratios of own funds and eligible liabilities to TREA or TEM.

The SMST process consists of a series of steps (see Figure 1). The starting point is the definition of economic scenarios (see section 2), from which the evolution of macroeconomic and subsequently also financial and credit variables is derived using a number of satellite models (see section 2) over the test horizon. The next step is to determine how the scenarios and macroeconomic, financial and credit variables affect the banking sector's capital resilience through their impact on capital and the total risk exposure amount (TREA). The SMST can thus be divided into two relatively separate but interdependent **model frameworks**: (i) **capital** and (ii) **TREA**.

[1] Their scope is currently being extended to include climate risks, and testing of cyber risks is also being discussed.
[2] With the exception of the National Development Bank and the Czech Export Bank.

The **capital** model framework covers five areas: (i) profit for covering losses (see section 4.1), (ii) the impact of credit risk on profit (see section 4.2), (iii) the impact of market risk on profit and other comprehensive income (see section 4.3), (iv) the effect of interbank contagion risk on capital (see section 4.4) and (v) the effect of dividends on capital (see section 4.5). The **TREA** model framework covers two areas: (i) exposure amount and portfolio structure (see section 4.1) and (ii) risk weights for credit exposures (see section 4.2).

The key piece of information as regards the domestic banking sector's solvency is the **capital ratio** during and at the end of the test period. The test monitors (i) the **total** capital ratio (the ratio of total regulatory capital to the TREA) and (ii) the **CET 1** capital ratio (the ratio of CET 1 regulatory capital to the TREA). These traditional indicators, which take into account the riskiness of a bank's exposures, are complemented by a non-risk-weighted leverage ratio (the ratio of Tier 1 capital to the value of balance sheet and off-balance sheet exposures), which acts as a prudential backstop against the risk of excessive growth in leverage. These indicators are used to evaluate how many banks would fail to the meet capital requirements[3] and the need for and method of capital replenishment.

Additional information on the preparedness of the domestic banking sector for resolution and restoring its solvency is provided in the *Adverse Scenario* by the level of compliance with minimum requirement for own funds and eligible liabilities (MREL)[4], which requires the relevant banks to have the resources to recapitalise and continue to operate even in the event of a crisis.

The starting point for evaluating the banking sector's solvency is an assessment of its ability to meet the Pillar 1 and Pillar 2 capital requirements (TSCR) at all times, including in an adverse phase of the economic cycle (usually represented by an *Adverse Scenario*). A drop in the Czech banking sector's total capital ratio below the TSCR would mean that a large proportion of domestic banks, including systemically important ones, would fail to meet the TSCR on an individual basis.[5] This would indicate a systemic risk of insufficient capital resilience of the domestic banking sector. Such a situation would be an important factor in the CNB's decision-making on the application of cyclical (CCyB) or structural (SyRB, sectoral SyRB) capital buffers or other macroprudential tools to enhance the banking sector's capital resilience.

Additional information about the level of compliance with the MREL allows the potential risks of adverse economic developments to be evaluated for the effectiveness of the resolution framework. In accordance with the transparency principle contained in the CNB's Macroprudential Policy Strategy,[6] the results of the SMST are published in the *Financial Stability Report* and in *Risks to financial stability and their indicators*.

[3] I.e. the total regulatory capital ratio would drop below the TSCR (the total SREP capital requirement, the sum of Pillar 1 and Pillar 2), the sum of the TSCR and the O-SII buffer or the leverage ratio requirement.

[4] For details see BRRD2 and the General approach of the Czech National Bank to setting a minimum requirement for own funds and eligible liabilities

[5] As a general rule, insolvency of individual banks does not necessarily imply insolvency of the entire sector. Conversely, an insolvent system does not necessarily mean that all banks are insolvent.

