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Stress test of the collective investment funds and pension management company participation funds[1]

Contents

1 The methodology is valid as of 2022 but will be updated on an ongoing basis.

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1. Introduction

Stress tests of the collective investment funds and pension management company participation funds sector (hereinafter funds) are used at the CNB to assess the resilience of individual funds and the sector as a whole in adverse economic situations. The tests primarily monitor balance-sheet liquidity risk and the extent to which the behaviour of funds in a difficult liquidity position contributes to growth in systemic risk.

The test methodology is based on the nature of doing business in the collective investment funds sector and a holistic view of it. The test also covers the sector of participation funds of pension management companies, which are similar to collective investment funds in their business model and regulation. The test assumes that losses on a fund's investment portfolio arising from adverse developments on financial markets are directly passed on to unit holders in collective investment funds and participants in pension management company funds (hereinafter investors). They respond to the losses incurred in the form of increased sell-offs of fund units. By redeeming units and paying out shares, collective investment funds and partly also participation funds gradually exhaust their liquid asset buffers and are forced to sell their other assets if the buffers are insufficient. This adversely affects their price. In the case of assets held across the domestic financial system (for example, Czech government bonds), their sell-off and a related drop in prices would lead to losses being incurred by other asset holders too (banks, insurance companies, transformed pension funds). Consequently, the adverse developments in the funds sector would spread to other sectors of the domestic financial system.

The test is constructed dynamically on two levels. According to the scenarios considered (part 2), the impact of shocks on fund balance sheets is computed in each quarter. For each quarter, the additional shock resulting from investors' redemptions is then calculated on a monthly basis (i.e. three times per quarter). The following schematic diagram (Box 1) shows the simplified test calculation procedure for each quarter. At the beginning of each quarter, assets held by funds are repriced according to the given scenario (part 2) and margin requirements are generated from derivative contracts (part 3). Part of the investors react to the decrease in the value of the fund by leaving the fund (part 4). In the event of a discrepancy between the volume of the fund's repurchased securities (and fund shares/units) and the volume of deposits held by the fund, the fund sells part of its assets, with a possible negative impact on their prices and thus the value of the fund. This leads to additional departures of investors in the given quarter.

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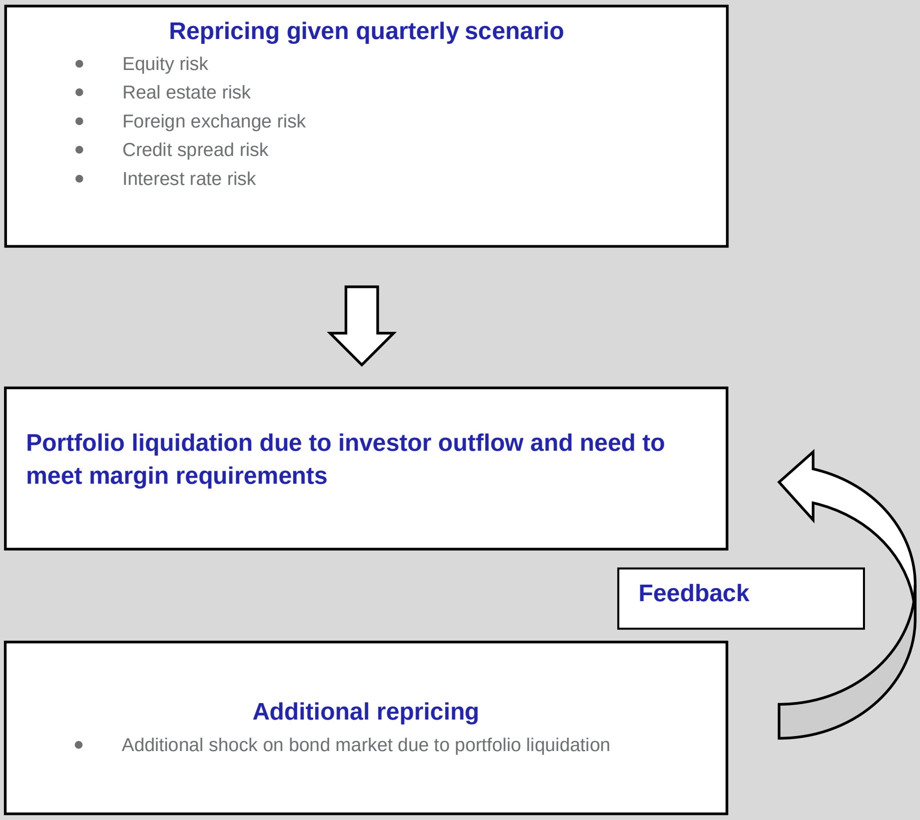
BOX 1: Schematic diagram of one quarter of the stress test



