

EBA/GL/2018/02

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19 July 2018

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## Guidelines

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# on the management of interest rate risk arising from non-trading book activities

# Abbreviations

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<b>ALCO</b>	asset and liability management committee
<b>ALM</b>	asset and liability management
<b>BCBS</b>	Basel Committee on Banking Supervision
<b>BSG</b>	Banking Stakeholder Group
<b>CET1</b>	Common Equity Tier 1
<b>CSRBB</b>	credit spread risk from non-trading book activities
<b>CRD</b>	Capital Requirements Directive (Directive 2013/36/EU)
<b>CRR</b>	Capital Requirements Regulation (Regulation (EU) No 575/2013)
<b>EBA</b>	European Banking Authority
<b>EaR</b>	earnings at risk
<b>EV</b>	economic value
<b>EVaR</b>	economic value at risk
<b>EVE</b>	economic value of equity
<b>FVOCI</b>	fair value through other comprehensive income
<b>ICAAP</b>	Internal Capital Adequacy Assessment Process
<b>IFRS 9</b>	International Financial Reporting Standard 9 – Financial instruments
<b>IMS</b>	internal measurement system
<b>IR</b>	interest rate
<b>IRRBB</b>	interest rate risk arising from the banking book (referred to in CRD as interest rate risk arising from non-trading book activities)
<b>IT</b>	information technology
<b>MIS</b>	management information system
<b>NII</b>	net interest income
<b>NMD</b>	non-maturity deposit
<b>NPE</b>	non-performing exposure
<b>P&amp;L</b>	profit and loss
<b>QIS</b>	quantitative impact study
<b>SREP</b>	supervisory review and evaluation process

# 1. Compliance and reporting obligations

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## Status of these guidelines

1. This document contains guidelines issued pursuant to Article 16 of Regulation (EU) No 1093/2010<sup>1</sup>. In accordance with Article 16(3) of Regulation (EU) No 1093/2010, competent authorities and financial institutions must make every effort to comply with the guidelines.
2. Guidelines set the EBA view of appropriate supervisory practices within the European System of Financial Supervision or of how Union law should be applied in a particular area. Competent authorities as defined in Article 4(2) of Regulation (EU) No 1093/2010 to whom guidelines apply should comply by incorporating them into their practices as appropriate (e.g. by amending their legal framework or their supervisory processes), including where guidelines are directed primarily at institutions.

## Reporting requirements

3. According to Article 16(3) of Regulation (EU) No 1093/2010, competent authorities must notify the EBA whether they comply or intend to comply with these guidelines, or otherwise with reasons for non-compliance, by (dd.mm.yyyy). In the absence of any notification by this deadline, competent authorities will be considered by the EBA to be non-compliant. Notifications should be sent by submitting the form available on the EBA website to [compliance@eba.europa.eu](mailto:compliance@eba.europa.eu) with the reference 'EBA/GL/2018/xx'. Notifications should be submitted by persons with appropriate authority to report compliance on behalf of their competent authorities. Any change in the status of compliance must also be reported to the EBA.
4. Notifications will be published on the EBA website, in line with Article 16(3).

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<sup>1</sup> Regulation (EU) No 1093/2010 of the European Parliament and of the Council of 24 November 2010 establishing a European Supervisory Authority (European Banking Authority), amending Decision No 716/2009/EC and repealing Commission Decision 2009/78/EC, (OJ L 331, 15.12.2010, p.12).

## 2. Subject matter, scope and definitions

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### Subject matter and scope of application

5. These guidelines specify:

- (a) the systems to be implemented by institutions for the identification, evaluation and management of the interest rate risk arising from the non-trading book activities, also referred to as interest rate risk arising from the banking book, (IRRBB) referred to in Article 84 of Directive 2013/36/EU;
- (b) institutions' internal governance arrangements in relation to the management of IRRBB;
- (c) sudden and unexpected changes in the interest rate in accordance with Article 98(5) of Directive 2013/36/EU for the purposes of the review and evaluation performed by competent authorities;
- (d) general expectations for the identification and management of credit spread risk in the non-trading book (CSRBB).

### Addressees

6. These guidelines are addressed to competent authorities referred to in point (i) of Article 4(2) of Regulation (EU) No 1093/2010, and to financial institutions referred to in Article 4(1) of that regulation which are also institutions in accordance with point 3 of Article 4(1) of Regulation (EU) No 575/2013.

### Definitions

7. Unless otherwise specified, terms used and defined in Directive 2013/36/EU<sup>2</sup> and in Regulation (EU) No 575/2013<sup>3</sup> have the same meaning in the guidelines. In addition, for the purposes of these guidelines, the following definitions apply:

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Interest rate risk arising from non-trading book activities	The current or prospective risk to both the earnings and the economic value of an institution arising from adverse movements in interest rates that affect interest rate sensitive
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<sup>2</sup> Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC (1) - OJ L 176, 27.6.2013.

<sup>3</sup> Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012 – OJ L 176, 27.6.2013.