[6] https://www.cnb.cz/en/financial-stability/macroprudential-policy/

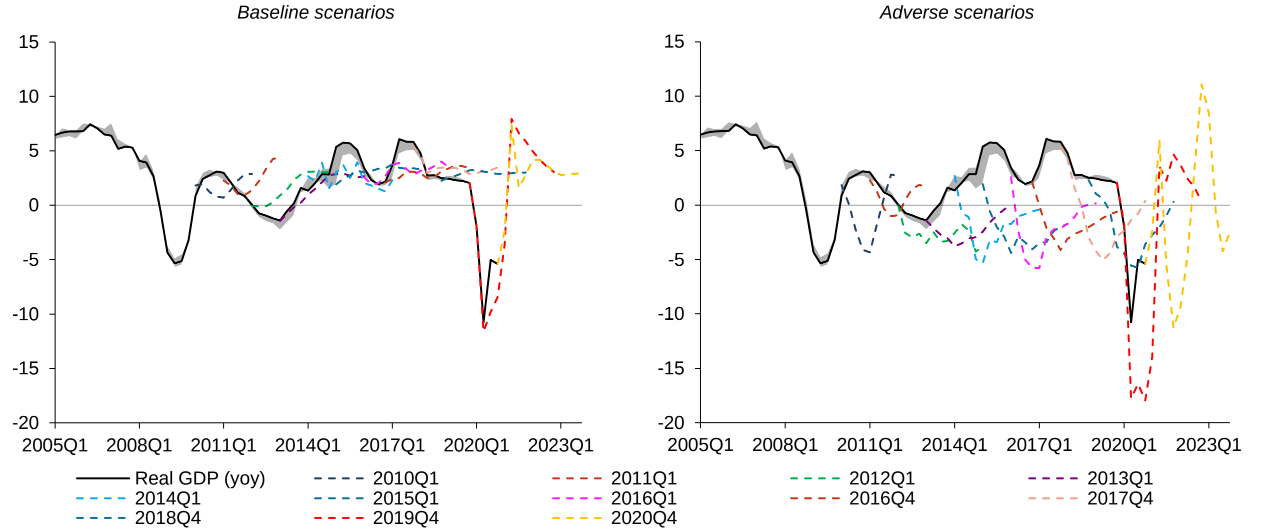
2 Scenarios

The evolution of the economy in the *Baseline* (expected) *Scenario* and *Adverse Scenario* at the horizon of 12 (or alternatively 20) quarters is simulated using the Monetary Department's g3+ DSGE forecasting model (Brázdik et al., 2020). The *Baseline Scenario* is based on macroeconomic forecasts published in the CNB's *Monetary Policy Report* and represents highly likely future economic developments.[7] The hypothetical (worse than expected) *Adverse Scenario* is used to assess severe but plausible tail risks.

When setting the intensity of the stress in the *Adverse Scenario*, the CNB draws on relevant historical experience, especially GDP growth during and after the 2008–2009 financial crisis and during banking crises in other OECD countries, and will also take into account experience acquired during the 2020–2021 pandemic crisis. In designing the scenarios, the CNB does not take into account the distribution quantiles for the historical values of the variables used, as the size and openness of the domestic economy and, from the modelling perspective, the relatively short history of the market economy in the Czech Republic make it difficult to estimate those quantiles with sufficient accuracy and they may not be a sufficient guide for identifying the intensity of shocks to which the economy may be exposed.

Chart 1: Historical stress test scenarios used in *Financial Stability Reports* 2010–2020

(change in real GDP; y-o-y; %)



Note: In 2010 and 2011, the tests had a two-year horizon. Since 2012, they have been conducted at a three-year horizon. The grey area captures the range of data revisions.

The CNB also takes into account the extent of the systemic risks identified and the cyclical position of the real economy and the financial sector. It uses more severe scenarios in expansionary phases

[7] The time series of the variables for the third (and any subsequent) year of the *Baseline Scenario* and all years of the *Adverse Scenario* were created solely for stress testing purposes. For this reason, neither the *Baseline Scenario* beyond the forecast horizon, nor the *Adverse Scenario* is an official forecast of the CNB.

of the cycle than in periods of recession. GDP growth in the *Adverse Scenario* thus usually falls towards the lows historically observed in the Czech Republic and other relevant economies (see Chart 1).

Satellite models developed by the Financial Stability Department are used to supplement the main macroeconomic variables of the DSGE model – such as GDP, inflation, the unemployment rate, the PRIBOR and the exchange rate – with projections of financial variables (interest rates, yield curves, equity prices and property prices), loan amounts and variables characterising credit risk, such as the probability of default (PD) and loss given default (LGD). A more detailed description of the satellite models used can be found in Panoš and Polák (2019a,b), Kučera and Szabo (2019), Časta (2021) and Plašil (2021).

3 Capital requirements, the MREL and the banking sector's solvency

Capital requirements are a traditional form of banking sector regulation, which is based on the Basel framework under which banks' exposures (i.e. their assets and off-balance sheets) are not a homogeneous group and banks should create sufficient capital capacity to absorb unexpected losses, taking into account the riskiness of those exposures. This is reflected in **capital requirements** specifying the minimum amount and quality of own funds that banks are required to hold. Capital requirements are determined mainly through: (i) regulatory capital ratios and (ii) a regulatory leverage ratio. The regulatory capital ratios set a minimum binding capital-to-TREA ratio for banks (see section 4); the riskiness of individual exposures is thus taken into account in the process of setting the capital requirement. By contrast, since 2021 the regulatory leverage ratio has determined the capital requirement relative to the total exposure measure (TEM) and is thus a non-risk-weighted regulatory capital requirement. The required ratio of banks' Tier 1 capital to the TEM is 3%.

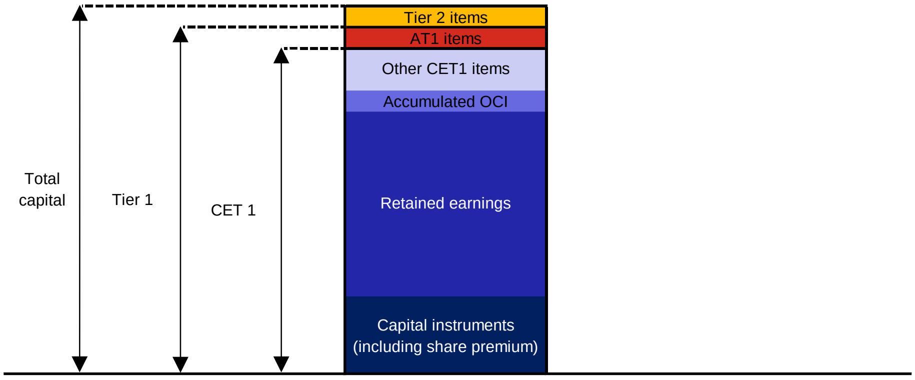
Figure 2: Overview of current solvency requirements

		Expressing the requirement	
		TREA	**TEM**
Subject of regulation	**Capital (capital requirements)**	**Capital ratios** (CET1, Tier 1, total capital ratio)	**Leverage ratio** (Tier 1)
	Own funds and eligible liabilities (MREL)	**$MREL_{TREA}$**	**$MREL_{TEM}$**

Traditional regulation by means of capital requirements has recently been complemented by the **requirement for own funds and eligible liabilities (MREL)** which aims to ensure that specified banks have sufficient resources to maintain their activities even in the event of a crisis.

