Guidelines on interest rate risk in the banking book

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1 BACKGROUND

These guidelines are intended to assist the examining officers of the Nederlandsche Bank ('DNB') who are responsible for ongoing supervision and for periodic inspections to evaluate the quality of interest risk management of the banking books of supervised institutions. These guidelines have been drawn up with a view to the implementation of the new Basel framework (Basel II) and the European Capital Requirements Directive ('CRD') that is to be based upon it. The implementation of Basel II with regard to the interest rate risk in the banking book is an important element of the second pillar. The principle underlying the second pillar is that the institutions are responsible for putting proper risk management systems in place and for holding sufficient capital in relation to the various risks. For this purpose, the institutions need to establish their capital adequacy by means of a standardised assessment process, the Internal Capital Adequacy Assessment Process ('ICAAP'). The supervisory officers’ task is to evaluate the methodology and systems used by the institutions to evaluate and determine capital adequacy through a Supervisory Review and Evaluation Process ('SREP'). With regard to interest rate risk, this means that the adequacy of the economic capital that is allocated will be tested based upon the adequacy of the risk management and the magnitude of the interest rate risk. The assessment of internal capital allocation systems will become vitally important when Basel II and the CRD are implemented. As a transitional arrangement prior to the implementation of Basel II, the second pillar, institutions will be able to report on interest rate risk management to DNB based upon their internal systems and/or assumptions, i.e. based upon internal reports. Under the interim arrangement for the reporting of interest rate risk in the banking book, institutions may be granted an exemption from standard interest rate risk reporting based upon statement/form 8035, and instead will be permitted to submit their internal interest rate risk reports and some specified key data to DNB, provided that a number of conditions laid down in the scheme are met. These guidelines consider the relevant interest rate risk indicators and key data as well as the conditions on which supervisory officers will grant an exemption. Please note that the guidelines are still in the course of development and will be amended periodically in the light of new insights.

2 SCOPE

The guidelines focus on the quantitative aspects of the interest rate risk of institutions, i.e. on measurement and reporting. In view of the fact that both the quantitative and qualitative aspects of interest rate risk management are essential for an overall assessment of the interest rate risk of an institution, the guidelines also refer to a number of important qualitative factors.

However, for a full overview of the qualitative aspects and requirements of the risk management process, such as a transparent organisation structure, clear relationships between activities, management units and group functions, proper reporting lines at all levels and a proper structure of responsibilities and authorisations, please refer to the existing Regulation on Organisation and Control/ROC (Regeling Organisatie en Beheersing/ROB) and the Basel guidelines on interest rate
risk. The structure of these guidelines is as follows: first, Section 3 covers the Temporary Interest Rate Risk Reporting Scheme. Sections 4 and 5 cover the conditions to be met in order to qualify for an exemption from standard interest rate risk reporting. Section 6 discusses the obligation of financial institutions to report to DNB and the requirements that their reports have to meet. Section 7 explains the different ways of measuring interest rate risk and the strengths and weaknesses of each technique. Section 8 focuses on the model risk inherent in the interest rate risk in the banking book. Section 9 provides an overview of the quantitative and qualitative factors that are considered by supervisory officers when assessing the interest rate risk in the banking books of institutions. Section 10 covers the supervision of financial institutions that have an increased risk profile. A number of appendices are also included that explain particular aspects of the different types of interest rate risk (Appendix 1), optionality in the banking book (Appendix 2), non-maturity deposits (Appendix 3) and funds transfer pricing (Appendix 4).

3 INTERIM ARRANGEMENT FOR THE REPORTING OF INTEREST RATE RISK IN THE BANKING BOOK

A good interpretation of the data that is reported under the existing standard interest rate risk reporting to DNB depends on information on the treatment of positions with uncertain maturities. If this information is obtained by further investigation based upon internal models and techniques, the standardised interest rate risk reporting offers little added value, but it does impose a cost burden on supervised financial institutions. In order to reduce this administrative burden, as a transitional provision until the implementation of the Basel framework, the interim arrangement for reporting of interest rate risk in the banking book has been introduced. Under this arrangement, since 1 April 2005, banks have been able to obtain an exemption from the existing standard interest rate risk reporting, which means that they can report based upon their internal systems. This arrangement will be in effect until it is replaced by new regulations under Basel II and the European CRD. Based upon the interim arrangement, institutions can qualify for an exemption from standard interest rate risk reporting in two ways:

1) Generic exemption for institutions with structurally low interest rate profiles; and
2) Dispensation from standard reporting requirements for institutions to the effect that under certain conditions, they may base their statements on internal reports.

Re 1) Institutions able to demonstrate that their interest rate risk profile is structurally low may be exempted from reporting interest rate risk. Such institutions will have to supply data to DNB only by request or periodically under a bilateral agreement, mainly for the purpose of monitoring the structurally low nature of their interest rate profile.

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1 Principles for the Management and Supervision of Interest Rate Risk, BIS, July 2004
2 Instructions for 8035, Interest Rate Risk Report, Credit System Supervision Manual, the Nederlandsche Bank, April 2005.
Re 2) If the conditions set out below in Section 4 have been met, dispensation from standard interest rate risk reporting (form 8035) may be applied for under the temporary arrangement. Institutions that use this arrangement may report interest rate risk on the basis of their internal systems. Their reporting requirement vis-à-vis DNB will then include (i) internal interest rate reporting data and (ii) a limited number of key figures.

4 CONDITIONS TO BE MET IN ORDER TO BE EXEMPT FROM STANDARD INTEREST RATE RISK REPORTING

An institution will be exempted from standard interest rate risk reporting if both the requirements of the ROB and each of the following conditions have been met:

1.1. Interest rate risk is reported on the basis of the institution’s internal systems and assumptions;
1.2. Subject to DNB’s opinion, the data provide an adequate consolidated understanding of the risk involved over a relevant horizon;
1.3. Subject to DNB’s opinion, the data allow the development of interest rate risk to be monitored sufficiently.
1.4. The institution reports the following key figures, based on its internal systems:
   1.4.1. The projected net interest income during the first and second twelve-month period after the reporting date, based on the baseline interest rate scenario.
   1.4.2. The size of the institution’s Own Funds, based on the baseline interest rate scenario.
   1.4.3. Earnings-at-Risk (EaR) during the first and second twelve-month period after the reporting date, based on scenarios of gradual shifts away from the yield curve, over the course of twelve months, to a value 200 basis points above and below the baseline projection.
   1.4.4. Capital value changes based on stress scenarios projecting 200 basis point interest rate shocks in the form of parallel upward and downward shifts vis-à-vis the yield curve, taking account of effects caused by convexity and of embedded options.
   1.4.5. Price Value of 1 basispunt (PV01) of the institution’s Own Funds, based on the baseline interest rate scenario.
   1.4.6. Regulatory Capital excluding Tier 3.

Explanation
On the basis of the data provided under points 1.1, 1.2 and 1.3 above, DNB, through its examining officer, may impose additional conditions regarding the number of data, the type of data, the degree of detail and the form in which the data should be reported. Data should be understood as including, inter alia, the scenarios used and their underlying assumptions. Regarding 1.4.3 en 1.4.4, given current low interest rate levels, DNB offers, for the time being, the facility to report the respective information on the basis of an internally used maximum downward stress scenario, instead of the regular 200 basis points downward shift of the yield curve, subject to prior approval by the examining officer.