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	instruments, including gap risk, basis risk and option risk.
Interest rate sensitive instruments	Assets, liabilities and off-balance-sheet items in the non-trading book, excluding assets deducted from CET1 capital, e.g. real estate or intangible assets or equity exposures in the non-trading book.
Gap risk	Risk resulting from the term structure of interest rate sensitive instruments that arises from differences in the timing of their rate changes, covering changes to the term structure of interest rates occurring consistently across the yield curve (parallel risk) or differentially by period (non-parallel risk).
Basis risk	Risk arising from the impact of relative changes in interest rates on interest rate sensitive instruments that have similar tenors but are priced using different interest rate indices. Basis risk arises from the imperfect correlation in the adjustment of the rates earned and paid on different interest rate sensitive instruments with otherwise similar rate change characteristics.
Option risk	Risk arising from options (embedded and explicit), where the institution or its customer can alter the level and timing of their cash flows, namely the risk arising from interest rate sensitive instruments where the holder will almost certainly exercise the option if it is in their financial interest to do so (embedded or explicit automatic options) and the risk arising from flexibility embedded implicitly or within the terms of interest rate sensitive instruments, such that changes in interest rates may affect a change in the behaviour of the client (embedded behavioural option risk).
Credit spread risk from non-trading book activities (CSRBB)	The risk driven by changes in the market perception about the price of credit risk, liquidity premium and potentially other components of credit-risky instruments inducing fluctuations in the price of credit risk, liquidity premium and other potential components, which is not explained by IRRBB or by expected credit/(jump-to-)default risk.
Earnings measures	Measures of changes in expected future profitability within a given time horizon resulting from interest rate movements.

Economic value (EV) measures	Measures of changes in the net present value of the interest rate sensitive instruments over their remaining life resulting from interest rate movements. EV measures reflect changes in value over the remaining life of the interest rate sensitive instruments, i.e. until all positions have run off.
Economic value of equity (EVE) measures	A specific form of EV measure where equity is excluded from the cash flows.
Conditional cash flow modelling	Cash flow modelling under the assumption that the timing and amount of cash flows is dependent on the specific interest rate scenario.
Unconditional cash flow modelling	Cash flow modelling under the assumption that the timing and amount of cash flows is independent of the specific interest rate scenario.
Run-off balance sheet	A balance sheet where existing non-trading book positions amortise and are not replaced by any new business.
Dynamic balance sheet	A balance sheet incorporating future business expectations, adjusted for the relevant scenario in a consistent manner.
Constant balance sheet	A balance sheet including off-balance-sheet items in which the total size and composition are maintained by replacing maturing or repricing cash flows with new cash flows that have identical features with regard to the amount, repricing period and spread components.

## 3. Implementation

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### Date of application

8. Competent authorities should ensure that institutions apply these guidelines from 30 June 2019 and reflect the guidelines in the 2019 ICAAP cycle, i.e. ICAAP reports presented in 2020, based on end-year 2019 data, should take these guidelines into account.

### Transitional provisions

9. These specific provisions of the guidelines are subject to the following transitional arrangements:
  - (a) For institutions that fall under SREP categories 3 and 4 as set out in the EBA *Guidelines on the revised common procedures and methodologies for the supervisory review and evaluation process and supervisory stress testing* (SREP Guidelines)<sup>4</sup>, paragraph 18 will apply as from 31 December 2019 [6 months after the application date of the guidelines].
  - (b) For SREP category 3 and 4 institutions, paragraph 114 will apply as from 31 December 2019 [6 months after the application date of the guidelines].

### Repeal

10. The following guidelines are repealed with effect from 30 June 2019: Guidelines on the management of interest rate risk arising from non-trading activities (EBA/GL/2015/08)<sup>5</sup>.

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<sup>4</sup> EBA/GL/2014/13. Available online: <http://www.eba.europa.eu/regulation-and-policy/supervisory-review-and-evaluation-srep-and-pillar-2/guidelines-for-common-procedures-and-methodologies-for-the-supervisory-review-and-evaluation-process-srep>

<sup>5</sup> Available online: <http://www.eba.europa.eu/regulation-and-policy/supervisory-review-and-evaluation-srep-and-pillar-2/guidelines-on-technical-aspects-of-the-management-of-interest-rate-risk-arising-from-non-trading-activities>.

