

# Interest rate risk in the foreign exchange reserve – duration intervals for the investment portfolio

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*The Riksbank manages a foreign reserve representing approximately SEK 136 billion.<sup>2</sup> The management of this reserve entails a significant responsibility. In light of the Riksbank's recently expanded independent status, it is important to outline in a clear manner how this reserve is managed. This article aims to explain the interest rate risk exposure the Riksbank has chosen for its foreign reserve, why the bank has done so and the implications for the Riksbank's total earnings.*

## Why the Riksbank manages a foreign reserve

One of the tasks assigned to the Riksbank is the management of Sweden's foreign exchange reserve. A foreign reserve is required since it may be necessary for

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implementing monetary and exchange rate policies. Depending on the exchange rate policy regime, it may be necessary to intervene in the foreign exchange market. When the Riksbank intervenes in the foreign exchange market, it buys or sells Swedish kronor for foreign currency in order to influence the relative value of the krona. The need for available foreign currency for intervention purposes is greatest when a fixed exchange rate applies and least when a floating exchange rate applies. Since 19 November 1992, Sweden has had a floating exchange rate. Under the current monetary policy regime, the value of the Swedish kro-

<sup>1</sup> This article is the result of a long work process within the Riksbank's asset management activities. Consequently, many people have been involved in this process, especially Paul Klinkert and Marcus Söderberg. I am also very grateful to JP Morgan for their help in compiling data for this article.

<sup>2</sup> As of 31 December 1998; includes gold and claims on the IMF.

na is only one of several variables that affect the Riksbank's policy. The need to maintain a foreign reserve is therefore relatively small<sup>3</sup> at present. The Riksbank nonetheless maintains a relatively high intervention capacity since exchange rate policy regime may change in the future, which could involve a rapid change in the need for intervention.<sup>4</sup>

The capacity to intervene places high demands on the liquidity of the assets the foreign reserve is invested in. The liquidity requirement not only restricts the choice of possible assets, it also restricts the choice of possible currencies and their relative distribution. After these factors have been taken into consideration, the management of the foreign reserve must be conducted in accordance with "best practice" in business and risk management. This means that the foreign reserve shall be managed so as to achieve the highest possible return within the authorised limits for risk-taking and with possible future intervention in mind.

## How the Riksbank can influence its earnings

The Riksbank cannot freely influence its balance sheet in order to avoid unfavourable results. Several items in the balance sheet are conditional upon monetary policy and cannot therefore be changed merely to influence the bank's financial result. However, the foreign reserve is an item that can be influenced in some ways without weakening intervention capacity, of course, and which at the same time can have a large significance on the financial result. The Riksbank's total net income is thus largely influenced by the choice of interest rate risk in the foreign reserve. However, it is not possible to actively manage the entire foreign reserve.

The reserve is divided into two portfolios, an investment portfolio and a liquidity portfolio.

### THE INVESTMENT PORTFOLIO – THE RIKSBANK'S LONG-TERM BOND HOLDING

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The investment portfolio can be managed more systematically with a view to earnings.

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At present, the investment portfolio comprises the major part of the foreign reserve. The investment portfolio is the Riksbank's long-term holding of foreign

<sup>3</sup> What may be regarded as a suitable size for the foreign reserve is not discussed in this article.

<sup>4</sup> The need for intervention can also arise under the current exchange rate regime.

government bonds and represents that part of the foreign reserve that can be managed more systematically with a view to earnings. The rest of the foreign reserve, primarily the liquidity portfolio<sup>5</sup>, is intended to meet the short-term need for intervention funds and other Riksbank commitments in its capacity as a “foreign exchange bank” for various foreign exchange transactions on behalf of other central government authorities.<sup>6</sup>

Both investment and liquidity portfolios in turn are divided into four different currency portfolios. These portfolios reflect the currencies in which the Riksbank invests its foreign reserves. As things stand at present, these currencies are the euro, the US dollar, the yen and the pound sterling.<sup>7</sup> The relative distribution between the different currencies is fixed and is therefore not actively managed.<sup>8</sup> The reason why the exchange rate risk is not actively managed is that the Riksbank is just one of many central banks; and if the Riksbank actively managed the exchange rate risk, this could disrupt the monetary and exchange rate policies of other central banks. Furthermore, the capacity for intervention may be affected negatively if the currency distribution was actively managed.