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3 Referring to: on the basis of the current yield curve.
With regard to condition 1.4, the requested key data will be recorded by major currency type, in principle on a consolidated basis. The relevant currency code will be used for this. A major currency should be understood, in this context, to mean a currency accounting for over 5% of assets or liabilities in the banking book, taking into account both on- and off-balance-sheet items. This criterion may also be applied at lower levels of consolidation, subject to prior approval by the examining officer.

5 A GENERIC EXEMPTION FOR INSTITUTIONS WITH STRUCTURALLY LOW INTEREST RATE PROFILES

Institutions able to demonstrate that their interest rate risk profile is structurally low may be exempted from reporting interest rate risk. Such institutions will have to supply data to DNB only by request or periodically under a bilateral agreement, mainly for the purpose of monitoring the structurally low nature of their interest rate profile. Institutions have to demonstrate that they qualify for such an exemption, as by their balance sheet composition over time, in combination with limitations ensuing from their Articles of Association or strategy decisions that strongly reduce the likelihood of activities carrying high interest rate risk. Whether an institution qualifies for exemption is for the examining officer to decide. In evaluating the application, the examining officer will decide what further information is needed over and above the data supplied initially by the institution in order to demonstrate the structurally low nature of the institution’s interest rate risk profile.

Institutions with a low interest rate risk profile have virtually no mismatch risk and/or embedded option risk. Such a profile would be indicated on the liability side of an institution’s balance sheet by a low volume of savings deposits, current account credit balances and/or other interest rate sensitive funding on an ongoing basis. On the asset side of the balance sheet, it would be indicated by a small mortgage, investment and/or loan portfolio on an ongoing basis. The factors that will need to be considered will include, but will not be limited to:

- the amount and the maturity and/or repricing structures of loans, investments and interest-sensitive liabilities;
- the proportion of products with embedded options (e.g. mortgages and savings with uncertain maturities);
- the relative size and composition of the investment portfolio;
- the use of derivative products;
- other off-balance-sheet products (such as fee business);
- stable funding sources as a proportion of the total;
- trends in the balance sheet.

6 REPORTING REQUIREMENT VIS-À-VIS DNB

Institutions that have a material interest rate risk, potential or otherwise, are required to report to DNB (i) internal interest rate reporting data and (ii) a limited number of key figures. This group
includes institutions whose balance sheets are composed to a substantial extent of long-term fixed-income assets, e.g. mortgage, loan and investment portfolios, and/or of interest-sensitive funding, e.g. savings. Institutions that are system-relevant as well as, in particular, the larger institutions that are involved in on- and off-balance-sheet activities (such as interest rate caps, products with embedded options and interest rate swaps) are typically considered to be institutions that have a material interest rate risk. For these institutions, accrual as well as economic value measurement techniques need to be used.

As outlined in Section 3, the conditions under which institutions will be permitted to report are:
- Interest rate risk is reported on the basis of the institution’s internal systems and assumptions;
- Subject to DNB’s opinion, the data provide an adequate consolidated understanding of the risk involved over a relevant horizon;
- Subject to DNB’s opinion, the data allow the development of interest rate risk to be monitored sufficiently.

6.1 Dispensation from standard reporting requirements for institutions to the effect that under certain conditions, the may base their reports on internal reports

A number of important quantitative and mutually complementary indicators that institutions with a material interest rate risk need to report internally are listed below. A number of important conditions that these indicators need to meet are also listed. The indicators need to provide proper information on the interest rate risk in the banking book on a consolidated level, including by currency. An internal interest rate risk report that needs to be reported to DNB on at least a quarterly basis must include the following indicators. For a description of the interest rate risk measurement techniques or indicators referred to, including their advantages and disadvantages, please refer to Section 7 of these guidelines.

a) the duration of equity and/or price value of one basis point (PV01)
b) the earnings at risk (EaR)
c) the economic value of equity (EVE)
and possibly also
d) the value-at-risk (VaR)

Re a) An assessment of the duration of equity (and/or PV01) will consider whether the number of different maturity segments or buckets into which the yield curve is divided in this connection matches the types of position taken by the institution. Attention will also be paid to the correctness of the benchmark yield curves needed in this connection.
Institutions also calculate the effective duration, which is also referred to as the option-adjusted spread or OAS duration, of equity.
Effective duration not only takes account of changes in the discount rate resulting from interest rate movements, but also of changes in the magnitudes of the expected cash flows as a result of interest rate movements. The assessment will consider whether the changes in the expected cash flows in the case of various interest rate scenarios have been estimated in a realistic and conservative manner, and also whether the correct discount rates have been applied when calculating the present values of the various instruments. It will consider whether the maturities
of the zero-coupon yields (or the implied forward rates derived from spot rates) correspond to the durations of the cash flows. In addition, the assessment will check that a reasonable set of scenarios have been calculated so that a thorough picture is obtained of the impact of interest rate movements on the cash flows, and, therefore, on the value of instruments with embedded options. In addition, consideration will be given to whether the assumptions relating to factors such as the interest sensitivity of retail products (such as sight deposits and non-maturity deposits, and loans with a prepayment or extension risk) and the assumptions regarding saving and/or prepayment behaviour are realistic, whether they are stress-tested periodically and whether sensitivity analyses are carried out periodically (see also Section 8 and Appendices 2 and 3).

One of the criteria included in the new Basel framework, as set out in Annex 3 of the Basel document ‘Principles for the Management and Supervision of Interest Rate Risk’, is an important quantitative criterion used to assess the duration of equity. This criterion refers to the fact that the interest rate risk of an institution and the adequacy of the capital allocated to it specifically requires increased attention if in the stress scenario of a 200 basis point upward or downward interest rate shock (a parallel shift of the yield curve) for interest positions in G10 currencies or an equivalent approach in the form of an interest rate change equal to the 1st and 99th percentile of observed interest rate changes in the preceding five years using a holding period of 240 working days results in a loss of economic value of more than 20% of the sum of the institution’s Tier 1 and Tier 2 capital. In addition, the economic value loss should also be compared with the market value of equity in order to obtain a more complete picture of the risk. This will be applied to the current position, taking account of convexity and embedded options. For positions in non-G10 currencies, a stress scenario based on the method for the equivalent approach for G10 currencies or a parallel interest rate shock that is substantially consistent with this will apply.

Re b) An assessment of the EaR will take into account whether the EaR analysis analyses the interest rate risk as fully as possible. This means that the analysis needs to be based upon various scenarios that are realistic but also reflect stress situations (e.g. 200 basis point interest rate change, in the form of an interest rate shock and gradually). Examples are scenarios concerning parallel shifts and non-parallel shifts (rotation) of the yield curve, gradual shifts and in the form of an interest rate shock, measured over a time horizon of between one and two years. Once again, consideration will be given to whether the classification of all relevant assets and liabilities by maturity bucket according to the maturity and the type of the instrument reflects the type of positions taken by the institution.