## 4. Guidelines on the management of interest rate risk arising from non-trading book activities

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### 4.1 General provisions

11. Institutions should treat IRRBB as an important risk and always assess it explicitly and comprehensively in their risk management processes and internal capital assessment processes. A different approach should be fully documented and justified in the course of the supervisory dialogue.
12. Institutions should identify their IRRBB exposures and ensure that IRRBB is adequately measured, monitored and controlled.
13. Institutions should manage and mitigate risks arising from their IRRBB exposures that affect both their earnings and economic value.
14. When calculating the impact of interest rate movements in the earnings perspective, institutions should consider not only the effects on interest income and expenses, but also the effects of the market value changes of instruments — depending on accounting treatment — either shown in the profit and loss account or directly in equity (e.g. via other comprehensive income). Institutions should take into account the increase or reduction in earnings and capital over short- and medium-term horizons resulting from interest rate movements.
15. The change in earnings should be the difference between expected earnings under a base scenario and expected earnings under an alternative, more adverse shock or stress scenario from a going-concern perspective.
16. Institutions should consider non-performing exposures<sup>6</sup> (net of provisions) as interest rate sensitive instruments reflecting expected cash flows and their timing.
17. Institutions should consider interest rate derivatives, as well as off-balance-sheet items such as interest rate sensitive loan commitments, as interest rate sensitive instruments.
18. Institutions should monitor and assess their CSRBB-affected exposures, by reference to the asset side of the non-trading book, where CSRBB is relevant for the risk profile of the institution.
19. When implementing the guidelines, institutions should identify their existing and prospective exposure to IRRBB in a proportionate manner, depending on the level, complexity and riskiness of the non-trading book positions they face, or an increasing risk profile taking into account their

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<sup>6</sup> Non-performing exposures as defined in Annex V of Regulation (EU) 680/2014.



business model, their strategies and the business environment they operate in or intend to operate in.

20. Based upon the assessment of their existing and prospective exposure to IRRBB, institutions should consider elements and expectations stipulated in this section and in the sections on capital identification, calculation and allocation (section 4.2.), governance (section 4.3.) and measurement (section 4.4.) and implement them in a way that is commensurate with existing and prospective exposure to IRRBB.

21. In addition to the existing and prospective exposure to IRRBB, when implementing the guidelines, institutions should also consider their general level of sophistication and internal approaches to risk management to make sure that their approaches, processes and systems for the management of IRRBB are coherent with their general approach to risk management and their specific approaches, processes and systems implemented for the purpose of the management of other risks.

## 4.2 Capital identification, calculation and allocation

22. When evaluating the amounts, types and distributions of internal capital pursuant to Article 73 of Directive 2013/36/EU, institutions should base the contribution of IRRBB to the overall internal capital assessment on the institution's internal measurement systems outputs, taking account of key assumptions and risk limits. The overall level of capital should be commensurate with both the institution's actual measured level of risk (including for IRRBB) and its risk appetite, and be duly documented in its report on the Internal Capital Adequacy Assessment Process (ICAAP report).

23. Institutions should demonstrate that their internal capital is commensurate with the level of IRRBB, taking into account the impact on internal capital of potential changes in the institution's economic value and future earnings resulting from changes in interest rates. Institutions are not expected to double-count their internal capital for EV and earning measures.

24. In their ICAAP analysis of the amount of internal capital required for IRRBB, institutions should consider:

- (a) internal capital held for risks to economic value that could arise from adverse movements in interest rates; and
- (b) internal capital needs arising from the impact of rate changes on future earnings capacity, and the resultant implications for internal capital buffer levels.

25. Institutions should not only rely on the supervisory assessments of capital adequacy for IRRBB or on the outcome of the supervisory outlier test (see section 4.5.), but should develop and use their own methodologies for capital allocation, based on their risk appetite, level of risk and risk management policies. In determining the appropriate level of capital, institutions should consider both the amount and the quality of capital needed.

26. Capital adequacy assessments for IRRBB should take into account the following:

- (a) the size and tenor of internal limits on IRRBB exposures, and whether or not these limits are reached at the point of capital calculation;
- (b) the expected cost of hedging open positions that are intended to take advantage of internal expectations of the future level of interest rates;
- (c) the sensitivity of the internal measures of IRRBB to key or imperfect modelling assumptions;
- (d) the impact of shock and stress scenarios on positions priced with different interest rate indices (basis risk);
- (e) the impact on economic value and earnings (including effects on the fair value through other comprehensive income (FVOCI) portfolio) of mismatched positions in different currencies;
- (f) the impact of embedded losses and embedded gains;
- (g) the distribution of capital relative to risks across legal entities included in the group's prudential perimeter of consolidation, in addition to the adequacy of overall capital on a consolidated basis;
- (h) the drivers of the underlying risk; and
- (i) the circumstances under which the risk may materialise.

27. The outcomes of the capital adequacy for IRRBB should be considered in an institution's ICAAP and flow through to the assessments of capital associated with business lines.

28. To calibrate the amount of internal capital to be held for IRRBB, institutions should use measurement systems and a range of interest rate shock and stress scenarios, which are adapted to the risk profile of the institution in order to quantify the potential scale of any IRRBB effects under adverse conditions.

29. Institutions that operate economic capital models should ensure that the internal capital allocation for IRRBB is properly factored into the overall economic capital allocation and that any assumptions on diversification are documented and their reliability as well as stability is verified using historical data appropriate for the individual institution and the markets in which it operates. Economic capital costs may be allocated back to the business units and products to ensure that the full costs of the underlying business units or products are properly understood by those responsible for managing them.

