The new conceptual risk budget framework and implementation of the new FX reserves investment strategy at the Central Bank of Hungary

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Abstract

Reserve portfolios prior to the Global Financial Crisis provided positive (low) returns for central banks or had extremely low probabilities of earning negative returns. In the wake of the crisis, expansionary monetary policy created a low yield environment at a scale that was never seen before. Central banks like the Central Bank of Hungary (MNB)[2] had to make a decision: either continue reserve management based on the traditional approach or increase their risk tolerance for higher yields. The Bank decided to embrace a new approach, i.e. put in place a risk budget framework in reserve management. This framework aims to find the optimal strategic asset allocation of the institution based on the risk appetite and capacity of the Bank and to prudently keep the risk of the portfolio within the predefined levels. In practice, the risk budget is a risk measure expressed in nominal terms that cannot be exceeded by the portfolio. This paper presents the implementation process of the MNB's risk budget framework, including the determination of the risk budget size and the new strategic asset allocation.

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Keywords: risk budget, risk management, expected shortfall, international reserves, strategic asset allocation, reserve adequacy

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[2] MNB – Magyar Nemzeti Bank i.e. the Central Bank of Hungary

1. Motivation behind the changes

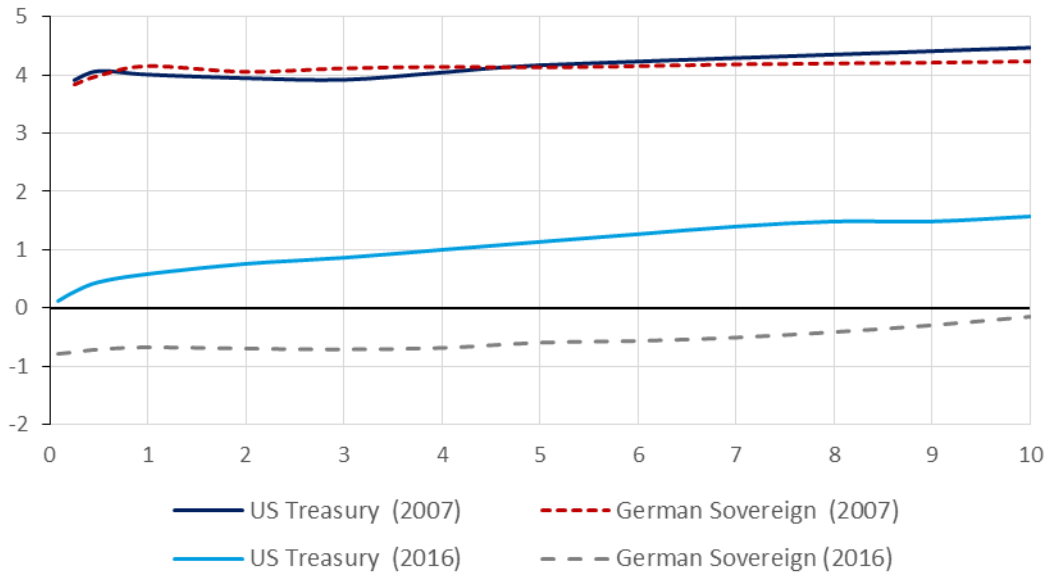
1.1 Traditional pre-crisis approach of safety-liquidity-return

Reserve management in the traditional sense is characterised by a safety-liquidity-return approach best expressed in the IMF guidelines for foreign exchange reserve management.

The first aspect of reserve management – i.e. safety – seeks to ensure that (i) the reserve portfolio is made up of high-quality assets with low volatility, (ii) risks are prudently controlled and (iii) the central bank faces very low probability of negative return. The purpose of the second aspect – the liquidity requirement – is to ensure that reserve assets can be converted into a major currency (for intervention, liquidity needs or other purposes) when they are most needed, while also avoiding significant financial losses. The final aspect – generating a reasonable return on the reserve portfolio over the medium to long term – is sought after provided that priority is given to the first two requirements.