In addition, consideration will be given to whether the assumptions relating to factors such as the interest sensitivity of retail products (such as sight deposits and non-maturity deposits, and loans with a prepayment or extension risk) and the assumptions regarding savings and/or prepayment behaviour are realistic, whether they are stress-tested periodically, and whether sensitivity analyses are carried out periodically (see also Section 8 and Appendices 2 and 3). One important criterion applied when assessing the interest rate risk in this connection will be the adequacy and the stability of net interest income. The adequacy needs to be measured against the income level needed to maintain normal business activities. An increased interest rate risk will apply if it is clear from the interest rate scenarios that the income would be inadequate in this connection on an ongoing basis.
Re c) When EVE is assessed the factors considered will include the same factors considered in the case of the EaR, such as a sufficient range of interest rate scenarios, whether the assumptions underlying the non-maturity deposits and/or positions with embedded options are realistic, whether these factors are stress-tested periodically, and whether sensitivity analyses are carried out periodically (see also Section 8 and Appendices 2 and 3). The assessment will also consider whether the correct discount rates have been applied when calculating the present values of the various instruments, and whether the maturities of the zero-coupon yields (or the implied forward rates derived from the spot rates) correspond to the durations of the cash flows. Whether the correct information regarding the timing and magnitude of the cash flows has been used will also be checked. A further factor that may be considered is whether an additional spread has been allowed for reflecting the additional credit and/or liquidity risk relative to a risk-free asset (such as a government bond) when setting the discount rates for each instrument.

An important factor that will be considered when assessing the interest rate risk in this connection is the adequacy of the capital allocated to the risk. An increased interest rate risk will apply if the 200 basis point interest rate shock scenario analysis results in a loss of economic value of more than 20% of the sum of the institution’s Tier 1 and Tier 2 capital. In order to obtain a more complete picture of the risk, the economic value loss should also be compared with the economic value of equity.

Re d) When assessing the VaR, consideration will be given to whether the time horizon applied corresponds with the policy objective of holding positions for a longer period (a maximum of one year). This means, therefore, that a one-day VaR is not suitable to analyse the strategic interest rate risk in the banking book. In addition, a sufficiently long historical data period should be considered, e.g. a historical period equal to the preceding five years based upon monthly data).

The assessment will take account of whether the various risk factors reflect the actual risk positions in terms of maturity segment and type of instrument. In contrast to a short-term VaR, such as a one-day VaR, in the case of a VaR to which a longer time horizon applies, the expected return - measured over a corresponding time horizon - cannot be disregarded. This means that the VaR should be seen in the light of the expected return. The assessment will consider whether the expected return has been estimated or measured in a realistic but conservative manner. An increased interest rate risk will apply if the relative VaR, measured over a time horizon of one year, is greater than zero on an ongoing basis.

6.2 Reporting of key figures to DNB

In addition to internal reports, institutions whose interest rate risk is material also need to report certain key figures calculated on the basis of internal systems to DNB quarterly through an automated application known as the Ribes application (form 8035A). As outlined in Section 3, the key figures concerned involve:

- The projected net interest income during the first and second twelve-month period after the reporting date, based on the baseline interest rate scenario.
- The size of the institution’s Own Funds, based on the baseline interest rate scenario.
- 10 -

- Earnings-at-Risk (EaR) during the first and second twelve-month period after the reporting date, based on scenarios of gradual shifts away from the yield curve, over the course of twelve months, to a value 200 basis points above and below the baseline projection.
- Capital value changes based on stress scenarios projecting 200 basis point interest rate shocks in the form of parallel upward and downward shifts vis-à-vis the yield curve, taking account of effects caused by convexity and of embedded options.
- Price Value of 1 basispunt (PV01) of the institution’s Own Funds, based on the baseline interest rate scenario.
- Regulatory Capital excluding Tier 3.

When assessing the key figures referred to above, examining officers may consider the same factors referred to in the case of the internal reporting in Section 6.1.

7 INTEREST RATE RISK IN THE BANKING BOOK AND INTEREST RATE RISK MEASUREMENT TECHNIQUES

7.1 Economic value versus earnings perspective of interest rate risk

Interest rate risk can be viewed from the perspective of earnings (or accrual accounting) and/or economic value. In the case of the earnings perspective, the focus is on the impact of interest rate movements on the net interest or accrued income of a bank over a time horizon of one to two years. This is the traditional approach used by banks to assess their interest rate risk position. As a result of the relatively short time horizon of one to two years, the potential impact of interest rate movements on long-term positions is not analysed adequately. For this reason, particularly in the case of larger institutions, interest rate risk management policy also takes account of the economic value perspective as well as the earnings perspective. The economic value perspective focuses on the potential impact of interest rate movements on the market values of an institution’s assets, liabilities and off-balance-sheet instruments. Using the economic value perspective, the potential impact of interest rate movements on the present value of all future cash flows is analysed based upon the current composition of the balance sheet. It therefore supplements the information provided by the earnings perspective of interest rate risk by analysing the potential long-term effects of interest rate movements.

7.2 Interest rate risk measurement techniques

A variety of techniques and models are used by institutions to analyse interest rate risk, both in terms of economic value and in terms of earnings. These models vary from very simple calculations to statistical simulation models of a wide range of scenarios. The most commonly used techniques for analysing the interest rate risk in the banking book are gap analysis, earnings

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4 In this context, the concept of economic value should be interpreted more as a mark-to-model value and not as the value or price at which assets can actually be traded.
at risk (EaR), duration of equity (and/or price value of one basis point [PV01]) and economic value of equity (EVE). Value at risk (VaR) is also mentioned in this context, although it is not general practice to use this interest rate risk measurement method for the banking book. This is in contrast to trading books, for which the VaR method is commonly used. These techniques are outlined below, together with the advantages and disadvantages of each method.

- **Gap analysis**

  Gap analysis is one of the most traditional management techniques and has been developed by banks to analyse the mismatch or repricing risk in the banking booking in particular. Gap analysis measures the arithmetic difference between the interest-sensitive assets and liabilities of the banking book in absolute terms.

  Based upon the contractual maturities of financial instruments or assumptions regarding them, gap analysis shows the cash flows, including on a cumulative basis, of a portfolio, subportfolio or product by maturity segment (e.g. <1 month, 1-3 months, 6-12 months, 1-2 years…10-15 years, >15 years) (see Table 1). The gap report shows the exposure that is released during a particular time period and the exposure that is outstanding during a particular time period. Using gap analysis, the earnings sensitivity of the banking book to interest rate movements can be derived. When the value of interest-sensitive liabilities exceeds that of interest-sensitive assets, including off-balance-sheet positions, there is a negative or liability-sensitive gap. This means that if market interest rates rise, net interest income is adversely affected. Conversely, a positive or asset-sensitive gap means that if market interest rates fall, net interest income is adversely affected.

  An advantage of gap analysis is that it is a simple method, which is fairly easy to communicate to management.

  Gap analysis is associated with a number of important shortcomings:
  - it is a static model that does not take account of the interest sensitivity of retail products and/or of changes in savings or payment behaviour as a result of interest rate movements;
  - yield curve and/or basis risk cannot be analysed properly using gap analysis;
  - no account is taken of the changes in interest rate spreads that may occur as a result of a change in the general level of interest rates;
  - it is based on the assumption that all positions within a particular maturity segment mature or are repriced simultaneously.