30. In considering whether or not an allocation of internal capital should be made in respect of IRRBB to earnings, institutions should take into account the following:

- (a) The relative importance of net interest income to total net income, and therefore the impact of significant variations in net interest income from year to year;
- (b) The actual levels of net interest income achievable under different scenarios (i.e. the extent to which margins are wide enough to absorb volatility arising from interest rate positions and changes in the cost of liabilities);
- (c) The potential for actual losses to be incurred under stressed conditions, or as a result of secular changes in the market environment, e.g. where it might become necessary to liquidate positions that are intended as a long-term investment to stabilise earnings;
- (d) The relative importance of interest rate sensitive instruments (including interest rate derivatives) in the non-trading book, with potential effects shown either in the profit and loss account or directly in equity (e.g. via other comprehensive income); and
- (e) The fluctuation of net interest income, the strength and stability of the earnings stream and the level of income needed to generate and maintain normal business operations. Institutions with a high level of IRRBB that could, under a plausible range of market scenarios, result in losses, in curtailing normal dividend distribution, or in a decrease in business operations should ensure that they have sufficient capital to withstand the adverse impact of these scenarios.

31. Institutions should consider internal capital buffer adjustments where the results of their stress testing highlight the potential for reduced earnings (and therefore reduced capital generation capacity) under stress scenarios.

## 4.3 Governance

### 4.3.1 Overall IRRBB strategy

32. The IRRBB strategy of the institution, including the risk appetite for IRRBB and IRRBB mitigation, should be part of the overall strategy, in particular the strategic objectives and risk objectives, which the management body must approve as laid down in subparagraph (2), letter (a) of Article 88(1) of Directive 2013/36/EU.

33. The institution's risk appetite for IRRBB should be expressed in terms of the acceptable impact of fluctuating interest rates on both earnings and economic value and should be reflected in limits. Institutions with significant exposures to gap risk, basis risk or option risk should determine their risk appetite in relation to each of these material sub-types of IRRBB.

34. The overall IRRBB strategy should also include the decision about the extent to which the business model relies on generating earnings by 'riding the yield curve', i.e. funding assets with a comparatively long repricing period with liabilities with a comparatively short repricing period. Where the business model relies heavily on this source of earnings, the management body

should explain its IRRBB strategy and how it plans to survive periods of flat or inverse yield curves.

35. Institutions should duly assess proposals to use new products, or engage in new activities, risk-taking or hedging strategies, prior to acquisition or implementation to ensure that the resources required to establish sound and effective IRRBB management of the product or activity have been identified, that the proposed activities are in line with the institution's overall risk appetite, and that procedures to identify, measure, monitor and control the risks of the proposed product or activity have been established. It should be ensured that the IRRBB characteristics of these new products and activities are well understood.
36. Institutions using derivative instruments to mitigate IRRBB exposures should possess the necessary knowledge and expertise. Each institution should demonstrate that it understands the consequences of hedging with interest rate derivatives.
37. Institutions using models of customer behaviour as input for the measurement of their IRRBB should possess the necessary knowledge and expertise. Each institution should be able to demonstrate that it understands the consequences of modelling the behaviour of its customer base.
38. When making decisions on hedging activities, institutions should be aware of the effects of accounting policies, but the accounting treatment should not drive their risk management approach. The management of economic risks should therefore be a priority, and the accounting impacts managed as a secondary concern.
39. Consolidating institutions should ensure that internal governance arrangements and processes for the management of IRRBB are consistent and well integrated on a consolidated and a sub-consolidated basis.

#### **4.3.2 Risk management framework and responsibilities**

40. In view of having internal governance arrangements pursuant to Article 74 and 88 of Directive 2013/36/EU, institutions should, in relation to IRRBB, ensure the following:
  - (a) That their management body bears the ultimate responsibility for the oversight of the IRRBB management framework, the institution's risk appetite framework and the amounts, types and distribution of internal capital to adequately cover the risks. The management body should determine the institution's overall IRRBB strategy and approve the corresponding policies and processes. The management body may, however, delegate the monitoring and management of IRRBB to senior management, expert individuals or an asset and liability management committee under the conditions further specified in paragraph 41.
  - (b) That they have in place an IRRBB management framework that establishes clear lines of responsibilities and that consists of a limit system, policies, processes and internal controls

including regular independent reviews and evaluations of the effectiveness of the framework.