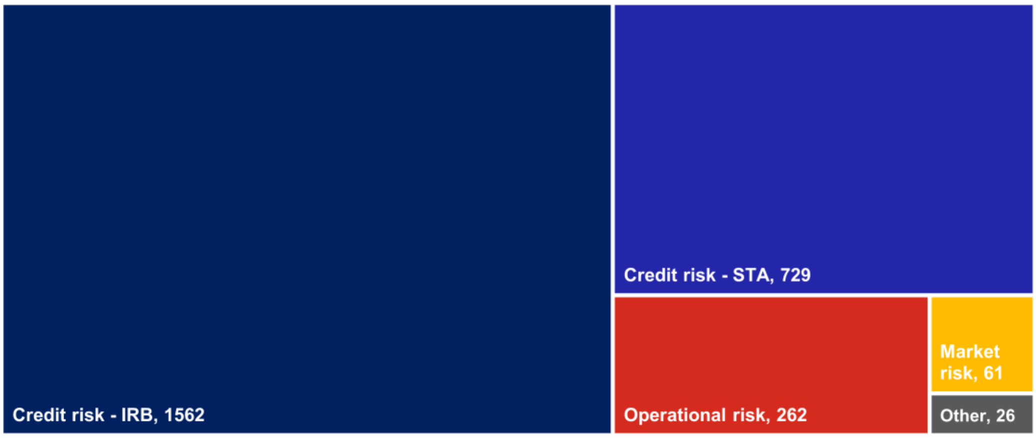
Banks are required to meet the regulatory capital requirements by means of regulatory capital. The requirements regarding its amount and quality are set by legislation. The highest-quality component of regulatory capital is Common Equity Tier 1 (CET1) capital. Lower-quality Additional Tier 1 (AT1) capital and Tier 2 capital can only be used to meet some of the capital requirements. The vast majority of the regulatory capital in the Czech banking sector consists of CET1 items (see Figure 3), the most important of which are retained earnings and capital instruments, including related share premium. They are followed by other CET 1 items, the most important of which are other funds.[8]

Figure 3: Illustrative structure of regulatory capital in the domestic banking sector



Banks' risk profiles are reflected in the total risk exposure amount (TREA). The TREA takes into account the riskiness of individual exposures or groups of exposures and the structural character of the activities of the sector and banks. It thus accounts for exposure amounts for all regulatory risks (Article 92(3) of CRR2), of which risk-weighted exposure amounts for credit risk are the most important in the domestic banking sector (see Chart 2).

Chart 2: Structure of the TREA in the domestic banking sector
(as of 30 June 2021; CZK billions)

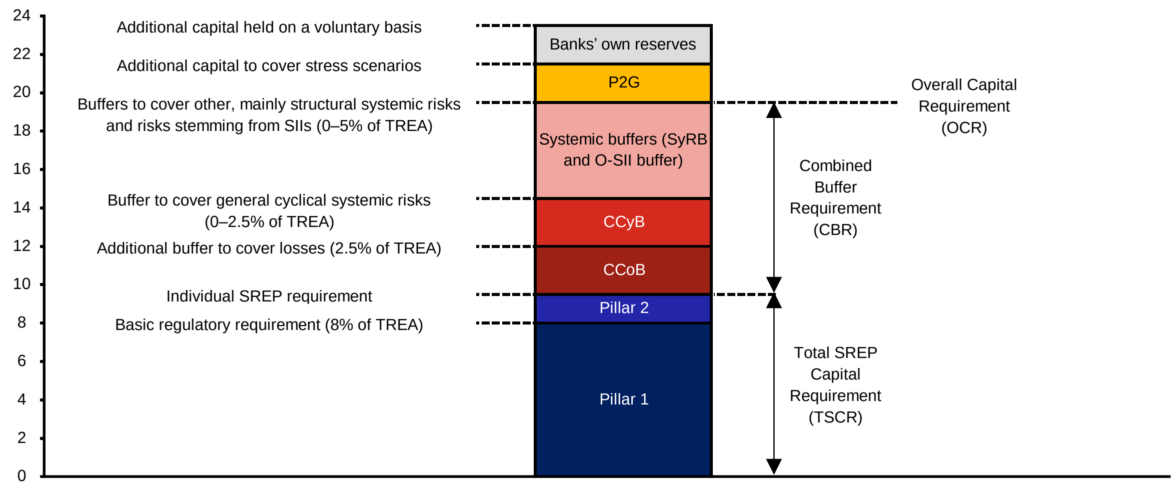


The basic microprudential capital requirement sets a CET1 ratio of 4.5%, a Tier 1 ratio of 6% and a total regulatory capital ratio of 8% of TREA (the "Pillar 1 requirements"). In addition to this requirement, banks are obliged to meet "Pillar 2 requirements", i.e. to hold any additional capital specified at the decision of the CNB. The sum of these two pillars is called the total SREP capital