This trade-off between the safety-liquidity pair and investment return usually results in a conservative asset allocation containing safe but lower yielding financial assets. The job of finding a balance, which is considered more of an art than a science by some, was more feasible prior to the Global Financial Crises (GFC) of 2007–08, given the higher (and positive) yields available on high-quality instruments (Graph 1).

Yield curves before and after the GFC — Graph 1



In general, reserve portfolios before 2007 provided moderate positive returns for central banks or had extremely low probabilities of earning negative returns. The return distribution of the reserve portfolio was characterised by an expected value located in the positive territory, low standard deviation and low probability of extreme values.

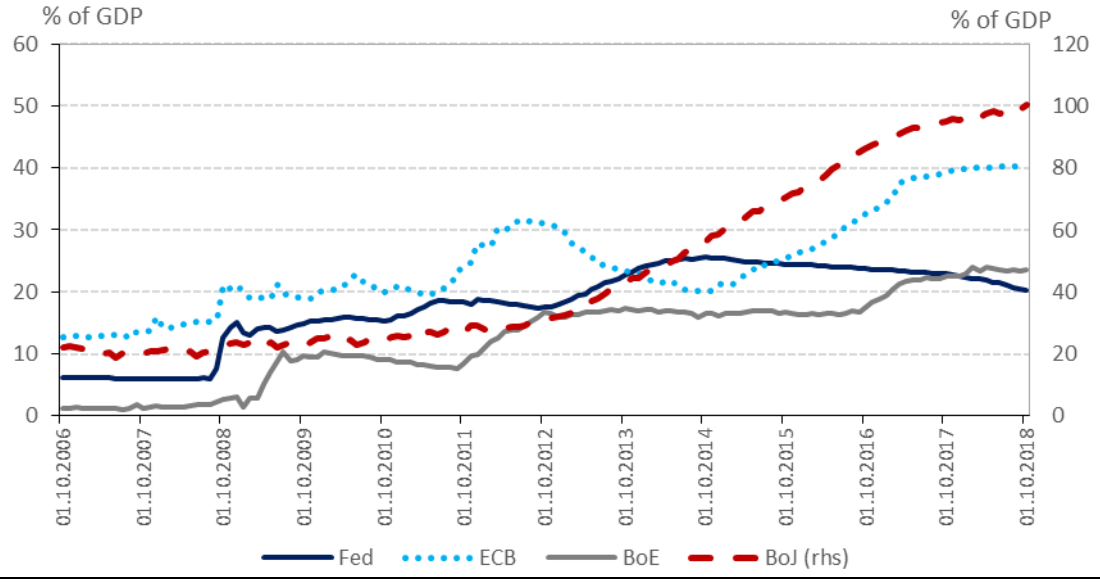
1.2 Changes in the market environment regarding safety, liquidity and return since 2008

In the wake of the GFC, central banks initially used conventional monetary policy tools to stimulate their economies, however lowering interest rates close to zero (or even lower) between 2008 and 2010 had limited effects.

Sustained weak economic activity and high unemployment rates forced central banks to turn to unconventional monetary policies. Quantitative easing and asset purchase programmes implemented after 2010 by major central banks – i.e. the Fed, European Central Bank (ECB), Bank of England (BoE) and Bank of Japan (BoJ) – had unintended, negative consequences for central banks in emerging market economies (EMEs). Due to the rapid growth of the major central banks' balance sheets, reserve managers of EMEs faced the challenge of a shrinking investment universe (Graph 2). Reserve managers were forced up the risk curve as the so-called portfolio rebalancing effect impacted not only the private sector but also smaller central banks. Furthermore, combining these asset purchase programmes with the different kinds of regulations imposed after the crises resulted in a declining market liquidity.

All things considered, expansionary monetary policy created a low yield environment at a scale never seen before.