  Particularly for larger institutions, gap analysis is nothing more than the first step (in this case, the distribution of the relevant assets and liabilities according to maturity) in analysing the interest rate risk in the banking book. The following techniques play a much more crucial role in the control and monitoring of interest rate risk.
Table 1. Example of gap report (amounts in EUR)

<table>
<thead>
<tr>
<th></th>
<th>&lt; 1 mth</th>
<th>1-3 mth</th>
<th>3-6 mth</th>
<th>6-12 mth</th>
<th>1-2 yr</th>
<th>2-3 yr</th>
<th>&gt; 3 yr</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans</td>
<td>100</td>
<td>10</td>
<td>20</td>
<td>45</td>
<td>5</td>
<td>20</td>
<td>30</td>
<td>230</td>
</tr>
<tr>
<td>Investments</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>20</td>
<td>50</td>
<td>15</td>
<td>110</td>
</tr>
<tr>
<td>Other assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td><strong>Total assets</strong></td>
<td>105</td>
<td>15</td>
<td>25</td>
<td>55</td>
<td>25</td>
<td>50</td>
<td>95</td>
<td>360</td>
</tr>
<tr>
<td>Non-maturity deposits</td>
<td>-65</td>
<td></td>
<td></td>
<td></td>
<td>-30</td>
<td></td>
<td>-50</td>
<td>-145</td>
</tr>
<tr>
<td>CD’s/other liabilities</td>
<td>-35</td>
<td>-35</td>
<td>-45</td>
<td>-30</td>
<td>-10</td>
<td>-20</td>
<td>-185</td>
<td></td>
</tr>
<tr>
<td><strong>Total liabilities</strong></td>
<td>-100</td>
<td>-35</td>
<td>-45</td>
<td>-30</td>
<td>-40</td>
<td>-70</td>
<td>-330</td>
<td></td>
</tr>
<tr>
<td><strong>Equity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-30</td>
<td></td>
</tr>
<tr>
<td><strong>Net periodic gap</strong></td>
<td>5</td>
<td>-20</td>
<td>-20</td>
<td>25</td>
<td>-15</td>
<td>30</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td><strong>Cumulative gap</strong></td>
<td>5</td>
<td>-15</td>
<td>-35</td>
<td>-10</td>
<td>-25</td>
<td>5</td>
<td>30</td>
<td>0</td>
</tr>
</tbody>
</table>

- **Duration of equity**

Modified duration is an interest-sensitive method, which in general terms shows the change in price of a financial instrument corresponding to marginal and parallel shifts of the yield curve. Modified duration is a relative measurement, which is expressed as a percentage. The price value of a basis point (PVO1) measurement is an absolute measurement derived from duration, which shows in monetary units the change in price resulting from a one basis point (0.01%) shift in the yield curve. In addition to being applied to individual instruments, the modified duration or PVO1 concept can also be applied on an aggregated basis to portfolios or the total banking book. For this purpose, as in the case of gap reporting, all relevant assets and liabilities are allocated to maturity buckets according to maturity and the type of instrument (see Table 2). A benchmark yield curve is selected that most closely represents the characteristics of the instruments concerned. The benchmark duration per maturity segment relating to each cash flow of a particular type of instrument is then multiplied by the long or short position concerned (expressed in monetary units) and an assumed interest rate change of one basis point. The result of this calculation expresses in monetary units the economic value impact on the economic value of the positions concerned resulting from the specified change in interest rates. Finally, the difference between the sum of the changes in the economic value of all relevant assets, liabilities and off-balance-sheet positions is the economic value impact on equity resulting from a particular change in interest rates. The following table, for instance, shows that the institution concerned loses EUR 3,944 (12.43%) of equity when interest rates rise by one percentage point.

One benefit of the duration method is that it analyses the economic value impact of a particular change in interest rates relating to a particular class of assets and/or liabilities and/or the balance sheet in a simple way.
Table 2. Example of a report based upon duration of equity

<table>
<thead>
<tr>
<th>Products</th>
<th>Positions</th>
<th>Risk weighting based upon modified duration</th>
<th>Change in economic value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed-interest mortgage products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5 years</td>
<td>18,755</td>
<td>-3.90%</td>
<td>-732</td>
</tr>
<tr>
<td>&gt; 5 years</td>
<td>65,235</td>
<td>-8.50%</td>
<td>-5,545</td>
</tr>
<tr>
<td>Other interest-sensitive assets</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td><strong>Total interest-sensitive assets</strong></td>
<td><strong>153,610</strong></td>
<td></td>
<td><strong>-10,030</strong></td>
</tr>
<tr>
<td>Core deposits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2 years</td>
<td>18,954</td>
<td>1.20%</td>
<td>227</td>
</tr>
<tr>
<td>5-7 years</td>
<td>52,345</td>
<td>5.40%</td>
<td>2,827</td>
</tr>
<tr>
<td>10-30 years</td>
<td>14,354</td>
<td>12.00%</td>
<td>1,722</td>
</tr>
<tr>
<td>Other interest-sensitive liabilities</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td><strong>Total interest-sensitive liabilities</strong></td>
<td><strong>145,859</strong></td>
<td></td>
<td><strong>6,086</strong></td>
</tr>
<tr>
<td>Equity</td>
<td>31,721</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in value of assets</td>
<td></td>
<td></td>
<td>-10,030</td>
</tr>
<tr>
<td>Change in value of liabilities</td>
<td></td>
<td></td>
<td>6,086</td>
</tr>
<tr>
<td><strong>Net change in equity</strong></td>
<td></td>
<td></td>
<td>-3,944</td>
</tr>
<tr>
<td>Net change in equity/equity</td>
<td></td>
<td></td>
<td>-12.43%</td>
</tr>
</tbody>
</table>

There are a number of disadvantages associated with the duration method, i.e.:
- it only applies to parallel shifts of the yield curve and it cannot be used to measure basis or yield curve risk;
- it only applies to marginal shifts of the yield curve. Relatively large movements in interest rates, and therefore convexity, cannot be measured accurately;
- it takes no account of the change in expected cash flows resulting from interest rate movements;
- it is a static method in the sense that it shows a snapshot in time of the risk based upon the current composition of the portfolio or balance sheet.

As a result of a number of the disadvantages of modified duration described above institutions also calculate the effective duration of portfolios, subportfolios and of equity. Effective duration\(^5\) not only takes account of changes in the discount rate as a result of interest rate movements, but also of changes in the magnitude of the expected cash flows as a result of interest rate movements. The latter effect on the price of an instrument or the value of a portfolio or

\(^5\) Calculated as follows: Effective duration = \( \frac{V_- - V_+}{2(Vo)(\Delta y)} \)

where:
\(V_- = \) price or value if interest rate decline by \(\Delta y\)
\(V_+ = \) price or value if interest rate rise by \(\Delta y\)
\(Vo = \) price or value in the base scenario
\(\Delta y = \) interest rate movement (expressed in decimals)
subportfolio is very important for instruments containing embedded options, such as mortgages that are subject to prepayment risk. For example, relatively large movements in market interest rates can cause prepayments to be delayed (if rates rise) or accelerated (if rates fall), leading in turn to a change in the magnitude of the cash flows. The same applies to savings with uncertain maturities. The extent to which and speed at which customer rates follow market rates, and therefore the expected cash flows, will also depend in part on whether there is a rise or fall in market interest rates and on the relative size of the change. The accuracy of the pricing and/or valuation models underlying the calculations is therefore vitally important. In order to obtain a thorough picture of the impact of interest rate movements on cash flows, and therefore on the value of instruments with embedded options, the effects of a range of interest rate scenarios are typically calculated.