[8] The other CET 1 items reflect losses for the current financial year and other CET 1 deductions (Article 36 et seq. of CRR2).

requirement (TSCR). Furthermore, banks are required to comply with the – predominantly macroprudential – combined buffer requirement (CBR), which consists of the capital buffer for other systemically important institutions (O-SII buffer), the capital conservation buffer (CCoB), the systemic risk buffer (SyRB) and the countercyclical capital buffer (CCyB). The capital buffers must be filled with CET1 capital. The sum of the Pillar 1 and Pillar 2 requirements and the CBR represents the overall capital requirement (OCR). On top of the OCR, Pillar 2 guidance (P2G) may be set for banks, usually on the basis of supervisory stress test results.

Figure 4: Illustrative structure of capital requirements
(percentage of TREA)



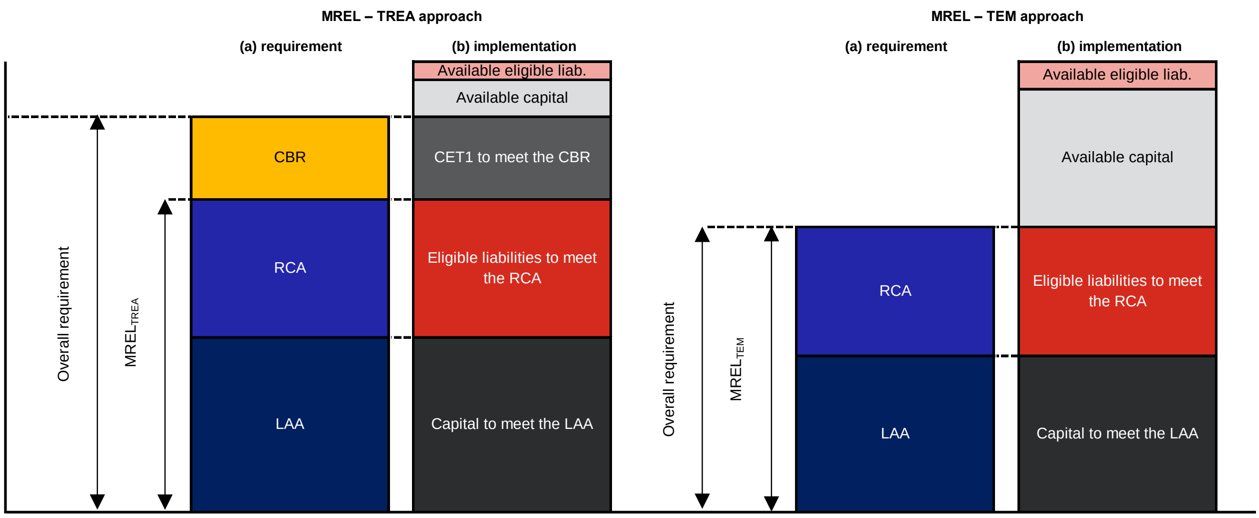
The requirement for own funds and eligible liabilities (MREL) stipulates that banks hold resources filled with own funds, eligible liabilities, subordinated debt or a combination thereof. The CNB sets the MREL for specified banks as the sum of the loss absorption amount (LAA) and the recapitalisation amount (RCA). The two amounts are expressed both in the TREA and the TEM. While the LAA is filled with capital which covers a bank's unexpected losses in a period of adverse developments, the RCA can be topped up using not only own funds but also eligible liabilities or a combination thereof. The RCA is used to recapitalise a bank in default by converting eligible liabilities into own funds. LAA_{TREA} currently corresponds to the TSCR and LAA_{TEM} amounts to 3% of the TEM. The RCA is derived from the preferred resolution strategy and the assumed resolution tool.

Figure 5: Structure and way of expressing the MREL

		Expressing MREL amounts	
		TREA	**TEM**
MREL amounts	**Loss absorption amount (LAA)**	**LAA_{TREA}** (TSCR, sum of Pillar 1 and Pillar 2)	**LAA_{TEM}** (3% of TEM)
	Recapitalisation amount (RCA)	**RCA_{TREA}** (approx. 80–100% of LAA_{TREA})	**RCA_{TEM}** (approx. 80–100% of LAA_{TEM})

Capital requirements and the MREL interact with each other. If banks do not have a sufficient amount of eligible liabilities to meet the MREL, they may top it up using a capital surplus, if available. It holds true that banks cannot meet the $MREL_{TREA}$ by means of capital which they use to meet the requirements stemming from the CBR. However, this does not apply to the $MREL_{TEM}$ and banks can thus use the CBR to meet the $MREL_{TEM}$. While the overall requirement for own funds and eligible liabilities expressed in the TREA is the sum of the $MREL_{TEA}$ and the CBR, it is identical to the $MREL_{TEM}$ if expressed using the TEM. (See Figure 6).

Figure 6: Illustrative structure of MREL requirements and their implementation



A bank or the banking sector is regarded as solvent if it has capital (with an appropriate qualitative structure) that meets the regulatory capital ratios and the regulatory leverage ratio in any phase of the business and financial cycle. Insufficient systemic solvency of the banking sector is indicated by a drop of the actual capital ratio below the regulatory capital ratio corresponding to the TSCR (see Figure 4) or below the regulatory leverage ratio (3% of the TEM). This level would signal the need to resolve a systemic crisis by converting eligible liabilities into own funds to the extent that the sector/bank has sufficient capital to continue its activities.[9] The resolution framework thus significantly enhances the banking sector's ability to continue to function properly and lend to the real economy even in times of very adverse developments.