Balance sheet growth of major central banks — Graph 2



1.3 Rethinking the traditional FX reserves asset allocation concept

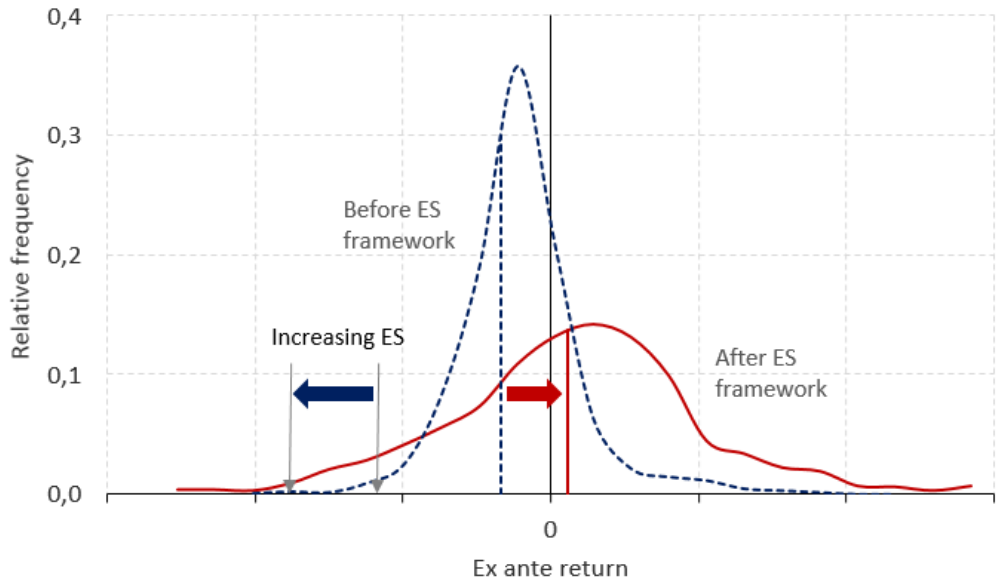
In this new market environment, the traditional safety–liquidity–return concept had to be reconsidered by central banks. Worsening liquidity and low or even negative yields on conventional reserve assets paved the way for new asset classes and markets. Regarding the safety aspect, expected returns on the reserve portfolios had turned into negative territory for many central banks. As a consequence, capital preservation has since become a paramount concern, especially for central banks heavily invested in the euro zone government bond market.

As negative expected return threatened the preservation of capital, the importance of avoiding certain or highly probable negative return increased, especially compared to the importance of strictly focusing on limiting extreme losses on the portfolio.

Naturally, increasing the expected return to positive levels requires higher risk-taking from the central bank. In this trade-off, higher expected returns or, in other words, an increased first momentum (in the expected value) of the return distribution comes at a higher financial risk and a return distribution with a higher standard deviation, and increased kurtosis (Graph 3).

Hypothetical changes in the return distribution

Graph 3



Looking at long-term international trends, it is clear that as an immediate response to the GFC central banks narrowed the range of financial instruments they invested in, but this process has reversed in the era of permanent low yields. An argument could be made that central banks tend to have some level of procyclicality in their reserve management behaviour.

Central banks like the MNB had to make a decision: continue reserve management based on the traditional approach or increase their risk tolerance for higher yields, i.e. having a return distribution with a higher standard deviation, and increased kurtosis. Facing this trade-off, the MNB decided to embrace a new approach in reserve management. The decision was partly triggered by a special, unfavourable development. Though both the ex ante and ex post returns on the FX reserves were shrinking after the GFC, prior to 2015 they remained in positive territory. But as the front end of the relevant yield curves declined significantly below zero, the ex ante return became negative by 2016.

In order to control additional risk-taking, the MNB decided to implement a new risk budget framework for its reserve portfolio.

2. The MNB's risk budget framework

2.1 Different definitions of risk budgeting

Financial literature provides a couple of definitions related to risk budgeting and capital budgeting, e.g. Rahl (2000), Denault (2001), Tasche (2002), Kalkbrener (2005)[3]. Keeping in mind that finding a definition everybody agrees upon is not easy as the meaning varies throughout the financial world.

Over the past 65 years, most of the literature has focused on the allocation of funds from an asset class perspective, i.e. how the portfolio should be divided between different asset classes in order to maximise return. This approach is often referred to as the capital budgeting exercise.