#### THE VALUE OF THE INVESTMENT PORTFOLIO

The value of the investment portfolio is mainly affected by three factors: exchange rate developments, the degree of credit risk and the exposure to interest rate risk. Of these three overall risk factors, only interest rate risk is actively managed. The Riksbank has chosen to minimise the credit risk as far as possible, while the exchange rate risk is managed only passively.

Interest rate risk arises as a result of unforeseen changes in the yield curve. These changes in interest rates affect the value of the Riksbank’s investment portfolio.

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Movements in the yield curve are captured by a couple of factors. The most important factor is parallel shifts in the yield curve.<sup>9</sup> The risk entailed by these parallel shifts can be measured and controlled by the

<sup>5</sup> The Riksbank also manages a gold portfolio. However, this is not managed in the same way as investment and liquidity portfolios and is therefore not discussed in this article.

<sup>6</sup> The largest transactions are associated with Sweden’s external debt.

<sup>7</sup> The current distribution is 35 per cent EUR, 35 per cent USD, 15 per cent JPY and 15 per cent GBP.

<sup>8</sup> Exchange rate risk is managed in conjunction with periodic reviews of the currency distribution, although considerations of intervention capacity receive greater attention.

<sup>9</sup> Other significant factors include the slope and curvature of the yield curve.

choice of the portfolio's "modified duration"<sup>10</sup>. Thus for the Riksbank, the question of the level of interest rate risk exposure for the foreign reserve mainly concerns the choice of modified duration for the investment portfolio. The Riksbank has chosen to use modified duration to control risk not only on account of the fact that it captures the most important risk factor, the parallel shifts, but also due to the simplicity of the measurement. Modified duration is uncomplicated to use, both for implementing and evaluating risk management.

## Starting points for choosing the duration level

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Matching the duration of assets and liabilities can immunise the market risk.

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The choice of duration<sup>11</sup> for a portfolio is simplest if the investor has a clear investment horizon. Matching the duration of assets and liabilities can immunise the market risk, i.e. assets and liabilities become equally sensitive to interest rates. Thus, any change in interest rates that increases the value of the liabilities will be neutralised by a corresponding increase in the value of the assets. With a definite investment horizon, the choice of duration thus becomes relatively easy. The task becomes more difficult if the investor departs from the natural investment horizon as sometimes constituted by the liability side of the balance sheet, or if a natural investment horizon is lacking.

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The Riksbank lacks a clear investment horizon.

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The problem is that the Riksbank lacks a clear investment horizon, and thus, the choice of duration is less obvious.

Attempting to immunise the Riksbank against market risk is difficult. The reason is that the Riksbank does not have any interest-bearing liabilities to directly match the assets with, which would give the "natural" investment horizon. The central government debt is instead managed by the Swedish National Debt Office.<sup>12</sup> Nor is it known in advance when the need will arise for liquid funds from the foreign reserve. These needs arise in connection with interventions and financial turbulence, although hardly ever in connection with debt payment.

<sup>10</sup> Modified duration measures how the value of the portfolio is affected by a general change in interest rates, a parallel shift of the yield curve, of 1 percentage point. The higher the duration, the larger the effect that a change in interest rates has on the value of the portfolio.

<sup>11</sup> Duration measures the average remaining period to maturity of a portfolio. This measure is very closely related to modified duration, which measures the portfolio's interest rate sensitivity.

<sup>12</sup> Attempting to immunise against interest rate risk would therefore entail practical problems relating to risk control, risk monitoring and evaluation.



The Riksbank quite simply lacks a natural investment horizon, and, consequently, alternative starting points must be sought when choosing duration. The relationship between risk and yield, i.e. the shape of the yield curve, thus becomes a natural starting point.

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## Unclear investment horizons and the relationship between risk and return

The liquidity-preference hypothesis is a common explanation of why the yield curve normally has a positive slope. The meaning is that bonds with a long period to maturity have a positive risk premium to compensate for increased volatility in return. This is in light of the fact that most investors dislike short-term variations in return due to a relatively short evaluation and/or investment horizon.