The banking sector can be regarded as solvent even if some individual banks are insolvent. In this case, the key factor is an assessment of (i) the size of the capital injections and converted eligible liabilities that would be needed to top up the capital to comply with the TSCR and (ii) the solvency of systemically important banks (O-SIIs). A fall the actual capital ratio towards the TSCR, or a fall of the actual leverage ratio towards 3% of the TEM, signals a growing systemic risk of banking sector vulnerability and a higher probability of activating resolution tools.

[9] This is a schematic simplification used only in the SMST. In practice, the start of the resolution process is fully within the competence of a resolution authority, requires a comprehensive assessment of the bank's financial situation and is not linked to a breach of a threshold, e.g. the TSCR.

4 Capital modelling

Capital is primarily affected by (i) current accounting period profit/loss after tax (PAT), (ii) other comprehensive income (OCI) and (iii) dividends paid. In accordance with the legislation in force, regulatory capital in the SMST is set using the following equations:

$$C_t = C_{t-1} + EP_t - (DIV_{t-1} - PAT_{t-1}^{DIV}) + OCI_t$$

$$PAT_t = PAT_t^{DIV} + EP_t$$

In each year (*t*), PAT_t is divided into a portion to be paid out in dividends next year (PAT_t^{DIV}) and a portion to be left as part of CET1 (eligible profit, EP_t). Retained capital (C_{t-1}) is then increased or reduced by EP_t pursuant to the legislation in force. However, the amount of capital is negatively affected by dividends (calculated in accordance with section 4.5) for year *t-1* paid out in year t (DIV_{t-1}). However, their impact on regulatory capital is reduced by the amount set aside for dividend payments in the previous year (PAT_{t-1}^{DIV}).

The projection of PAT is based on the forecast for current accounting period profit/loss before tax (PBT), which is subsequently adjusted for tax (T). PBT consists of profit for covering losses (PCL; see section 4.1) minus the impacts of risks on profit, which include: (i) credit losses (impairment), i.e. the costs of provisioning for loans and receivables due to credit risk (impairment due to credit risk, I_{CredR}; see section 4.2), (ii) market risk profit/loss from exposures measured at FVPL (market risk P/L, $MR_{P/L}$; see section 4.3) and (iii) the costs of provisioning for interbank exposures due to interbank contagion risk (impairment due to contagion risk, I_{ContR}; see section 4.4).

$$PBT = PCL - I_{CredR} - MR_{P/L} - I_{ContR}$$

$$PAT = PBT - T$$

In the stress scenario, banks typically incur losses due to a fall in income (a decrease in PCL, mainly because of a decline in interest income, fee and commission income, etc.), growth in credit losses and realised losses from market risk.

4.1 Profit for covering losses (PCL)

PCL is the main source of income used for covering losses in the SMST modelling framework. It consists mainly of (i) **net interest income** (NII) and (ii) **net fee and commission income** (NFCI), and is reduced by (iii) **administrative expenses**. The evolution of these items is projected using econometric models on the aggregate data for the entire banking sector by applying the ARDL approach and on data for individual banks by means of dynamic panel regressions. iv) The **other**

PCL items are projected in the form of expert estimates taking into account the results of analyses of their evolution and relations indicating low reliability of model predictability.

4.1.1 Net interest income (NII)

NII is the difference between interest income and interest expenses. It is modelled structurally, i.e. it is estimated not in its aggregate form, but using the individual items of interest income and interest expenses. Interest income consists of: (i) interest income on loans and receivables, (ii) interest income on debt securities, (iii) interest income on derivatives, (iv) interest income on other assets and (v) other interest income. Interest expenses consist of: (i) interest expenses on deposits, (ii) interest expenses on debt securities issued, (iii) interest expenses on derivatives and (iv) other interest expenses.

Interest income on loans and receivables is the most important item of interest income. Interest income on loans to the non-financial sector accounts for the largest part. The test models the evolution of interest rates on individual portfolios in relation to the macroeconomic situation, risk-free rates and the time, interest, duration and maturity structure of portfolios. Under certain economic conditions, a large part of interest income on loans and receivables can be generated by interest income on the banking sector's claims on the central bank, which are modelled on the basis of the monetary policy rate (the two-week repo rate) and the banking sector's excess liquidity.

Interest income on debt securities consists of interest on bonds held by banks at amortised cost, which is calculated using granular bond-level data. The primary source of interest income is mainly interest on government bonds and, to a lesser extent, mortgage bonds. The modelling of the amount is based on the maturity structure of current bond portfolios while taking into account purchases of new government bond issues. The purchases of new government bond issues are based on the macroeconomic scenario, national fiscal policy and the historical behaviour of the banking sector and other financial institutions in this area.

Interest income on derivatives is largely offset by **interest expenses on derivatives**, and analyses performed by the supervisory authority enable them to be modelled as relatively constant under certain assumptions, taking into account expert judgement regarding the banking sector's hedging policies.