41. The management body should, in particular, be responsible for the following:

- (a) Understanding the nature and the level of the IRRBB exposure. The management body should ensure that there is clear guidance regarding the risk appetite for IRRBB in respect of the institution's business strategies.
- (b) Establishing that the appropriate actions are taken to identify, measure, monitor and control IRRBB, consistent with the approved strategies and policies. In this regard, the management body or its delegates are responsible for setting:
  - i. appropriate limits on IRRBB, including the definition of specific procedures and approvals necessary for exceptions, and ensuring compliance with those limits;
  - ii. systems and standards for measuring IRRBB, valuing positions and assessing performance, including procedures for updating interest rate shock and stress scenarios and key underlying assumptions driving the institution's IRRBB analysis;
  - iii. a comprehensive IRRBB reporting and review process; and
  - iv. effective internal controls and management information systems (MISs).
- (c) Approving major hedging or risk-taking initiatives in advance of implementation. Positions related to internal risk transfers between the non-trading book and the trading book should be properly documented.
- (d) Carrying out the oversight of the approval, implementation and review of IRRBB management policies, procedures and limits. The level of and changes in the institution's IRRBB exposure should be provided regularly to the management body (at least quarterly).
- (e) Ensuring that the validation of IRRBB measurement methods and assessment of corresponding model risk are included in a formal policy process that should be reviewed and approved by the management body or its delegates.
- (f) Understanding and assessing the functioning of its delegates in monitoring and controlling IRRBB, consistent with policies approved by the management body, on the basis of regular reviews of timely and sufficiently detailed information.
- (g) Understanding the implications of the institution's IRRBB strategies and their potential linkages with market, liquidity, credit and operational risk but without requiring all the management body members to be experts in the area. Some of the members should have sufficient technical knowledge to question and challenge the reports made to the management body. The institution should establish that management body members are

responsible for ensuring that senior management has the competence to understand IRRBB and that IRRBB management is provided with adequate resources.

42. Institutions should have delegation arrangements and procedures in place for any delegation by the management body of the monitoring or management of IRRBB, including, but not limited to, the following:

- (a) Persons or committees to which tasks of the management body are delegated for developing IRRBB policies and practices, such as senior management, expert individuals or an asset and liability management committee (ALCO), should be identified and have objectives clearly set out by the management body.
- (b) The management body should ensure that there is an adequate separation of responsibilities in the risk management process for IRRBB. The IRRBB identification, measurement, monitoring and control functions should have clearly defined responsibilities, should be independent from risk-taking functions on IRRBB and should report IRRBB exposures directly to the management body or its delegates.
- (c) The institution should ensure that the management body's delegates have clear lines of authority over the units responsible for risk taking on IRRBB. The communication channel to convey the delegates' directives to these line units should be clear.
- (d) The management body should establish that the institution's structure enables its delegates to carry out their responsibilities, and facilitates effective decision-making and governance. In this regard, an ALCO should meet regularly and its composition should reflect each major department linked to IRRBB. The management body should foster discussion regarding the IRRBB management process, both between its members and its delegates and between its delegates and others in the institution. The management body should also ensure that regular communication between the risk management and strategic planning areas facilitate the monitoring of the risk arising from future business.

### **4.3.3 Risk appetite and policy limits**

43. Institutions should articulate their risk appetite for IRRBB in terms of the risk to both economic value and earnings in particular:

- (a) Institutions should have clearly defined risk appetite statements that are approved by their management body and implemented through comprehensive risk appetite frameworks, i.e. policies and procedures for limiting and controlling IRRBB.
- (b) Their risk appetite frameworks should delineate delegated powers, lines of responsibility and accountability over IRRBB management decisions and should list the instruments, hedging strategies and risk-taking opportunities authorised for IRRBB.

- (c) In defining their risk appetites, institutions should take account of earnings risks that may arise as a consequence of the accounting treatment of transactions in the non-trading book. The risk to earnings may not be limited to interest income and expenses: the effects of changes in interest rates on the market value of instruments that, depending on accounting treatment, are reflected either through the profit and loss account or directly in equity (via other comprehensive income), should be taken into account separately. Institutions should particularly take into account the earnings impact related to embedded optionalities in fair value instruments under ongoing interest rate shocks and stress scenarios. Institutions should also take into account the potential impact on the P&L accounts of hedging interest rate derivatives if their effectiveness was hampered by interest rate changes.

44. Institutions should implement limits that target maintaining IRRBB exposures consistent with their risk appetite and with their overall approach for measuring IRRBB, in particular the following:

- (a) Aggregate risk limits that clearly articulate the amount of IRRBB acceptable to the management body should be applied on a consolidated basis and, as appropriate, at the level of individual affiliates.
- (b) Limits may be associated with specific scenarios of changes in interest rates and term structures, such as their increase or decrease or a change in shape of the yield curve. The interest rate movements used in developing these limits should represent sufficiently adverse shock and stress situations, taking into account historical interest rate volatility and the time required by management to mitigate those risk exposures.
- (c) Policy limits should be appropriate to the nature, size, complexity and capital adequacy of the institution, as well as its ability to measure and manage its risks.
- (d) Depending on the nature of an institution's activities and business model, sub-limits may also be identified for individual business units, portfolios, instrument types, specific instruments or material sub-types of IRRBB risk such as gap risk, basis risk and option risk.
- (e) Systems should be in place to ensure that positions that exceed, or are likely to exceed, limits defined by the management body or its delegates receive prompt management attention and are escalated without delay. There should be a clear policy on who will be informed, how the communication will take place and the actions which will be taken in response.
- (f) The reporting of risk measures to the management body or its delegates should have at least a quarterly frequency and should compare current exposure with policy limits.