- **Earnings at risk (EaR)**

EaR measures the loss of net interest income resulting from upward/downward interest rate movements, either gradual movements or as a one-off large interest rate shock) over a particular time horizon. EaR is a simulation method that analyses the interest rate risk in the banking book in terms of earnings (accrual basis). Compared to the gap, duration and EVE techniques, which are based upon a snapshot in time of the interest rate risk, the EaR method is more dynamic in nature. It evaluates the risk exposure of the banking book over a particular time horizon (1 to 2 years), taking account of projected changes in maturities and/or repricing relationships and/or the size of the banking book. As in the case of the gap report, first of all, all of the relevant assets and liabilities are allocated to maturity buckets by maturity and type of instrument. A crucial role is played by the assumptions regarding retail products with embedded optionality relating to factors such as interest sensitivity, prepayment and/or savings behaviour. Using this simulation method, a base interest rate scenario is defined under which the net interest income of the banking activities is calculated under the current or the forecast interest rate environment, based upon an assumed interest rate sensitivity of customer rates and forecast volumes of assets and liabilities. The results of the alternative interest rate scenarios are then compared against the result of the base scenario (see Table 3 below).

<table>
<thead>
<tr>
<th>Interest rate scenario (in bp)</th>
<th>Net interest income (in EUR)</th>
<th>Change relative to base scenario (in EUR)</th>
<th>% change</th>
<th>Absolute limits (as a %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+300</td>
<td>5,670</td>
<td>-205</td>
<td>-3.49</td>
<td>5.00</td>
</tr>
<tr>
<td>+200</td>
<td>5,739</td>
<td>-136</td>
<td>-2.31</td>
<td>5.00</td>
</tr>
<tr>
<td>+100</td>
<td>5,807</td>
<td>-68</td>
<td>-1.16</td>
<td>5.00</td>
</tr>
<tr>
<td>0</td>
<td>5,875</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-100</td>
<td>5,942</td>
<td>67</td>
<td>1.14</td>
<td>5.00</td>
</tr>
<tr>
<td>-200</td>
<td>6,008</td>
<td>133</td>
<td>2.26</td>
<td>5.00</td>
</tr>
<tr>
<td>-300</td>
<td>6,075</td>
<td>200</td>
<td>3.40</td>
<td>5.00</td>
</tr>
</tbody>
</table>
The advantages of the EaR method are:
- it analyses the interest rate risk profile of the banking book in a detailed way tailored to the bank’s specific circumstances. In that sense it is a meaningful method, providing management with a complete picture of the earnings risk resulting from interest rate movements;
- it is a dynamic method that takes account of the interest rate sensitivity of retail products and it analyses the interest rate risk profile of the banking book in a detailed way tailored to the bank’s specific circumstances. In that sense it is a meaningful method, providing management of changes in savings and payment behaviour, such as the growth rate of savings and of prepayments resulting from interest rate movements.

The disadvantages of the EaR method are:
- it only analyses the short-term earnings effect (accrued interest) resulting from interest rate fluctuations and not the long-term economic value effects (capital gains/losses).
- it can be complex and non-transparent as a result of the underlying assumptions.

- **Economic value of equity (EVE)**

The EVE measures the change in the market value of equity resulting from upward and/or downward interest rate shocks, taking account of changes in positions, e.g. as a result of optionality. As in the case of the EaR, under this method the value of equity under alternative interest rate scenarios is compared with the value under a base scenario. This base interest rate scenario is the present value of the assets less the liabilities under the current or the forecast interest rate environment. The balance sheet is then revalued under the alternative interest rate scenarios and the difference between the value of equity under the base scenario and the alternative scenario is calculated (see Table 4 below). The accuracy of the valuation of the balance sheet positions is extremely dependent upon the cash flows calculated and the discount rates used. When selecting the discount rates used it should be checked whether the risk and the duration match those of the cash flows. When the cash flows are calculated, account needs to be taken of the fact that the size and the timing of the cash flows may differ under the various scenarios as a result of customer behaviour regarding the growth of deposits and also that of prepayment. This customer behaviour is modelled by specifying a relationship between the interest rate scenario and the extent of prepayment and/or growth of deposits. The table below shows that in the institution’s balance sheet there is negative convexity and optionality: the EVE reduces regardless of the direction of the interest rate shocks.

Table 4. Example of a report based upon the EVE model

| Interest rate scenario | EVE    | Change relative to base scenario | % change | Absolute limits
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>+300</td>
<td>11,991</td>
<td>-6,103</td>
<td>-33.73</td>
<td>30</td>
</tr>
<tr>
<td>+200</td>
<td>14,669</td>
<td>-3,425</td>
<td>-18.93</td>
<td>20</td>
</tr>
<tr>
<td>+100</td>
<td>17,005</td>
<td>-1,089</td>
<td>-6.02</td>
<td>10</td>
</tr>
<tr>
<td>0</td>
<td>18,094</td>
<td>-</td>
<td>0.0</td>
<td>-</td>
</tr>
<tr>
<td>-100</td>
<td>17,864</td>
<td>-230</td>
<td>-1.27</td>
<td>10</td>
</tr>
<tr>
<td>-200</td>
<td>17,645</td>
<td>-449</td>
<td>-2.48</td>
<td>20</td>
</tr>
<tr>
<td>-300</td>
<td>17,157</td>
<td>-947</td>
<td>-5.18</td>
<td>30</td>
</tr>
</tbody>
</table>
The benefits of EVE models are:
- interest rate risk is measured in terms of economic value;
- unlike the duration method, this method enables basis and yield curve risk as well as convexity to be measured properly.

The disadvantages of the EVE model are:
- most of the assets and liabilities relating to the banking book cannot be traded and are therefore difficult to value at market prices. Most assets and liabilities are valued on a mark-to-model basis (using theoretical pricing models);
- it is a static method in the sense that it shows a snapshot in time of the risk based upon the current portfolio or balance sheet composition. It cannot make allowance for the market valuation of future (forecast) growth in existing or new business activities.

• Value at risk (VaR)

The VaR method is an economic value method that measures the potential loss of market value from the positioning on one or more yield curves resulting from interest rate movements. When calculating the VaR, statistical techniques such as frequency distributions, standard deviations and variance-covariance matrices can be used to analyse the risk of a portfolio and the relationships existing in the portfolio. Strictly speaking, VaR measures the expected maximum loss in terms of interest rate risk that can be incurred under normal market circumstances on a fixed-income security or portfolio over a given time horizon and subject to a given confidence level. When the VaR method is applied to the banking book, a time horizon should be considered that is in accordance with the policy intention of holding positions for a longer period of time.