An additional explanation of the liquidity-preference hypothesis may be that many investors lack clear investment horizons.<sup>13</sup> If the investment horizon is so unclear that it cannot be used as a basis for decision making, there is a risk that investors will be less willing to accept price risk<sup>14</sup> as against reinvestment risk.<sup>15</sup> This increases the probability of a manager choosing an investment horizon that matches the accounting period. This investment horizon – which corresponds to the duration of the portfolio – is normally relatively short. If, for example, an investor reports results quarterly, he tends therefore to choose interest rate instruments with a corresponding maturity. By choosing such maturity, the actual result will always be close to the forecasted result. The asset manager thus minimises the price risk. From some kind of short-term perspective, this strategy can be termed a “risk-free” strategy. The disadvantage of this strategy is that the asset manager is exposed to a large reinvestment risk, i.e. it is difficult

<sup>13</sup> See Ilmanen (1996), “Does duration extension enhance long-term expected returns?”

<sup>14</sup> The risk that interest rates, and thereby bond prices, will develop unfavourably and thus have a direct effect on the result. If the interest rate rises, the cash flows must be discounted at a higher rate of interest, and will therefore decrease in value. The longer the cash flow horizon, the greater is the influence of the higher interest rate on the market value. A portfolio’s risk therefore increases with longer average duration.

<sup>15</sup> Reinvestment risk arises when capital is to be invested over several periods, since the reinvestment rate during the later periods is unknown. By investing assets with the same duration as the accounting period, the only risk exposure is to reinvestment risk, and the annual result will be known at the beginning of the year.

to predict the interest rate at which the reinvestments can be made. Furthermore, the strategy entails an alternative cost, considering the normally positive slope of the yield curve, since an investment horizon has been chosen which will not maximise the return over time.

Asset managers without a clear investment horizon are thus faced with the choice of either investing in accordance with a strategy which maximises results over time, i.e. the manager accepts a greater price risk (long duration), or investing in accordance with a strategy that enables a more stable reported result, i.e. the manager accepts greater reinvestment risk (short duration). Short-term evaluation or reporting of results entails a tendency among managers to choose a short investment horizon for fear of greater variations in the result. It is likely that this tendency strengthens the mechanisms of the liquidity-preference hypothesis and contributes to a steeper slope in the yield curve than would otherwise be the case.

## What yield requirements can be placed on the Riksbank?

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A reasonable assumption is that the central government has a long-term perspective on its activities and its assets.

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Which duration is most suitable for the Riksbank's investment portfolio? A logical starting point is to consider the perspective of the owners – the central government. A reasonable assumption is that the central government has a long-term perspective on its activities and its assets. Consequently, the central government looks to the long-term result and is less concerned by short-term variations in reported results. This is of course on condition that the long-term result over time can be expected to exceed the short-term results. With this assumption, the Riksbank would not be obliged to invest with a duration in accordance with the accounting period. There is therefore no reason for the Riksbank to pay the extra liquidity premiums that market players, on the basis of the above reasoning, appear willing to pay for interest rate securities with a short duration. Since a duration of reasonable length is expected to contribute positively to the Riksbank's average result, this opportunity should be utilised, even if it entails an expected increase in volatility in the short-term earnings trend.

In the case of the Riksbank, this reasoning is probably further strengthened by compliance with the principles governing the transfer of Riksbank profits to the central government. According to these principles,



the Riksbank shall annually remit to the central government 80 per cent of the average earnings for the most recent five-year period. Variations in the annual result are therefore probably of subordinate interest, and the central government can instead be expected to maximise its earnings in the long term. For the Riksbank, a larger price risk is worth taking, in contrast to the reinvestment risk, since the short-term evaluation is less significant. The Riksbank has therefore selected this approach for the choice of the investment portfolio duration and has therefore concentrated on a relatively long duration (two years or longer).<sup>16</sup>

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#### PRACTICAL ASPECTS – THE NEED FOR BENCHMARK PORTFOLIOS

Regarding the choice of duration, it is difficult, if not impossible, to establish the exact level which provides maximum return.