45. A framework should be in place to monitor the evolution of hedging strategies that rely on instruments such as derivatives, and to control mark-to-market risks in instruments that are accounted for at market value.

#### 4.3.4 Risk policies, processes and controls

##### a. Risk policies and processes

46. The management body should, based on its overall IRRBB strategy, adopt robust risk policies, processes and systems which should ensure that:

- (a) procedures for updating scenarios for the measurement and assessment of IRRBB are set up;
- (b) the measurement approach and the corresponding assumptions for measuring and assessing IRRBB, including the allocation of internal capital to IRRBB risks, are appropriate and proportional;
- (c) the assumptions of the models used are regularly reviewed and, if necessary, amended;
- (d) standards for the evaluation of positions and the measuring of performance are defined;
- (e) appropriate documentation and control over permissible hedging strategies and hedging instruments exist; and
- (f) the lines of authority and responsibility for managing IRRBB exposures are defined.

47. The policies should be well reasoned, robust and documented and should address all IRRBB components that are important to the institution's individual circumstances. Without prejudice to the proportionality principle, the IRRBB policies should include the following:

- (a) The application of the boundary between 'non-trading book' and 'trading book'. Internal risk transfers between the banking book and the trading book should be properly documented and monitored within the broader monitoring of the IRRBB originated by interest rate derivatives instruments.
- (b) The more detailed definition of economic value and its consistency with the method used to value assets and liabilities (e.g. based on the discounted value of future cash flows, and on the discounted value of future earnings) adopted for internal use.
- (c) The more detailed definition of earnings risk and its consistency with the institution's approach to developing financial plans and financial forecasts adopted for internal use.
- (d) The size and the form of the different interest rate shocks to be used for internal IRRBB calculations.
- (e) The use of conditional or unconditional cash flow modelling approaches.



- (f) The treatment of ‘pipeline transactions’<sup>7</sup> (including any related hedging).
- (g) The aggregation of multicurrency interest rate exposures.
- (h) The measurement and management of basis risk resulting from different interest rate indexes.
- (i) Whether or not non-interest-bearing assets and liabilities of the non-trading book (including capital and reserves) are included in calculations measuring IRRBB for the ICAAP.
- (j) The behavioural treatment of current and savings accounts (i.e. the maturity assumed for liabilities with short contractual maturity but long behavioural maturity).
- (k) The measurement of IRRBB arising from behavioural and automatic options in assets or liabilities, including convexity effects and non-linear payoff profiles.
- (l) The degree of granularity employed in measurement calculations (e.g. use of time buckets).
- (m) The internal definition of commercial margins and adequate methodology for internal treatment of commercial margins.

48. All IRRBB policies should be reviewed regularly, at least annually, and revised as needed.

49. To ensure that the institution’s IRRBB management policies and procedures remain appropriate and sound, the management body or its delegates should review the IRRBB management policies and procedures in the light of the outcomes of regular reports.

50. The management body or its delegates should ensure that analysis and risk management activities related to IRRBB are conducted by sufficient and competent staff with technical knowledge and experience, consistent with the nature and scope of the institution’s activities.

#### **b. Internal controls**

51. With regard to IRRBB control policies and procedures, institutions should have appropriate approval processes, exposure limits, reviews and other mechanisms designed to provide a reasonable assurance that risk management objectives are being achieved.

52. Institutions should undertake regular reviews and evaluations of their internal control systems and risk management processes, seeking assurance that personnel comply with established policies and procedures. Such reviews should also address any significant changes that may affect the effectiveness of controls, including changes in market conditions, personnel, technology and structures of compliance with exposure limits, and ensure that there are

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<sup>7</sup> Pipeline exposures (e.g. where a loan has been agreed and the customer can choose whether to draw down or not) effectively provide the customer with an option that will most likely be exercised when market conditions least suit the institution (negative convexity). Management of pipeline exposures relies on accurate data on applications received, and modelling of expected drawdowns.

appropriate escalation procedures for any exceeded limits. The reviews and evaluations should be conducted regularly by individuals or units that are independent of the function under review. When revisions or enhancements to internal controls are warranted, there should be an internal review mechanism in place to ensure that these are implemented in a timely manner.

53. Institutions should have their IRRBB identification, measurement, monitoring and control processes reviewed by an independent auditing function, which may be an internal or external auditor, on a regular basis. In such cases, reports written by internal or external auditors or other equivalent external parties should be made available to relevant competent authorities.