This is in contrast to the one-day VaR that is applicable to trading books, where the policy intention is to trade positions daily. If the VaR is measured over a longer time horizon, such as the banking book (e.g. over a time horizon of one year), the potential loss needs to be seen in relation to the expected return\(^6\). The expected economic return needs to be measured over a time horizon corresponding to that used for the VaR calculation. This is also referred to as the relative VaR, being the difference between the absolute VaR and the expected return.

The VaR approach covers three different techniques, which are the analytical variance-covariance method, the full valuation historical simulation and the Monte Carlo simulation techniques. Each of these techniques is associated with disadvantages or shortcomings. For example, the variance-covariance method assumes that the returns are normally distributed statistically and that the portfolios are a linear combination of the underlying positions, which makes this method less appropriate for portfolios with high optionality. The historical simulation method is purely backward looking and requires a large volume of data, or a long observation period, in order to ensure the reliability of the results, whereas the Monte Carlo simulation method is very demanding in terms of system technology.

\(^6\) This follows from the fact that over time (t), the expected return increases by factor t, whereas the risk increases by the square root of (t). This therefore suggests that the longer the time horizon the greater the expected return in relation to the risk.
Table 5 gives an example of the risk in a portfolio in terms of the relative VaR calculated based upon the variance-covariance method. The following assumptions apply:
- a unilateral reliability level of 99.5% (2.33 standard deviation
- the portfolio has a market value of EUR 400 million
- the measured standard deviation of the portfolio is 0.59% (monthly volatility)
- the expected annual return is EUR 19.58 million
- the time horizon is one year
- the data used is month-end total return figures.

Table 5. Example of the Value at Risk method (absolute and relative)

<table>
<thead>
<tr>
<th>Description</th>
<th>Calculation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute VaR</td>
<td>$2.33 \times 0.59% \times \text{EUR 400 million} \times \sqrt{12} = \text{EUR 19,100,000}$</td>
<td>EUR 19,100,000</td>
</tr>
<tr>
<td>Relative VaR</td>
<td>VaR - E(TR) = 19,100,000 - 19,580,000 = EUR -480,000</td>
<td>EUR -480,000</td>
</tr>
</tbody>
</table>

Additional benefits of the VaR method relative to the other economic value techniques, modified duration and EVE, are 1) that it takes account of the historical volatility of prices and/or interest rates and 2) that it takes account of diversification effects in or between portfolios or balance sheet positions. The method also not only measures the magnitude of the loss, but also the probability of the loss.

An additional drawback relative to the other economic value techniques is that the VaR is a backward-looking method (to a certain degree, with the exception of the VaR based upon Monte Carlo simulation) and therefore the implicit assumption is made that history is indicative of the future.

Table 6 below summarises the interest rate risk models discussed above and the types of interest rate risk for which these models are the most/least appropriate. For a description of the different forms of interest rate risk, please refer to Appendix 1.
Table 6. The interest rate risk models used to measure the different types of interest rate risk

<table>
<thead>
<tr>
<th>Type of interest rate risk</th>
<th>Gap analysis</th>
<th>EaR</th>
<th>Duration/PV01</th>
<th>EVE/VaR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-term earnings exposure</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No*</td>
</tr>
<tr>
<td>Long-term earnings exposure</td>
<td>Yes*</td>
<td>No*</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Repricing risk</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Basis risk</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>Yes*</td>
</tr>
<tr>
<td>Yield curve risk</td>
<td>No</td>
<td>Yes</td>
<td>No*</td>
<td>Yes*</td>
</tr>
<tr>
<td>Embedded option risk</td>
<td>No</td>
<td>Limited*</td>
<td>Limited*</td>
<td>Yes*</td>
</tr>
</tbody>
</table>

*Based upon the most common applications

8 MODEL RISK

As explained in Section 3, the banking books of institutions are typically subject to option risk in the form of options that are embedded in retail products such as sight deposits and savings deposits whose maturity is uncertain, loans that are subject to prepayment or extension risk and/or loans and savings balances that have explicit/implicit caps and floors. On the asset side of the balance sheet, prepayment options are the most common form of embedded option. Mortgage and consumer loans may give the customer, and this is particularly relevant in the USA, the option of prepayment free of penalty, or subject to a very small penalty. On the liability side of the balance sheet, the most common form of option is the right of a customer to make early withdrawals of sight deposits and/or savings deposits (non-maturity deposits). For a detailed description of embedded option risk, please refer to Appendices 2 and 3. Since the techniques of determining and/or hedging the interest rate risk of products with embedded options and its pricing are based upon assumptions, they give rise to model risk. This model risk is reflected in the assumptions relating to factors such as the interest-sensitivity of retail products and the assumptions relating to savings and prepayment behaviour.

The principal risk is that the assumptions underlying the hedging and other techniques are incorrect, which means that institutions are unknowingly exposed to an unquantified interest rate risk on the mismatch. In view of this model risk, examining officers will ensure that the assumptions used are realistic and consistent with the observed behaviour (substantiated by analyses) and also that they are well documented and cannot be manipulated, for example, that they cannot be changed in order to generate the desired results. It is also of vital importance that periodically the core assumptions regarding pricing, interest sensitivity, savings behaviour, prepayment and reinvestment, are evaluated or back-tested, stress tested and that the institutions carry out periodic sensitivity analyses. Finally, it is important that independent model validations are carried out, both initially and periodically.
9 QUANTITATIVE AND QUALITATIVE FACTORS IN THE ASSESSMENT OF INTEREST RATE RISK

This section outlines a number of important quantitative and qualitative factors that will be addressed by supervisory officers when assessing the interest rate risk in an institution’s banking book in order to evaluate an institution’s exposure to interest rate risk. The factors that will need to be considered will include, but will not be limited to, the following:

- the principal sources of an institution’s interest rate risk;
- the magnitude of the interest rate risk assumed by the institution;
- the quality of the interest rate risk management process;
- the adequacy of the capital of the institution;
- observed shortcomings in the interest rate risk management process;
- improvements considered necessary with regard to the identification, measurement, monitoring, and control of interest rate risk.

Quantitative assessment of the interest rate risk

The quantitative factors that need to be considered will include, but will not be limited to, the following:

- the sources of interest rate risk exposures based upon the balance sheet structure of an institution in terms of:
  - the maturity and/or repricing structures of loans, investments and interest-sensitive liabilities;
  - the percentage of products with embedded options, such as mortgages and sight deposits and savings deposits with uncertain maturities);
  - the use of derivative products;
  - other off-balance-sheet products;
  - observed trends in the balance sheet;
  - the relative volume of and outlook for stable and relatively cheap funding sources.
- interest rate risk exposures - subdivided into repricing risk, basis risk, yield curve risk and option risk – relative to an institution’s interest income and capital;
- the adequacy and stability of interest income and interest-sensitive fee income;
- the adequacy of the (economic) capital allocated to interest rate risk;
- interest rate risk measured over the short term (tactical) and long term (strategic) horizon;
- the adequacy of interest rate scenarios in terms of:
  - sensitivity in relation to interest income and capital;
  - the existence of a reasonable set of scenarios based upon historical and/or hypothetical interest rate movements;
  - scenarios incorporating gradual interest rate movements, interest rate shocks, and non-parallel shifts of the yield curve;
  - the impact of a 200 basis point interest rate movement over a time horizon of one to two years;
  - the appropriateness of scenarios in the context of the current interest rate climate;
  - the ability to analyse potential risks arising from option-related positions properly.
the nature of the risk such as stickiness/attrition and the interest rate sensitivity of various products (e.g. of sight deposits and non-maturity deposits and loans that are subject to prepayment risk).