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The relationship between risk and return decreases the further you progress on the curve.<sup>17</sup> This means that if a clear investment horizon is lacking, the choice of duration will always be associated with a certain amount of subjectivity. It is therefore natural to weigh in practical aspects. The Riksbank's investment portfolio is currently evaluated using externally designed benchmark portfolios. These benchmark portfolios are used because it is obviously important to be able to evaluate and monitor portfolio management against some form of standard/benchmark. This holds for both active and passive portfolio management.

A specific portfolio should be chosen for benchmarking. The return of this portfolio can then serve as a basis for comparison. It is not possible to base the comparison solely on a specific duration level, since, in principle, it is possible to achieve a given duration by means of an infinite number of portfolio combinations. This important factor constitutes a basis for the Riksbank's choice of duration interval.

<sup>16</sup> The positive relationship between risk and yield is most pronounced on the shorter part of the yield curve, and then gradually decreases and even becomes negative on the longer part of the curve. The correlation naturally varies, both over time and from market to market. See, among others, Ilmanen (1996) or Domian, Maness and Reichenstein, "Rewards to Extending Maturity" (1998).

<sup>17</sup> The decreasing relationship can possibly be explained by the market segmentation hypothesis.

## Duration intervals and active portfolio management

So far, this article has focused on explaining why the Riksbank's investment portfolio has a relatively long duration and the choice of starting point for setting the risk exposure within the long duration span.

Another important issue concerns whether the investment portfolio should be managed actively or passively. In passive management, the benchmark portfolio constitutes not only a basis for determining the interest rate risk. There is also the aim for the investment portfolio to mirror as far as possible the benchmark portfolio's profile and holdings.

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Active management involves the issuance of a mandate enabling the investment portfolio's holdings to deviate from the benchmark portfolio, which instead becomes a measure for evaluating the active management. The Executive Board of the Riksbank has decided that the investment portfolio shall be managed actively. In order to enable active management, a duration interval must be specified within which the duration of the investment portfolio may vary.

Active management increases investment possibilities and entails more flexible risk-taking:

- Investment possibilities increase with active management. With passive management, many investment alternatives risk being lost, since it is very difficult to design benchmark portfolios that include all potential investment possibilities. The Riksbank uses, for example, derivative instruments and international issues<sup>18</sup> in its portfolio management that are not included in the benchmark portfolio.
- Active management increases flexibility, which means that risk-taking can be influenced to a greater extent. This makes it possible to anticipate and parry changes in the yield curve. If rising interest rates are anticipated, the portfolio's risk exposure is changed by reducing the portfolio's duration, and vice versa. There are corresponding opportunities for parrying other risk factors, such as changes in the slope and/or curvature of the yield curve.

<sup>18</sup> International issues, known as euro issues, are "offshore" issues, i.e. bonds issued in another currency.



- Active management also provides favourable conditions for recruiting skilled asset managers (these are also needed in the case of passive management).

#### POTENTIAL PROBLEMS USING BENCHMARK PORTFOLIOS

The benchmark portfolios currently used by the Riksbank have been constructed by JP Morgan. They are constructed as an average of a large number of liquid issues and represent, for each of the currencies included in the investment portfolio, an average for each market. The reason that externally constructed benchmark portfolios are used is due to the substantial work effort involved in constructing, implementing and maintaining benchmark portfolios.

A weakness often noted in global benchmark portfolios of the type used by the Riksbank is that their duration changes over time. Since they are constructed as an average of a large number of government bonds outstanding in a given market, the risk exposure of the benchmark portfolios is to a certain extent exogenously determined. In the case of the Riksbank, the risk level of the benchmark portfolios will depend on the structure of the central government debts of those countries included in the foreign exchange reserve. Consequently, a benchmark portfolio will never represent a constant risk level, since the structure of issues and central government debts in the different markets are constantly changing, which gives rise to a duration drift, i.e. the duration changes as bonds mature and new bonds are issued in line with the capital requirements of the individual central governments.<sup>19</sup>