Interest income on other assets is immaterial relative to the other NII items. It consists mainly of interest income on the minimum reserves held by the banking sector at the central bank. **Other interest income** is also a relatively unimportant item. It can be modelled at a relatively constant level taking into account expert judgement.

Interest expenses on deposits are the largest item of interest expenses. They are fundamentally affected by i) interest rates, which are modelled in relation to deposit characteristics (counterparty, type and the maturity structure), the interest rate path and the shape of yield curves, ii) the amount of deposits, which is modelled in relation to the balance sheet total, and iii) a change in the internal structure of deposits in relation the interest rate path.

Interest expenses on debt securities issued are linked mainly with mortgage bonds issued, the amount of which has long been stable in the domestic banking sector. The interest rate depends on the rates on mortgage loans in the relevant scenario. Eligible liabilities, used by banks to comply with the MREL, may be another important component of debt securities issued under certain conditions. Their volume is linked to banks' issuance plans, and the interest rate depends on interest rates on similar instruments and the shape of yield curves in the relevant scenario.

Other interest expenses are modelled using a constant, given their low importance and in light of analyses performed by supervisors.

4.1.2 Net fee and commission income (NFCI)

The modelling of NFCI is related to the modelling of assets that sufficiently approximate loans and deposits, which are the main sources of fees and commissions.

4.1.3 Administrative expenses

Administrative expenses are an important expense item and are modelled taking into account their observed correlation with GDP.

4.1.4 Other items

Other items, consisting of (i) dividend income, (ii) other operating income and expenses, (iii) depreciation and (iv) provisions or (-) reversal of provisions, fall into categories which are either difficult to model (dividend income, depreciation) or relatively unimportant (other operating income and expenses,provisions or (-) reversal of provisions). Given the above, they are modelled using expert judgement taking into account recent trends and possible scenario effects.

4.2 Credit risk

Credit risk is the most important of the risks tested in the domestic banking sector. It is assessed for debt instruments measured at amortised cost in accordance with IFRS 9. The level of its materialisation is expressed by credit losses (impairments) and loan provisioning due to increased credit risk. For banks' portfolios of (i) loans to non-financial corporations, (ii) loans to households secured by residential immovable property, (iii) other exposures to households, (iv) loans to financial institutions, (v) loans to other financial institutions and (vi) loans to governments, the test models the amount and structure of exposures according to the credit risk stages specified in IFRS 9. The model is described in more detail in Panoš and Polák (2019a).

Portfolio riskiness is expressed by expected credit losses (ECL)[10] and the loss rate (LR),[11] which are affected mainly by the PiT PD and PiT LGD risk parameters. The main variables for the size and structure of the exposures of the bank loan portfolios assessed are the initial loan staging, the transition probability matrix for flows between stages and the gross exposure forecasted using a satellite model (see section 2).

The LR and the exposure volume determine **individual banks' loss allowance for individual portfolios** and the credit losses (impairments) in individual periods.

4.3 Market risk

The market risk framework quantifies the effects of changes in relevant market variables (interest rates, risk spreads, exchange rates, capital asset prices and property prices) on the value of a bank's trading book (profit/loss from market risks is reflected in total profit/loss, and change in the value of securities is reflected in other comprehensive income) as a result of the revaluation of exposures sensitive to these variables. The market risks tested are (i) general and specific interest rate risk, (ii) foreign exchange risk and (iii) equity risk.

4.3.1 General interest rate risk

The scenario forecasts for the CZK and EUR yield curves (rates with 1Y–15Y maturities) have a direct effect on trading book exposures in the interest income and value of bond holdings items through interest rate changes. The revaluation of trading book securities uses detailed data on debt securities holdings measured at fair value on a quarterly basis and is performed using the discounted cash-flow method. The interest rate is constructed from a risk-free interest rate and a risk mark-up. The risk mark-up is the difference between the yield on the asset and the comparable risk-free return.

4.3.2 Credit spread risk (specific interest rate risk)

Credit spread risk is the risk of a change in the value of interest rate-sensitive assets due to a perceived change in their risk premium by financial markets. Shock calibration is performed separately for government and corporate debt securities, taking into account the relevant credit rating and maturity band. Impairment due to change in the credit spread is considered as an additional stress on top of impairment due to general interest rate risk.

4.3.3 Foreign exchange risk

The risk of the net open foreign exchange position (after adjustment for hedging) at the bank level is assessed by incorporating the effect of quarter-on-quarter changes in the CZK/EUR exchange rate (the predominant currency nature of the Czech banking sector's open position). This generates a loss in the case of a positive open position and appreciation of the CZK (i.e. a decline in the CZK value of foreign currency assets) or a profit in the opposite case. Data on the open foreign exchange

[10] ECLs were introduced in IFRS 9. According to paragraph B5.5.28 of IFRS 9, they are a probability-weighted estimate of credit losses (i.e. the present value of all cash shortfalls) over the expected life of the financial instrument.
[11] The LR is a concept derived from ECL. It is the ratio of ECL to defaulted exposures.

position are obtained from foreign exchange risk statements. These statements are completed by banks for which the sum of their net foreign exchange position and their net gold position, including foreign exchange and gold positions for which own funds requirements are calculated using an internal model, exceeds 2% of their total own funds pursuant to Article 351 of CRR2. Banks are required to comply with regulatory limits on the foreign exchange position, so the foreign exchange risk they undertake is limited by regulation.[12] Banks that do not complete this statement for the above reasons are assumed not to be exposed to foreign exchange risk.