Risk budgeting is different from capital budgeting in that it is concerned with how risk is distributed in the portfolio. Instead of asset classes, risk factors and risk measurement are at the core of the concept.

2.2 Risk budgeting at the MNB

Risk budgeting at the MNB aims to find the optimal strategic asset allocation of the institution based on the risk appetite and risk capacity of the bank, and to prudently keep the risk of the portfolio within the predefined levels. The risk budget seeks to ensure that risks are taken in a controlled and conscious manner.

In practice, the risk budget is a risk measure expressed in nominal terms that cannot be exceeded by the portfolio. This new reserve portfolio level limit is not meant to replace, but rather supplement the traditional limits already applied to reserve management.

During the strategic asset allocation process, a strategic benchmark is created representing the beta exposure wished to be taken by the MNB as an investor. Active management allows portfolio managers to deviate from this strategic benchmark when they deem to do so.

In reality, portfolio managers can under- or over-weight the different kinds of risk factors of the benchmark, creating active risk in the hope of outperforming the benchmark. Active portfolio management without the appropriate restrictions can significantly alter the risk characteristic and risk level of the portfolio from the strategic benchmark, therefore investors utilising active managers must take this aspect into account when setting the risk budget.

The most obvious solution is to set the risk level targeted with the strategic benchmark below the maximum risk limit. By doing so, the risk budget remains intact, but investors can provide as much leeway as they are comfortable with for active portfolio management.

[3] Denault, M. (2001): Coherent Allocation of Risk Capital, Journal of Risk 4(1), 1-34.

Kalkbrener M. (2005): An Axiomatic approach to capital allocation, Mathematical Finance, 15(3), 425-437.

Rahl, L., ed. (2000): Risk Budgeting: A New Approach to Investing, Risk Books.

Tasche, D. (2002): Expected Shortfall and Beyond, Journal of Banking and Finance 26, 1519-1533.

3. Implementation of the risk budget framework

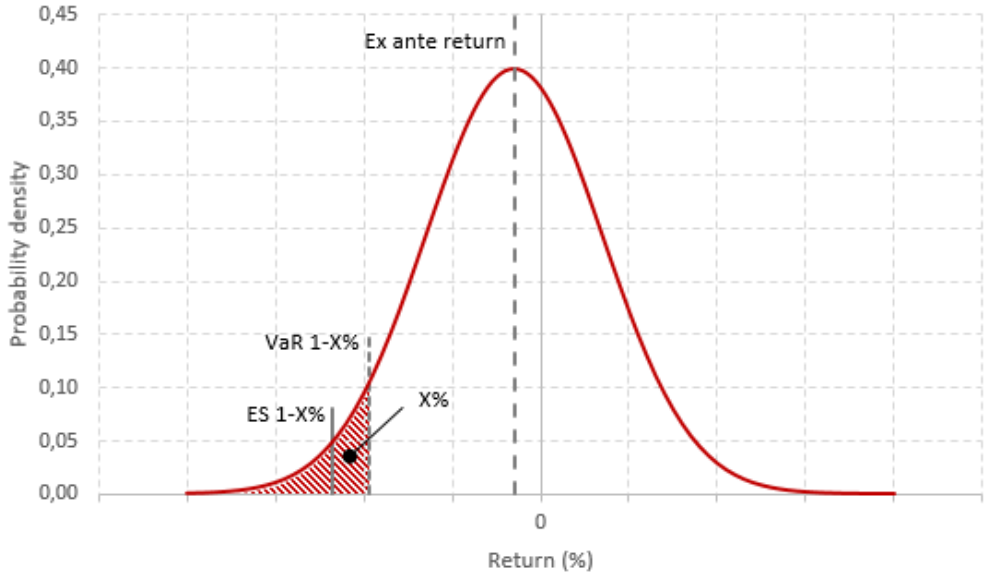
3.1 Defining and calculating the main risk measure

In the context of a low yield environment and the need for capital preservation, it was obvious that the traditional low level of market risks could not be maintained any longer. Potentially increasing market risks raised the need for an "umbrella tool" i.e. a higher-level risk control.