However, this problem should not be exaggerated, since, for most countries, the structure of the external debt usually changes only marginally in the short term. However, if a change were to result in significant changes in the duration of the benchmark portfolio, the duration drift could, in the worst case scenario, become so large that those who determine the duration may consider that the benchmark portfolio no longer reflects the chosen levels of risk and expected return. The Japanese mar-

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<sup>19</sup> For further reading on benchmark/bond indexes, see "Why use bond indexes?", Sveriges Riksbank Quarterly Review, no. 4, 1998.

ket is a current example of how public finances might have significant effects on the size and structure of the market and thereby also on benchmark portfolios. Against this background, it can be interesting to see how the duration has evolved since the end of 1987 for the investment portfolio's currencies, both separate and aggregated according to the current currency distribution (Diagram 1).

It can be noted that duration can vary for each currency portfolio, while the development for the investment portfolio as a whole is relatively stable. It is also interesting to note that the difference in duration between different currencies can be relatively large.

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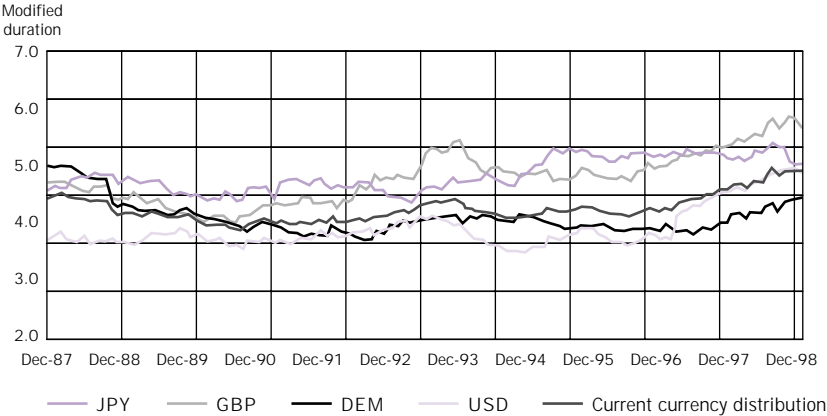
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However, the problem of duration drift should not be exaggerated. The main function of benchmark portfolios is to act as instruments to evaluate the results of portfolio management. If anything, duration drift is a problem for the evaluation of active portfolio management, although not for risk management. Even if the choice of risk exposure is based on the average modified duration of the current benchmark portfolios, the risk exposures of the investment portfolio are determined by the absolute duration levels and not by a benchmark portfolio. The guidelines for investment portfolio duration adopted by the Executive Board always apply, irrespective of the trend in the duration of the benchmark portfolios.

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**Diagram 1. Modified duration for the investment portfolio's different benchmark portfolios, aggregated according to the current currency distribution for the period December 1987–February 1999**



## The duration interval

Due to the difficulty in establishing which duration is best within the longer time span, it is appropriate to take certain practical aspects into consideration

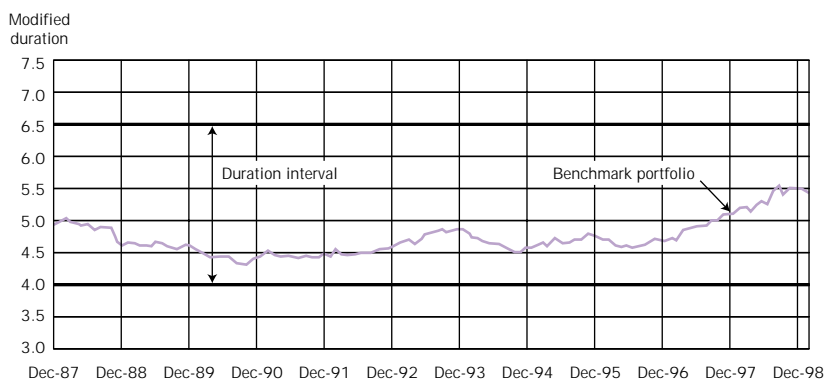
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The interval of 4.0–6.5 percentage points was based more on experience than on exact criteria.