4.3.4 Equity risk and real estate risk

All equity securities revalued at fair value and the unit certificates of equity collective investment funds sensitive to changes in equity market prices are exposed to equity risk. Equity securities are marked to market based on scenarios for equity indices modelled by Časta (2021). Real estate risk is tested for all assets whose valuation is sensitive to market property prices.

4.4 Interbank contagion risk

Interbank contagion risk represents an expansion of credit risks and is modelled on the basis of data on interbank exposures available in the AnaCredit database,[13] with the capital ratio of individual banks during the test before the payment of dividend being used to determine their probability of default (PD). The LGD for interbank exposures is set at 45% given the level used for the F-IRB approach. The expected losses due to interbank exposures are then calculated for each bank according to the formula PD*LGD*EAD. If these losses lead to a reduction in the bank's capital ratio and thus an increase in its PD, there follows another iteration of the transmission of the negative effects to other banks through an increase in the expected losses. These iterations are performed until this "domino effect" of interbank contagion stops, i.e. until the rise in PD induced in one bank or group of banks does not lead to an increase in the PD of other banks.

Other areas of interconnectedness that may potentially jeopardise the banking sector's stability (Kučera and Szabo, 2020) are monitored and, where necessary, assessed mainly using sensitivity or separate analyses: (i) linkages to the parent, (ii) linkages to foreign institutions (extra-group), (iii) linkages to domestic financial institutions such as insurance companies, pension management companies, investment funds and other financial intermediaries, (iv) linkages to households, (v) linkages to the largest debtors, (vi) linkages to sectors (e.g. automotive, tourism, gastronomy, energy, CO_2 producers potentially jeopardised by climate regulation), (vii) linkages by asset type (government bonds, corporate bonds, equities, currencies and real estate).

[12] Article 112 of Decree No. 23/2014 Coll., on the performance of the activities of banks, credit unions and investment firms.
[13] For details see https://www.cnb.cz/en/statistics/AnaCredit/

4.5 Dividends

The modelling of the amount of dividends paid is based on the assumption that banks cannot pay dividends in a way that breaches the binding regulatory requirements for capital ratios, the leverage ratio and the MREL. The starting point is the determination of the “targeted regulatory ratios”, i.e. targeted capital ratios, the targeted leverage ratio and the targeted ratio of own funds and eligible liabilities based on expert judgement taking into account the banking sector’s long-term patterns of behaviour in managing capital and dividend policies and any restrictions stemming from the CNB’s actions in this area.[14] For example, the targeted total capital ratio usually[15] exceeds the sum of the Pillar 1 and Pillar 2 requirements and the CBR (i.e. the OCR). Similarly, the targeted ratio of own funds and eligible liabilities exceeds the sum of the MREL and CBR for the $MREL_{TREA}$ or exceeds the $MREL_{TEM}$. If the actual regulatory ratios are higher than the targeted regulatory ratios during the test, the model allows dividends to be paid (however, the amount paid out must not exceed the level that guarantees that all the targeted regulatory ratios are maintained; otherwise, profits are accumulated to achieve the targeted regulatory ratios).

5 Total risk exposure amount modelling

The TREA structural model in the key area of credit risk and counterparty risk (RWE_{CR}) is based on individual bank data provided to the CNB (COREP, FINREP),[16] where RWE_{CR} for each bank depends on its risk profile and the approach it uses to measure credit risk (IRB, STA). The exposure amounts of the relevant portfolios (EA), on which changes in the structure and size of the total portfolio are conditional, and the risk weights (RW) are modelled.

Almost all exposure classes in the STA and IRB approaches (RWE_{CR}^{M}) are modelled within RWE_{CR}. They include the materially most important exposures that predominate in the banking sector as a whole, such as the “exposures to corporate” class in the STA approach and the “retail – secured by immovable property SME” class in the IRB approach. The remaining classes[17] are constant (RWE_{CR}^{NON-M}). As of 30 June 2021, RWE_{CR}^{M} accounted for 89% of RWE_{CR}, i.e. 77% of the TREA. The risk-weighted exposure for other types of risks (see Chart 2) is constant due to its immateriality (RWE_{Other}). For the TREA, it thus applies that:

$$TREA = RWE_{CR} + RWE_{Other} = RWE_{CR}^{M} + RWE_{CR}^{NON-M} + RWE_{Other}$$
$$= EA * RW + RWE_{CR}^{NON-M} + RWE_{Other}$$

[14] See, for example, https://www.cnb.cz/en/cnb-news/press-releases/Information-of-the-CNB-on-the-distribution-of-profits-for-2019-and-2020-by-credit-institutions/
[15] It may be lower where capital buffers are applied in periods of adverse economic developments.
[16] https://www.cnb.cz/cs/dohled-financni-trh/vykon-dohledu/informacni-povinnosti/vykaznictvi-bank-a-pobocek-zahranicnich-bank-vuci-ceske-narodni-bance/metodika-k-dohledovemu-vykaznictvi-pro-banky-dz-a-ocp-podle-narizeni-eu-a-narodnich-pozadavku-od-konce-roku-2018-eba20181201/index.html
[17] They include in particular the “equity” asset classes in both the IRB and STA approaches, and also “collective investment instruments“, “other exposures” and others.