The first step for this kind of higher-level risk measurement and control was to find a risk measure. In our case, for reserve management the most relevant market risk factors are the currency and interest rate risks. These kinds of market risks can be measured by different tools like value-at-risk (VaR) or expected shortfall (ES), the latter of which is a coherent measure with more weight on the tails of the return distribution. We thus chose ES because of its tail sensitivity – in the sense of market risks – and not like a black swan event.

The definition of coherent refers to several desirable properties, both mathematical and intuitive. The VaR, in comparison, is not coherent and is indifferent to the shape of the risk distribution's tail.

Hypothetical VaR vs. ES — Graph 4



Once we chose ES as our risk measurement, it was necessary to decide on the calculation parameters. There are several ways to quantify ES, but our decision was mainly driven by the need for longer stability of the methodology.

There are several things to consider when specifying the model, as changing the model parameters can have a considerable effect on the ES value. Do we model the distribution of the returns or do we use a historical method? In the case of the latter how long history should the model use? What should be the time horizon of the returns? In which currency should we quantify the risks? Deciding on the parameters can be challenging. There is no one set of optimal parameters to use; it is up to the discretion of the user which one(s) to apply.

Increasing the confidence level of the ES calculation increases the value of the ES. At a 95 percent confidence level, the calculation will take into account the worst 5 percent possible outcomes in quantifying the losses, but at a 99 percent confidence level, the model uses the worst 1 percent of returns, where the model uncertainty is the highest due to the low amount of data. It is easy to see that using lower confidence level can create a false sense of security by underestimating potential losses, while applying an excessively high confidence level will result in an unreasonably restrictive risk budgeting process.

Selecting the appropriate lookback period for the historical model is not less of a challenge. If we calculate daily returns for a 10-year horizon, then we will have a rich data set with which to work. The downside of using longer periods is that the further we go back in time, the higher the chances the data loses its economic relevance and thus its predictive power. As the financial world is in a constant state of change, historical data can become obsolete and outdated in a couple of years, not to mention that disruptive periods during regime shifts can reshape the whole system. On the other hand, using short (and more recent) periods carry the risk of over-emphasising recent events and trends that carry very different characteristics from more common ones, and the model output can vary significantly. The user of the model has to decide which period will fit the expected investment environment the best.

The investment horizon is influenced by the top management's preferences, and the confidence level is somewhat arbitrary.

The MNB has a target value of ES and two upper bounds – a yellow flag and a red flag – controlling the overall market risk level of the reserve. In the case of a breach, the deputy governor in charge of reserve management (who oversees the yellow flag), and the Monetary Policy Committee (who oversee the red flag) have the responsibility and authority to decide how to act to reach the target level by decreasing the total market risk of the portfolio.

3.2 Defining the risk budget size

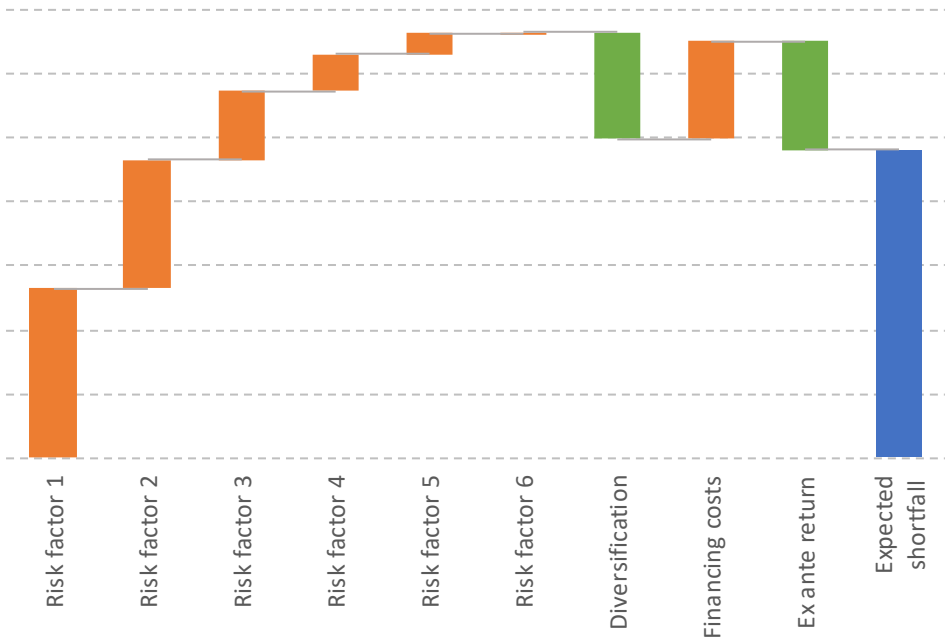
The determination of the budget size (i.e. the maximum tolerable loss at the given period) was based on a complex system taking into account four main considerations: (i) historical data; (ii) institutional constraints; (iii) scenario-analysis; and (iv) subjective elements.