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– it should be possible to perform an evaluation of the portfolio management by comparing it with a specific benchmark portfolio. This means that the approximate interest rate risk that was current in the Riksbank's benchmark portfolios when the interest rate risk was set was used as a basis for decisions regarding the interest rate risk exposure of the investment portfolio. The average interest rate risk, expressed as modified duration, was approximately 5.5 per cent, which thus became the guideline for the investment portfolio. An interval was set around this level to enable active management. In order for active management to be meaningful, it required a mandate enabling changes to the modified duration of the investment portfolio within an interval of 2.5 percentage points, and thus a duration interval of 4.0–6.5 percentage points for the entire investment portfolio (Diagram 2).<sup>20</sup> The size of the interval was based more on experience than on exact criteria.

Diagram 2. Development of the aggregated<sup>21</sup> modified duration of the Riksbank's benchmark portfolios and duration interval for the investment portfolio



However, the entire mandate is used only in exceptional cases and only then in connection with very strong views and assessments of the trend in

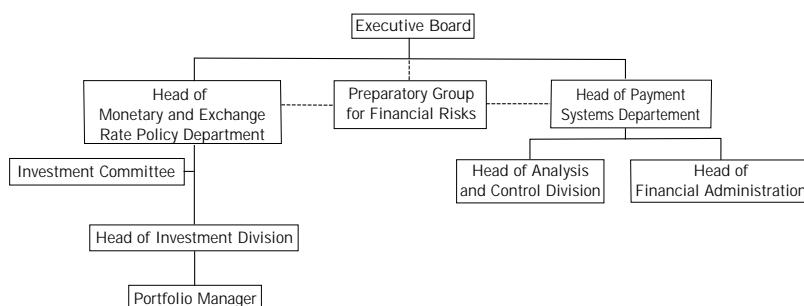
<sup>20</sup> The deviation mandate is asymmetric to allow the asset management division to reduce the risk exposure slightly more, relative to the benchmark portfolio average of 5.5 per cent, than it is able to increase the risk exposure.

<sup>21</sup> According to the current currency distribution.

interest rates. In the case of such extreme positions, scenario analyses using portfolio optimisations supplement analyses of the real economy and market conditions in an attempt to forecast as far as possible the consequences of different interest rate outcomes. Major, long-term investment decisions are taken by an investment committee, while less significant decisions are taken by individual managers (Figure 1, organisation chart). The investment committee is thus authorised to change the interest risk exposure of the investment portfolio within the duration interval set by the Executive Board, while individual investors have individual mandates to change the interest rate risk, albeit in line with the decisions taken by the investment committee.

However, the total interest rate exposure of the investment portfolio must never deviate from the duration interval set by the Executive Board. The evaluation is undertaken, independently of the asset management division, using JP Morgan benchmark portfolios.

Figure 1. Division of responsibility for investment and risk control operations



## Summary

A portfolio's duration is the single most significant factor for determining risk and expected return.

However, it can be maintained that the central government should have a long-term perspective on its activities and should

A portfolio's duration is the single most significant factor for determining risk and expected return. However, the Riksbank lacks a natural investment horizon, which means that the choice of duration interval

therefore not be sensitive to visible price risk, in comparison with the alternative cost entailed by placing the investment portfolio with a short-term duration. However, this does not indicate which duration is best for the investment portfolio within the longer time span. Due to difficulties in determining the duration that provides the maximum return within the longer time span, it was appropriate to take practical aspects into consideration. The average risk in the Riksbank's benchmark portfolios was therefore considered a suitable starting point. The reason that investment portfolio risk is controlled with an interval is that the Executive Board decided that the investment portfolio shall be managed actively. The mandate of the asset management division shall be within the scope of the guidelines set by the Executive Board. In all, the above reasoning produced a duration interval for the entire investment portfolio of 4.0–6.5 per cent.<sup>22</sup>

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The main reason why the Executive Board set this duration interval is that the average expected result will be higher with a longer duration. A higher expected yield is also associated with greater variability in the result – but given the long-term perspective of the activities of the Riksbank and the central government, the alternative cost that would arise in the case of a short duration cannot be justified.

<sup>22</sup> The decision applies to the entire investment portfolio, i.e. the aggregated, modified duration of the investment portfolio and not the duration of individual portfolios.