**c. IRRBB IT system and data quality**

54. The IT systems and applications used by the institution to carry out, process and record operations, to identify, measure and aggregate IRRBB exposures, and to generate reports should be capable of supporting the management of IRRBB in a timely and accurate manner. In particular, the systems should:

- (a) Capture interest rate risk data on all the institution's material IRRBB exposures including exposures to gap, basis, and option risk. This should support the institution's measurement system to identify, measure and aggregate the major sources of IRRBB exposures.
- (b) Be capable of fully and clearly recording all transactions made by the institution, taking into account their IRRBB characteristics.
- (c) Be tailored to the complexity and number of transactions creating IRRBB.
- (d) Offer sufficient flexibility to accommodate a reasonable range of shock and stress scenarios and any additional scenarios.
- (e) Enable the institutions to fully measure, assess and monitor the contribution of individual transactions to their overall exposure.
- (f) Be able to compute economic value and earnings-based measures of IRRBB, as well as other measures of IRRBB prescribed by their competent authorities, based on the interest rate shock and stress scenarios set out in sections 4.4.3 and 4.4.4.
- (g) Be sufficiently flexible to incorporate supervisory-imposed constraints on institutions' internal risk parameter assumptions.

55. The IT system and transaction system should be capable of recording the repricing profile, interest rate characteristics (including spread) and option characteristics of the products to enable measurement of gap risk, basis risk and option risk. In particular, the transaction system should be able to gather detailed information on the repricing date(s) of a given transaction, interest rate type or index, any options (including early repayment or redemption) and the fees relating to the exercise of these options.

56. The systems used to measure IRRBB should be capable of capturing the IRRBB characteristics of all products. The systems should also allow the disaggregation of the impact of individual IRRBB instruments and portfolios at the risk level of the non-trading book.
57. For complex, structured products in particular, the transaction system should be able to gather information about the separate parts of the product and to capture their IRRBB characteristics (e.g. the characteristics of assets and liabilities grouped by certain characteristics such as repricing dates or optionality elements). The institution should ensure that the IT system is able to keep pace with the introduction of new products.
58. Adequate organisational controls of IT systems should be in place to prevent the corruption of data used by IRRBB computer systems and applications, and to control changes to the coding used in those applications, so as to ensure, in particular:
- (a) the reliability of data used as input, and the integrity of processing systems for IRRBB models;
  - (b) that the likelihood of errors occurring in the IT system, including those occurring during data processing and aggregation, is minimised; and
  - (c) that adequate measures are taken if market disruptions or slumps occur.
59. Risk measures should be based on reliable market and internal data. Institutions should scrutinise the quality of external sources of information used to establish the historical databases of interest rates, as well as the frequency at which databases are updated.
60. To ensure the high quality of data, institutions should implement appropriate processes that ensure that the data entered into the IT system is correct. Data inputs should be automated as much as possible to reduce administrative errors, and data mapping should be periodically reviewed and tested against an approved model version. In addition, there should be sufficient documentation of the major data sources used in the institution's risk measurement process. Institutions should also establish appropriate mechanisms to verify the correctness of the aggregation process and the reliability of model results. These mechanisms should confirm the accuracy and reliability of data.
61. Where institutions slot cash flows into different time buckets (e.g. for gap analyses) or assign the cash flows to different vertex points to reflect the different tenors of the interest rate curve, the slotting criteria should be stable over time to allow a meaningful comparison of risk figures over different periods.
62. Institutions should identify potential reasons for discrepancies and irregularities that may arise at the time of data processing. Institutions should have procedures in place to handle those discrepancies and irregularities, including procedures for the mutual reconciliation of positions to enable these discrepancies and irregularities to be eliminated.

63. Institutions should set up appropriate processes to ensure that the data used to feed models measuring the IRRBB across the group — e.g. for simulating earnings — is consistent with the data used for financial planning.

d. Internal reporting

64. Institutions' internal risk-reporting systems should provide timely, accurate and comprehensive information about their exposures to IRRBB. The frequency of internal reports should be at least quarterly.

65. The internal reports should be provided to the management body or its delegates with information at relevant levels of aggregation (by consolidation level and currency), and reviewed regularly. The reports should contain a level of information adapted to the particular management level (e.g. management body, senior management) and to the specific situation of the institution and the economic environment.

66. The IRRBB reports should provide aggregate information as well as sufficient supporting detail to enable the management body or its delegates to assess the sensitivity of the institution to changes in market conditions and other important risk factors. The content of the reports should reflect changes in the risk profile of the institution and in the economic environment, and compare current exposure with policy limits.

67. The IRRBB reports should, on a regular basis, include the results of the model reviews and audits as well as comparisons of past forecasts or risk estimates with actual results to inform potential modelling shortcomings. In particular, institutions should assess the modelled prepayment losses against historical realised losses. Portfolios that may be subject to significant mark-to-market movements should be clearly identified and the impact should be monitored within the institution's MIS and subject to oversight in line with any other portfolios exposed to market risk.

68. While the types of reports prepared for the management body or its delegates will vary based on the institution's portfolio composition, they should include, taking into account paragraph 65, the following:

- (a) Summaries of the institution's aggregate IRRBB exposures, including information on exposures to gap, basis and option risk. Assets, liabilities, cash flows, and strategies that are driving the level and direction of IRRBB should be identified and explained.
- (b) Reports demonstrating the institution's compliance with policies and limits.
- (c) Key modelling assumptions, such as characteristics of non-maturity deposits (NMDs), prepayments on fixed rate loans, early withdrawals of fixed term deposits, drawing of commitments, currency aggregation and treatment of commercial margins.