5.1 Exposure amount (EA) and portfolio structure

The modelling of EAs is based on estimates obtained from credit risk models (see section 4.2); loss allowance can be taken into account in the case of the STA approach (specific credit risk adjustments). Each modelled exposure class is assigned a corresponding counterparty on the basis of the results of the credit risk models. Exposure amounts for performing loans (approximated by Stages 1 and 2 under IFRS 9) and non-performing loans (approximated by Stage 3 under IFRS 9) are modelled taking into account the initial stock of exposures in individual banks and classes. A change in the default rate in the scenario leads to a change in portfolio structure, as the ratio of performing to non-performing exposures changes. This results in a change in the total size of RWE_{CR}^{M}, as different RWs are applied to performing and non-performing exposures in accordance with CRR2 and the model framework below. The evolution of the EA for each exposure class depends on the counterparty the class represents. For example, the evolution of the “exposures to corporate” class is thus determined by that of the credit risk exposure for “non-financial corporations” in the STA approach, and “retail – secured by immovable property SME”by “households secured by residential immovable property” in the IRB approach. This ensures a sufficiently granular approach that takes account of the evolution of exposures from the accounting perspective.

5.2 Risk weights (RW)

Risk weights are calculated separately for the IRB approach and the STA approach.

5.2.1 IRB approach

The modelling of risk weights uses data for individual banks at the level of the risk stages[18] of the individual exposure classes and responds to the evolution of the risk parameters of the probability of default through the cycle ($TTC\ PD$) and loss given default ($Stress\ LGD$). It is also affected by other regulatory parameters entering the risk weight calculation, such as the correlation coefficient ($R(TTC\ PD)$) and maturity adjustment ($Z(b;M)$). The formula for calculating RW is based on CRR2, i.e.

$$RW = \left(Stress\ LGD * N \left\{ \begin{array}{l} \dfrac{1}{\sqrt{\left(1 - R(TTC\ PD)\right)}} * G(TTC\ PD) + \\ \sqrt{\dfrac{R(TTC\ PD)}{1 - R(TTC\ PD)}} * G(0{,}999) \end{array} \right\} - TTC\ PD * Stress\ LGD \right) * Z(b;M) * 1{,}06 * 12{,}5$$

[18] Banks assign exposures to rating systems (Article 170 of CRR2), which are made up of risk grades. The grades can be viewed as baskets into which exposures are pooled to create more homogeneous groups according to borrowers’ risk of default.

However, the formula does not apply universally to all exposure classes and the A-IRB and F-IRB approaches, but changes depending on the specific requirements of CRR2.

A point-in-time (PiT) satellite model of risk parameters $PiT\ PD$ and $PiT\ LGD$ is employed to determine the evolution of RW, which changes depending on the evolution of $TTC\ PD$ and $Stress\ LGD$. The PiT values of the risk parameters are used to derive longer-term values through the cycle (TTC) and their evolution is applied to the initial risk parameter values reported by individual banks. It is subsequently entered in the RW calculation formula.

5.2.2 STA approach

The initial RW is obtained as the ratio of the risk-weighted exposure after adjustment by the SME supporting factor[19] to the exposure amount (i.e. after applying credit risk mitigation techniques). This RW is constant over the entire test for the relevant asset class.

$$RW = \frac{Risk - weighted\ exposure}{Exposure\ amount}$$

[19] Where amounts after adjustment by the SME supporting factor are used, the SME supporting factor need not be applied to the exposure ratio. The model thus assumes – for reasons of maintaining a conservative approach – that the ratio remains constant.

References

ANDERSEN, H., ET AL. (2019): *A Macroprudential Stress Testing Framework*. Oslo: Norges Bank, 2019. Staff Memo, No. 1/2019.

BRÁZDIK, F., ET AL. (2020): *The g3+ Model: An Upgrade of the Czech National Bank's Core Forecasting Framework.* Prague: Czech National Bank, 2020. Working Paper Series 7/2020.

ČASTA, M. (2021): *Deriving Equity Risk Premium Using Dividend Futures*. Prague: Czech National Bank, 2021. Working Paper Series 1/2021.

FRAIT, J., and KOMÁRKOVÁ, Z (2011): *Financial Stability, Systemic Risk and Macroprudential Policy*. Prague: Czech National Bank, 2011. Financial Stability Report 2010/2011.

KUČERA, A., and SZABO, M. (2019): *Estimating the Neutral Czech Government Bond Yield Curve.* Prague: Czech National Bank, 2019. Thematic Article on Financial Stability 3/2019.

KUČERA, A., and SZABO, M. (2020): *Interconnectedness and Contagion in the Czech Financial System*. Prague: Czech National Bank, 2020. Thematic Article on Financial Stability 5/2020.

PANOŠ, J., and POLÁK, P. (2019a): *The Impact of Expectations on IFRS 9 Loan Loss Provisions.* Prague: Czech National Bank, 2019. Research and Policy Notes 3/2019.

PANOŠ, J., and POLÁK, P. (2019b): *How to Improve the Model Selection Procedure within a Stress Testing Framework.* Prague: Czech National Bank, 2019. Working Paper Series 9/2019.

PLAŠIL, M. (2021): *Designing Macro-Financial Scenarios: The New CNB Framework and Satellite Models for Property Prices and Credit.* Prague: Czech National Bank, 2021. Research and Policy Notes 1/2021.