First, we analysed the time series of the selected risk measure in the case of the reserve portfolio and decomposed the changes in the main ES number into its most relevant components, namely: portfolio size, market volatility, ex ante return and duration as probably the most decisive risk factor. That is to say, while analysing the historical data we controlled for internal (e.g. duration), partly internal (e.g. portfolio size) and external factors (e.g. volatility and ex ante return) separately.

Minimum/maximum values of the series served as good starting points for the boundaries of the budget size. In this way, we were able to evaluate the subsequent proposals in historical context. However, this method has its own limitations and it is useful to keep in mind that the same value of risk could imply considerably different interpretations under different market circumstances.

Second, we specified the institutional constraints by quantifying the risk-bearing capacity of the bank. In the process, we used heuristics related to the central bank's

ES decomposition (illustration) Graph 5



balance sheet. The most important measure was the effect of a potential loss to reserve adequacy. In addition, ratios such as potential loss to total FX reserves, to (elements of) equity (i.e. retained earnings, revaluation reserves and total), to total balance sheet were calculated. The downside of this approach was that the range based on balance sheet heuristics was still extensive.

Third, putting different budget sizes into contemporaneous context we used scenario-analysis. Using a "what if" approach, we created dozens (close to 100) of hypothetical portfolios and scenarios along the following dimensions:

- The usage rate of the limit system and potential ease-off: portfolios compatible with the current limits vs. portfolios created by moderate or strong easing of the limits.
- The return target: how can we achieve the goal of improving the return?
- Institutional factors: what room do we have for change, taking into account institutional constraints (e.g. balance sheet restrictions)?

Before the implementation of the ES framework and the new asset allocation, the FX reserve of the MNB was already well-diversified, safe and liquid. The MNB, just like many other central banks, is primarily an international bond investor. The bank managed its reserve in five currencies (in order of importance: EUR, USD, JPY, GBP and CNY) organised in a variety of portfolios. The strategic target duration of the reserve was around one year.

The euro risk-free portfolio represented the core of the reserve only containing highly rated government, government guaranteed, and supranational securities. The euro investment portfolio was the second largest portfolio, where high-quality corporate, financial, and covered bonds were eligible. The reserve portfolios were predominantly actively managed, except for the Japanese yen government portfolio