2. Stress test scenarios

The starting point for the macro stress test is an adverse macroeconomic scenario. To compare the effects of the adverse scenario with the most probably outcome, the stress tests also use a baseline macroeconomic scenario. Such scenarios are designed using the CNB's forecasting model. Its output is supplemented by projections of selected financial variables, which are generated using the CNB's satellite models. The test uses the exchange rate scenario from the official forecasting model and takes property prices, yield curves and stock market developments from the satellite models.

The variables given by the scenario are used to revalue the assets held by the funds on a quarterly basis. The scenario always represents the development of the above quantities over a period of three years from the beginning of the test. The test also assumes a static balance sheet, which means that no change in assets due to the arrival of new participants or a change in the portfolio structure is considered. However, the test takes into account future liquidity inflows from debt security holdings. Inflows from coupons and maturing principal will increase funds' deposits at banks. Their reinvestment and bond issuer default are not considered. This means that the holder always receives

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income on debt securities earning positive rates of interest at maturity. Furthermore, the test does not consider yields on property, bank deposits and equity dividends. It thus represents the upper bound of the impact of changes in prices on the individual funds.

Data as of the end of the calendar year preceding the year of the stress test are considered as the basis for calculating profit/loss and liquidity (the ratio of liquid assets to total assets) in the stress test. The test includes most pension management company participation funds and open-end collective investment funds. By contrast, the test excludes funds for qualified investors, as they differ in terms of the nature of their business and their liquidity risk is thus often limited.

3. Risks considered by the scenario

Equity risk and real estate risk

All equity securities measured at fair value and the unit certificates of equity collective investment funds sensitive to a change in the level or volatility of equity market prices are tested for equity risk.

Real estate risk is tested for all assets whose valuation is sensitive to the level or volatility of market property prices. In addition to real estate, this applies to direct or indirect holdings in real estate companies if the look-through approach is applied.[2]

The change in the value of equity securities after the application of the equity shock and the change in the value of property is calculated as the product of a scenario-based coefficient on the relevant shock and the value of the security/property on the relevant date.

BOX 2: Method for calculating equity and real estate risk

Mathematically, the change in the value of an asset held by a fund in the form of an equity security or property ΔA_{type} is calculated as:

$$\Delta A_{type} = A_{type,T+1} - A_{type,T} = A_{type,T} * shock_{type} \qquad (1)$$

where A_{type} is the value of the asset and $shock_{type}$ is the coefficient on the relevant A_{type}.

Interest rate risk

A general interest rate shock is applied to all assets whose values are sensitive to a change in interest rates. This applies in particular to debt securities and interest rate derivatives. The scenario

[2] The look-through approach involves breaking down the fund's holdings by the real underlying investment assets (in this case, real estate). This approach is used if we can identify the specific risks associated with the real estate companies in which the investment fund has ownership interests. If we are unable to identify such risks, general equity risk is applied.

defines risk-free yield curve values separately for koruna interest rates and for foreign currency interest rates.

The interest rate shock is applied using the discounted cash-flow method. The discount rate is constructed from the risk-free interest rate[3] and a risk mark-up. The risk mark-up is the difference between the yield on the asset and the comparable risk-free return. When the shock is applied the risk-free interest rate changes according to the scenario, while the risk mark-up remains constant. The test also takes into account derivative hedging of the exposure against interest rate risk, where interest rate derivatives are marked to market by discounting payments arising from them using swap curves.

BOX 3: Method for calculating interest rate risk

Mathematically, the change in the value of a debt security or an interest rate derivative ΔA_{IR} is calculated as:

$$A_{IR} = A_{IR,T+1} - A_{IR,T} = A_{IR,T} * shock_{RFR} \quad (2)$$

where $A_{IR,T}$ is the value of the debt security (derivative) and $shock_{RFR}$ is the coefficient on the relevant $A_{IR\,,T}$ which represents the movement in the risk-free yield curve.