**Quality of interest rate risk management**

The factors that will be considered will include, but will not be limited to, the following:

- the existence of policies:
  - specifying responsibilities, accountability and limit structure;
  - that are consistent with the strategic direction and risk tolerance;
  - that have been approved by the management board or a delegated committee(s).
- the quality of risk control and the limit structure, in terms of:
  - the type and adequacies of limits;
  - the prudence of limits in relation to net interest income and the capital base;
  - whether the institution keeps within the limits and the risk tolerance set;
  - the process of exceeding limits: monitoring, reporting to management and approval.
- the availability of timely, accurate and meaningful management information for the purpose of monitoring risk positions at all relevant levels, including at the level of the management board, of the organisation.
- independent measurement and analysis of the risks, using a variety of scenarios.
- the accuracy, completeness and integrity of data.
- the adequacy of risk analysis systems in terms of:
  - the identification and measurement of the principal sources of interest risk exposure;
  - their appropriateness in view of the volume, nature and complexity of the business activities;
  - the provision of timely and comprehensive measurements of risk exposures.
- periodic base evaluation (back-testing) and the carrying out of sensitivity analyses and stress tests relating to assumptions concerning pricing, interest rate sensitivity and the savings and prepayment behaviour applicable to products with embedded options (such as savings deposits with uncertain maturities and loans that are subject to prepayment risk).
- the carrying out of initial and periodic independent model validations.
- the quality of the management and staff responsible for risk management as reflected in, for example:
  - an adequate/full understanding of all aspects of interest rate risk;
  - a full awareness of exposure to interest rate risk;
  - a pro-active approach by adjusting exposures to new market conditions or to a change in the view of market conditions.
- the quality of the staff responsible for internal controls, in terms of the following checks:
  - periodic reviews of the quality of the risk management process;
  - the adequacy of the risk analysis systems in relation to the volume, nature and complexity of business activities;
  - independent verification of the accuracy of the risk analysis systems (e.g. gap analyses, EaR and EVE, and VaR models);
  - the reasonableness of the interest rate scenarios and the assumptions used;
  - independent verification of the accuracy and completeness of the data.
10 INCREASED INTEREST RATE RISK AND STRICTER SUPERVISORY REGIME

If the assessment of the qualitative and quantitative factors referred to in Section 9 results in an increased interest rate risk, this will result in increased attention or a stricter supervisory procedure.

This may give rise to more frequent (policy)meetings and/or reporting, including regarding policy, and may result in the institution being instructed to reduce the risk. If this does not have the intended effect and/or the institution deliberately wishes to maintain a high interest risk profile, where the increased risk is not addressed adequately by the institution’s capital allocation system, this may result in an additional capital requirement7.

More specifically, the measures required by supervisory officers may relate to:

- improvements to the internal organisation of interest risk management;
- improvements to internal systems and the techniques used;
- improvements to internal controls.

In the latter case, the measures required may involve:

- a compulsory reduction in the risk positions;
- the imposition of an additional capital requirement.

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7 These capital allocation techniques for interest rate risk are still being developed by institutions and will be amended in the light of experience. The assessment of internal capital allocation systems will become vitally important when Basel II is implemented.
APPENDIX 1 - SOURCES OF INTEREST RATE RISK

Interest rate risk can be defined as the risk of a negative impact on profitability and/or equity as a result of interest rate movements. The different forms of interest rate risk are repricing risk, basis risk, yield curve risk and option risk. These risks are described briefly below.

- **Repricing or maturity mismatch risk**
  Repricing risk is the risk resulting from the maturity mismatch between on-balance-sheet assets and liabilities and off-balance-sheet instruments. Repricing risk is one of the principal forms of interest rate risk faced by an institution and is frequently analysed through gap, duration and scenario analysis. Institutions frequently deliberately take repricing risk for return reasons.

- **Basis risk**
  Basis risk results from a change in the relationship between the yields/yield curves of long and short positions with the same maturity in different financial instruments, which means that the long and short positions no longer fully hedge each other. For example, there will be a basis risk if the spread between three-month Treasury and three-month LIBOR changes. This change will affect the net interest margin of a bank as a result of changes in the spreads received or paid on instruments that are repriced at that time. Basis risk also results from a change in the interest rate spread relationship between cash and derivative instruments. For example, an interest rate swap that is priced on the basis of LIBOR to hedge a Treasury note will be subject to the basis risk resulting from a change in the spread relationship between the swap and the Treasury rate.

- **Yield curve risk**.
  Yield curve risk occurs in the case of non-parallel shifts in the yield curve, such as a steepening or flattening or inverse yield curve, and changes in the form of the yield curve, which are also referred to as butterfly shifts. It relates to the changing relationships between interest rates of various maturities for the same index or market, e.g. a three-month Treasury versus a five-year Treasury. A bank’s yield curve risk may increase its mismatch risk.

- **Option risk**
  Option risk arises when a customer of an institution has the right but not the obligation to influence the timing and the magnitude of the cash flows of an asset, liability or off-balance-sheet instrument. The option risk in the banking book consists of factors such as the implicit and/or explicit optionality of mortgage products and consumer loans with regard to the risk of early or delayed repayment (prepayment and extension risk, respectively), of interest ceilings and of loan proposals. Sight deposits and savings deposits whose maturities are uncertain for the institution also entail a risk for the banking book in the form of the right of withdrawal (in relation to the assumed maturity). For a detailed description of the option risk in the banking book, please refer to Appendix 2.
APPENDIX 2 - OPTIONALITY IN THE BANKING BOOK

As already discussed in Section 3, the banking books of institutions are typically subject to option risk in the form of embedded options in retail products. These options occur on both the asset and the liability side of the balance sheet.

On the asset side of the balance sheet, prepayment options are the most common form of embedded option. Mortgage and consumer loans can give the customer (particularly in the United States) the option of prepayment free of penalty, or subject to a very small penalty. A prepayment option is equivalent to the writing of a call option to the customer. This means that in an environment of falling interest rates, customers will prepay their mortgages and/or consumer loans, as a result of which the duration of the assets of the banking book may be reduced. The increased cash inflows generated by the prepayments will be reinvested by the institution at lower interest rates. This acceleration of prepayments is also referred to as the reinvestment or prepayment risk. In an environment of rising interest rates, the opposite occurs as prepayments are delayed, resulting in potential increase in the duration of the assets. This delay in prepayments is also referred to as extension risk.