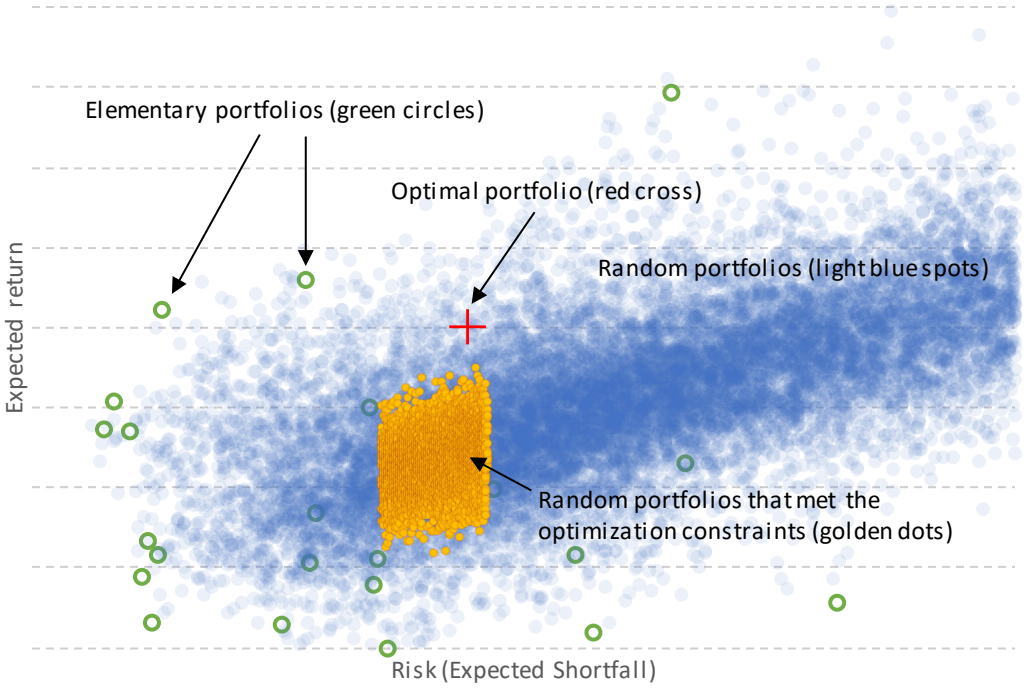
and US agency mortgage-backed securities (MBS) portfolio. In case of the MBS exposure, the bank relied on the expertise of external asset managers. Apart from the core portfolios, a small portion of the reserve was dedicated to Chinese government securities.

The MNB assumed the exchange rate exposure mainly in euros but had minor open currency positions in different currencies as well. The gold reserve of the central bank was extremely low in nominal terms compared to central bank peers.

In addition, we analysed the effect of changes in different risk factors on the risk-return profile. Some examples that were considered included:

- increasing duration;
- entering new bond markets (e.g. AUD and CAD);
- changing open FX positions; and
- new assets, increasing exposure (e.g. MBS and equity portfolio).

Sample portfolios in the risk-reward profile — Graph 6



With the abovementioned proposals, the ex ante return of the reserve portfolio was successfully increased into the proximity of zero. Nevertheless, using these scenarios we were able to narrow the risk tolerance range that provides acceptable risk and return characteristics at the same time and to find the short list (of 3–5 items) of the most promising sample portfolios.

As a final element, we considered some subjective elements, such as preferences, personal views, judgements and the risk appetite of the decision makers. As risk willingness and attitude of the decision makers cannot be calculated quantitatively – and are not entirely necessary – they are considered subjective, however unavoidable

and important constraints. The risk-return preferences of the management played a crucial role throughout the process.

The output of this process resulted in an evaluation matrix of different ES ranges, which summarised the pros and cons for different risk budget sizes.

Risk budget ranges and evaluation matrix

Table 1

Risk Budget ranges	Historical data	Institutional constraints		Scenario-analysis Sample portfolios	Summary
		Reserve adequacy based on the Guidotti-measure	MNB's financial result		
<A	- Provides a narrow range - Portfolio could breach it easily	- Meets the adequacy requirement easily	- Retained earnings is solely enough - Room provided by reserves is not utilized	- No room for improvement	- Portfolio management is bounded - No effective change - Does not meet the expectations
A-B	- Portfolio stayed in this range based on the historical data - Could provide a long-term reference level	- Meets the adequacy requirement easily	- Tolerable risk taking into account the revaluation reserves	- Moderate portfolio rebalancing - Moderate risk and return increase	- Keeping risk at a tolerable level while increasing return moderately - Moderate change - Meeting expectations more or less
B-C	- Normalization of market volatility will not limit the portfolio - Assuming higher level of risk than historically	- Meets the adequacy requirement easily	- Tolerable risk taking into account the revaluation reserves	- Significant change - Expected return increasing considerably - Risk staying at a managable level - Relatively effective risk/return trade-off	- Significant change - Increasing return significantly given the institutional constraints - Meeting expectations
>C	- High risk in historical context	- Meets the adequacy requirement	- Tolerable risk depending on the willingness to take risk - At the limit of the reserves in equity	- Palpable return improvement - Significant jump in the risk profile	- Possibly higher return... - ... but increasing risk largely

In this way, we ended up with a relatively narrow range for proposals of the maximum and the strategic/target/benchmark value of the ES measure.