Credit spread risk

Credit spread risk is applied to assets which are sensitive to interest rates (in the case of this test, debt securities). It represents the risk of change in the market price of these securities due to a perceived change in their risk premium by financial markets. The expected shortfall method is used to calibrate this risk. This method calculates the average loss on the given security type in the tail of the loss distribution.[4] 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 always considered an additional stress on top of impairment due to general interest rate risk and, in simplified terms, expresses the risk of default and other portfolio factors influencing the price.[5] The shock is calibrated so as to take into account the increase in the credit spread only and not movements in swap curves, which are part of the general interest rate risk (see Box 3).

[3] In this test, the swap interest rate is considered to be the empirical equivalent.

[4] For more details, see, for example: https://en.wikipedia.org/wiki/Expected_shortfall

[5] In the case of Czech government bonds, credit spread risk and general interest rate risk can be combined in the calculation.

BOX 4: Method for calculating credit spread risk for debt securities

Mathematically, the change in the value of a debt security ΔA_{IR} is calculated as:

$$\Delta A_{IR} = A_{IR,T+1} - A_{IR,T} = A_{IR,T} * shock_{maturity,rating} \quad (3)$$

where $A_{IR,T}$ is the value of the debt security and $shock_{maturity,rating}$ is the coefficient on the relevant $A_{IR,T}$.

Foreign exchange risk

Debt and equity securities denominated in foreign currency are subject to foreign exchange risk. If the foreign currency appreciates in the scenario, the koruna value of foreign currency assets rises. Conversely, an appreciation of the koruna is associated with a drop in the koruna value of foreign currency assets. In the case of equity securities, the change in the exchange rate in the scenario is applied to the koruna value of the foreign currency exposure as of the reference date. In the case of debt securities, where foreign exchange risk and interest rate risk work together, the exchange rate shock is applied to the koruna value of the asset only after the general interest rate shock has been applied. The test also takes into account derivative hedging of the exposure against foreign exchange risk. Currency hedging is also considered in connection with foreign exchange risk. Foreign currency derivatives are marked to market by discounting payments arising from them using swap curves.

BOX 5: Method for calculating exchange rate risk

Mathematically, the change in the value of a foreign currency equity holding ΔA_{ER} is calculated as:

$$\Delta A_{ER} = A_{ER} - A_{ER} * shock_{ER} = A_{ER} - A_{ER} * \left(\frac{ER_{T+1} - ER_T}{ER_T}\right) \quad (4)$$

where A_{ER} is the value of the foreign currency asset and $shock_{ER}$ represents the percentage change in the exchange rate in the period monitored.

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4. Additional risks considered on a monthly basis

After each quarterly repricing based on the scenario, the behavioural reaction of investors is considered in the next three months. Each month, investors' exit is estimated depending on the type of fund[6] and its losses. This puts liquidity pressure on the fund's portfolio (a liquidity outflow is caused by the repurchase of securities issued by the fund or the payout of shares). This caused not only by the outflow of individual investors, but also by the need to meet margin requirements arising from derivative contracts. As regards fund type, equity funds, bond funds, mixed funds and real estate funds are distinguished in the test. Participation funds of pension management companies are a special category. For simplicity, the test assumes an investment portfolio liquidation period of 30 days as the upper limit of the regulatory period. The test assumes that a 10% decline in the unit value will lead to the exit of investors holding 4% of assets in the case of equity funds, 8% in the case of mixed and other funds and 12% in the case of bond funds. For real estate funds, a very low monthly liquidity outflow of 1% was chosen due to the low sensitivity of investors to price changes, as for them the regulatory period for redeeming a unit is up to two years. Similarly, loss of state support and additional taxation upon early termination of pension savings is taken into account in the case of participation funds. For this reason, the sensitivity parameter is also set at 1% for them. For precautionary reasons, the model does not assume the possibility to suspend the redemption of fund units.

The test assumes two methods for selling off assets from the fund's portfolio due to an outflow of investors and the need to meet margin requirements. The first is the waterfall method, under which funds address their liquidity needs first by using cash and bank deposits and only then by selling less liquid assets. The second is the slicing method, which assumes that funds maintain constant proportions of individual asset classes in the portfolio when selling their assets.