On the liability side of the balance sheet the most common form of option is the customer’s right to make early withdrawals from sight deposits and savings deposits (non-maturity deposits). The early withdrawal right is equivalent to a put option: if interest rates rise, the market value of deposits declines and customers have the right to exercise the put by withdrawing the deposits, and to reinvest the proceeds in higher yielding products. This option works in the favour of the deposit holder. The institution’s discretion of pricing retail products as non-maturity deposits can also be seen as a type of option. This type of option favours the institution: if market interest rates are rising, an institution’s pricing response can lag behind the change in the market, whereas in the case of falling market interest rates, the institution’s pricing response can lead the market. The modelling of the interest rate risk of these non-maturity deposits is covered specifically in Appendix 3.

Loans and savings accounts that contain caps and floors represent other sources of option risk. For the institution, a cap on a loan is the equivalent of writing a put option on a fixed-interest bond, whereas a loan with a floor is the equivalent of having a call option. The interest rate of the cap and the floor is the equivalent of the strike price. If market interest rates rise above the cap, the customer’s put option moves into-the-money, because the customer is paying a lower interest rate than the market interest rate. If market interest rates fall below the floor, the institution’s call option moves into-the-money, because the interest rate paid on the loan is higher than the market interest rate. Instead of explicit caps and floors there may be implicit caps and floors on the rates on savings deposits that the institution is willing to pay (as in the case of non-maturity deposits).

The techniques used by institutions to analyse the forms of option risk discussed above vary from traditional gap analyses to income simulation and economic value models. Although in practice various ways have been devised of incorporating option risk in gap analyses, such as multiple gap analyses under various scenarios and the delta equivalent method to determine the delta position, these techniques still have weaknesses. Income simulation models such as EaR are also unable to
analyse option risk fully and in general are only accurate for the short-term (two to three years) earnings component. In the case of prepayment options, generic prepayment speeds (based upon option-adjusted-spread [OAS] analyses) from external sources are used to incorporate this risk in income simulation models. In some cases, these generic speeds are used as a starting point and are modified in order to incorporate the idiosyncratic factors that characterise the local market. Economic value techniques, such as EVE, provide better measurements of exposures with embedded options. Institutions that have significant option risks use option-adjusted-value models (OAV) or Monte Carlo simulation models to supplement EVE models.
APPENDIX 3 - NON-MATURITY DEPOSITS

The interest rate risk arising from sight deposits and savings deposits with uncertain maturities and where there is no close correlation between changes in interest income and market interest rates requires particular attention. These positions are also referred to as non-maturity deposits. Various techniques are used by banks to determine the effective maturity of these positions. A number of these techniques are discussed below and we also explain how they are incorporated into risk measurement. These techniques can vary from basic to sophisticated techniques. As explained in Section 8, given the underlying assumptions, relating to interest sensitivity and volume characteristics, these techniques are subject to model risk and supervisory officers will ensure that the risk is estimated in a realistic but conservative manner. This will be checked by periodic evaluation, sensitivity analyses and stress testing.

Gap report
In a gap report, a distinction can be made between positions with uncertain maturities that are interest-sensitive and those that are not interest-sensitive. Interest-sensitive positions, where the interest income is sensitive to movements in market interest rates, are allocated to the short-term maturity segments of the gap report. With regard to positions that are not interest-sensitive, there are a number of possible allocation techniques depending on assumptions regarding customer behaviour. One option is to spread these positions across the various maturity segments in the gap report. An alternative option is to set a cap on the maximum maturity of these positions or to place them in the longest term maturity segment. From a risk perspective, the allocation of positions with uncertain maturities to maturity segments according to a gap profile is particularly important if these positions are used to hedge an institution’s economic exposure.

Net income simulation models
With net income simulation models, such as EaR, the effects of changing market interest rates on interest income and the volume of positions with uncertain maturities in terms of net interest income is calculated. Under the different scenarios, a distinction is typically made between interest rate sensitivity to falling and to rising market interest rates. In order to show the impact of a change in market interest rates on the volume of positions with uncertain maturities, depending on the interest rate scenario, the effects on the net interest income as a result of outflows or new inflows are also typically simulated. Since a time horizon of not more than two to three years is typically considered in the case of income simulation models, they do not provide any information on how positions with uncertain maturities behave over a longer period. From a risk perspective, however, it is important to be aware of the implicit assumptions regarding the assumed effective maturity of these positions when viewed over a longer period, because this is one of the pieces of information used to determine an institution’s balance sheet structure in terms of the effective maturity of investments and advances.

Replicating portfolio analysis
In view of net income simulation models some institutions use a method known as the replicating portfolio technique to measure the interest sensitivity and the volume characteristics of positions with uncertain maturities. The starting point of this technique is to find a portfolio that on an earnings basis most closely replicates the characteristics of positions with uncertain maturities in
terms of maturity, volume growth, and interest income. This hypothetical portfolio will consist of a mix of instruments with different effective maturities or repricing structures, for example, 30% of the portfolio has an effective maturity of 0-1 year and 70% has an effective maturity of 5 years. Key assumptions made by institutions in this connection, in some cases in terms of historical trends, relate to interest sensitivity and the mobility and average growth of, for example, savings deposits. Since these positions with uncertain maturities may typically be used to hedge part of an institution’s economic exposure, it is once again very important for them to be classified correctly in terms of effective maturity and type of instrument.

*Market value approach*
Some banks use a market value approach instead of replicating rule analysis to determine the effective maturity of non-maturity deposits. This approach uses duration and the convexity of the cash flows of positions with uncertain maturities themselves instead of a portfolio rule that best replicates the behaviour of positions with uncertain maturities. The cash flows of the positions with uncertain maturities are estimated by means of simulation or scenario analyses for various interest rate scenarios. The accuracy of the valuation and/or pricing models underlying the calculations with regard to the timing and the magnitude of the expected cash flows and the discount rates used is vitally important. Important input variables for determining the cash flows are the rate (tracking rate) and speed (instant or mean reverted tracking) at which customer rates follow market rates when interest rates change and the assumptions regarding savings inflows and outflows (attrition).
Some institutions, and particularly the larger institutions, use a funds transfer pricing (FTP) mechanism. The purpose of this mechanism is to enable the different risks of a transaction or the banking book to be identified clearly, to establish a transparent responsibility structure or clear management control in respect of the various risks in the banking book, and to allocate a price to these risks. Business units can use the funds transfer pricing mechanism to enter into internal transactions, typically with a central treasury unit, to hedge the market and other risks arising from their business activities. In the case of some institutions, the interest rate risk is transferred in entirety to the central treasury unit through internal contracts and the central treasury unit carries out active interest rate risk management, which may include management of the model risk, within limits, while the business units manage the business risks. In the case of other institutions, the interest rate risk is not transferred in entirety to the treasury unit, and the interest rate risk is actively managed by the business units. This varies from institution to institution and depending on the types of books and/or transactions, different risk transfer principles may apply. For example, in the case of positions that have certain maturities and stated contractual maturities, such as deposits and loans, a matched maturity transfer pricing principle is the logical way of hedging the interest rate risk. In the case of positions with uncertain maturities, such as savings deposits and current account credits, capital and reserves, and mortgages, FTP techniques may take the form of income simulation models, replicating rule analyses or market value approaches (see Appendix 3). It is important for the FTP mechanism used to be formalised in guidelines, which should set out clearly, for example, the market prices for the various internal contracts, who is responsible for the risks transferred through the internal contracts and for those that are not transferred, and how this is reflected in the results of the different units concerned.
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