3.3 Defining the new strategic asset allocation

As we set up our risk target and tolerance, we should change the strategic asset allocation (SAA) of FX reserves. The goal of our optimisation is to maximise the expected return of the investments given the market risk (and other risks, e.g. liquidity and credit) constraints. The expected returns as input parameters are arbitrary of course – representing our experts' and management's view.

FX-hedges against the numeraire currency and its costs (the FX-basis) were also accounted for during the optimisation process. In addition to quantitative considerations, we also applied qualitative ones as well, which included:

- accounting for moderate and gradual changes in the currency composition;
- accounting for low transaction/transition costs;
- avoiding concentration in the risk factors; and
- keeping the major exposure toward the euro zone in credit, interest rate risk, etc.

We then simulated more than 100-thousand portfolios with the applied constraints. We examined the composition and concentration of portfolios around our risk targets. The qualitative constraints were accounted for as well, and the management selected the desirable composition. Some other tools we used as a supplementary analysis included:

- a risk factor model;
- scenario analysis; and
- portfolio sampling and concentration quantifications.

The results showed that the strategic benchmark was affected.

Due to the potential changes in the investor's ability and willingness to take risks, both periodical and event-based revisions of the risk budget size is recommended:

- reviews on an annual basis in accordance with the MNB's practice;
- reviews in the case of external shocks, including a sudden and considerable change in the market environment that is deemed to be persistent;
- reviews in case of a significant increase/decrease in the major balance sheet items affecting the Bank's loss-absorbing capacity (FX reserve, retained earnings);
- reviews following a large movement in the portfolio's or the benchmark's risk.

The level of risk is influenced by internal portfolio management decisions and exogenous market developments:

- Internal factors – independent decisions of the portfolio managers.
- External factors – economical events, changing correlations/volatilities.
- Partly internal, partly external factors – e.g. the size of the portfolio is managed through the reduction or increase of the MNB's balance sheet, but this means a constraint for reserve management.

If the risk of the benchmark or the portfolio moves out of the range specified by the decision-makers, different actions are required depending on the magnitude of the change: informing upper management, proposing recommendations and/or initiating immediate responses to reduce risk. Breaching the wider tolerance range of the strategic benchmark requires the action of the Monetary Policy Committee. Breaching the narrower tolerance range of the strategic benchmark requires the action of the deputy governor.

Overview of the new framework

The new risk budget framework and the ES limits provide a coherent structure for the risk-taking and investment decisions. This can be considered as an "umbrella" risk management tool with yield enhancement elements, and is supplementary to the current limit system focusing only on risk control.

It limits the maximum risk taken while also providing flexibility in choosing the risk factors in active management. The applied risk measure (ES) is more conservative than VaR, the measure previously used. The size of the budget is based on quantitative and qualitative considerations, and on a number of different aspects. The

main advantages of the framework – which is based mostly on quantitative methods but also includes qualitative criteria – include the following:

- controlled risk-taking;
- efficient risk allocation;
- return maximizing at a given risk level; and
- active responses to the changing risk environment.

However, the framework has its own risks and challenges. Setting up the system requires an increased workload, especially at the initiation of the system due to the learn-by-experience process, the more frequent decisions and the monitoring activity. The implementation is also resource intensive, as it requires a lot of expert judgement and subjectivity at initiation. It could also be a demanding challenge to mitigate the risk of "over-controlling" and deal with potential conflicts among the different rules. More intense monitoring is thus essential.