Investor outflows and additional margin requirements due to losses on derivatives contracts

In the case of exchange rate risk, dynamic changes in the exchange rate are considered on the basis of the macroeconomic scenario. Margin requirements arising from the revaluation of derivative contracts are also considered when calculating exchange rate risk for derivative contracts. As in the case of investor outflows, these requirements exert pressure for the liquidation of assets from the investment portfolio due to the need to replenish cash on the margin accounts of central counterparties.

BOX 6: Liquidity need of the fund in one month

[6] Type of investment fund in terms of dominant investment strategy, or pension management company participation fund.

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Mathematically, the total liquidity need is designated as $Liquidity\ outflow_{fund\ type,unit}$. In each fund, this liquidity outflow is expressed as the sum of the outflow of liquidity due to investor outflows ($Liquidity\ outflow_{investors}$) and the margin requirements ($Liquidity\ outflow_{ER}$).

$$Liquidity\ outflow_{fund\ type,unit} = Liquidity\ outflow_{ER} + Liquidity\ outflow_{investors} \quad (5)$$

Owing to the distribution of its impact on the various types of assets, the total liquidity need is then converted to a vector variable, where the sum of the elements of the vector is equal to the original scalar value. This vector is then deducted from the fund's balance sheet, which is expressed as a vector of the same size, which can be expressed as:

$$\vec{A}_{fund,T+1} = \vec{A}_{fund,T} - \overrightarrow{Outflow}_{fund\ type,unit,sell-off\ method} \quad (6)$$

$\vec{A}_{fund}$ is the vector of all assets in the fund's portfolio. The individual elements of this vector are determined on the basis of the liquidity of the asset type. $\overrightarrow{Outflow}_{fund\ type,unit,sell-off\ method}$ expresses the distribution of the scalar value of $Liquidity\ outflow_{fund\ type,unit}$. The value of each element of the vector $\overrightarrow{Outflow}_{fund\ type,unit,sell-off\ method}$ varies based on the sell-off method used and expresses the amount of the asset type sold. The value of $Liquidity\ outflow_{investors}$ is calculated as:

$$Liquidity\ outflow_{investors} = \Delta Unit * c_{fund\ type} \quad (7)$$

where $\Delta Unit$ is the change in the value of the fund unit and $c_{fund\ type}$ is the sensitivity of the investors in the given fund type to change in the value of the investment.

Mathematically, the liquidity outflow due to the need to meet the margin requirements is expressed as:

$$Liquidity\ outflow_{ER} = c * \Delta DERIV \quad (8)$$

where c is the coefficient on the margin requirements in relation to the change in the value of derivatives transactions. This coefficient is obtained using linear regression between the historically observed margin requirements need and the change in the fair value of derivatives based on data from the EMIR database. $\Delta DERIV$ is the change in the fair value of derivatives.

Additional shock on the government bond market due to portfolio liquidation

The test assumes that the amount of assets sold by funds affects the market prices of those assets. The test considers this effect only for Czech government bonds, as funds account for a negligible part of demand/supply on most of the other markets considered in the stress test. The decrease in the price of Czech government bonds is modelled in the test as being directly proportional to the amount of bonds sold and the depth of the market. Quantifying this affect enables the contribution of funds to the overall systemic risk associated with this market to be assessed.

BOX 7: Method for calculating the decrease in the price of Czech government bonds due to fire sales

Mathematically, the change in the value of a Czech government bond ΔA_{IR} is calculated as

$$\Delta A_{IR} = A_{IR,T} * shock_{amount\ of\ bonds\ sold} \tag{9}$$

where $A_{IR,T}$ is the value of the Czech government bond after the initial shock and $shock_{amount\ of\ bonds\ sold}$ is the coefficient on the relevant $A_{IR,T}$.

$$shock_{amount\ of\ bonds\ sold} = \frac{amount\ of\ bonds\ sold}{market\ depth} \tag{10}$$

where the *amount of bonds sold* is defined as the sum of all Czech government bonds sold by funds in the given period and market depth is defined as:

$$market\ depth = c * \frac{ADV}{\sigma} * \sqrt{t} \tag{11}$$

where ADV is the average daily volume of Czech government bonds traded, σ is the historical volatility of Czech government bonds traded, c is an adjustment coefficient and $\sqrt{t}$ is a scaling coefficient which enables the coefficient $shock_{amount\ of\ bonds\ sold}$ to be converted from a one-day to a multi-day impact.

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