- (d) Details of the impact of key modelling assumptions on the measurement of IRRBB in terms of both economic value measures and earnings measures, including changes in assumptions under various interest rate scenarios.
- (e) Details of the impact of interest rate derivatives on the measurement of IRRBB, in terms of both economic value measures and earnings measures.
- (f) Details of the impact of fair value instruments, including Level 3 assets and liabilities, on the measurement of IRRBB in terms of both economic value measures and earnings measures.
- (g) Results of stress tests as referred to in section 4.4.4, the shocks as referred to in section 4.4.3, the supervisory outlier test as referred to in section 4.5, and assessments of sensitivity to key assumptions and parameters; and
- (h) Summaries of the reviews of IRRBB policies, procedures and adequacy of the measurement systems, including any findings of internal and external auditors or other equivalent external parties (such as consultants).

69. Based on these reports, the management body or its delegates should be able to assess the sensitivity of the institution to changes in market conditions and other important risk factors, with particular reference to portfolios that may potentially be subject to significant mark-to-market movements.

70. The internal measurement system should generate reports in a format that allows the different levels of the institution's management to understand the reports easily and to make appropriate decisions in a timely manner. The reports should constitute the basis for regular monitoring of whether or not the institution operates in line with its strategy and the interest rate risk limits it has adopted.

#### e. Model governance

71. Institutions should ensure that the validation of IRRBB measurement methods — which should be reviewed and validated independently of their development — and the assessment of corresponding model risk are included in a formal policy process that should be reviewed and approved by the management body or its delegates. The policy should be integrated within the governance processes for model risk management and should specify:

- (a) the management roles and designate who is responsible for the development, validation, documentation, implementation and use of models; and
- (b) the model oversight responsibilities as well as policies including the development of initial and ongoing validation procedures, evaluation of results, approval, version control, exception, escalation, modification and decommission processes.

72. The validation framework should include the following four core elements:

- (a) evaluation of conceptual and methodological soundness, including developmental evidence;
- (b) ongoing model monitoring, including process verification and benchmarking;
- (c) outcomes analysis, including back-testing of key internal parameters (e.g. stability of deposits, loan prepayment rates, early redemptions of deposits, pricing of instruments); and
- (d) thorough assessment of any expert opinions and judgements used in internal models.

73. In addressing the expected initial and ongoing validation activities, the policy should establish a hierarchical process for determining model risk soundness based on both quantitative and qualitative dimensions such as size, impact, past performance and staff expertise with the modelling technique employed.

74. Model risk management for IRRBB measures should follow a holistic approach that begins with motivation, development and implementation by model owners and users. Prior to receiving internal approval for usage, the process for determining model inputs, assumptions, modelling methodologies and outputs should be reviewed and validated independently of the development of IRRBB models.

75. The review and validation results and any recommendations on model usage should be presented to and approved by the management body or its delegates. Upon approval, the model should be subject to ongoing review, process verification and validation at a frequency that is consistent with the level of model risk determined and approved by the institution.

76. The ongoing review process should establish a set of exception trigger events that obligate the model reviewers to notify the management body or its delegates in a timely fashion, in order to determine corrective actions and restrictions on model usage. Clear version control authorisations should be designated, where appropriate, to model owners.

77. On the basis of observations and new information gained over time, an approved model may be modified or withdrawn. Institutions should articulate policies for model transition, including change and version control authorisations and documentation.

78. Institutions may rely on third-party IRRBB models to manage and control IRRBB, provided that these models are adequately customised to properly reflect the specific characteristics of the institution in question. Institutions are expected to fully understand the underlying analytics, assumptions and methodologies of the third-party models and to ensure that they are adequately integrated into the institutions' overall risk management systems and processes. Where third parties provide input for market data, behavioural assumptions or model settings, the institution should have a process in place to determine if those inputs are reasonable for its business and the risk characteristics of its activities. Institutions should ensure there is adequate documentation of their use of third-party models, including any specific customisation.

79. Model inputs or assumptions, whether stemming from internal model processes or from third parties, should be included in the validation process. The institution should document and explain model specification choices as part of the validation process.

## 4.4 Measurement

### 4.4.1 General approach to measurement of IRRBB

80. Institutions should implement robust internal measurement systems (IMs) that capture all components and sources of IRRBB which are relevant for the institution's business model.

81. Institutions should measure their exposure to IRRBB in terms of potential changes to both the economic value (EV) and earnings. Institutions should use complementary features of both approaches to capture the complex nature of IRRBB over the short-term and long-term time horizons. In particular, institutions should measure and monitor (i) the overall impact of key modelling assumptions on the measurement of IRRBB in terms of both economic value measures and earnings measures, and (ii) the IRRBB of their banking book interest rate derivatives where relevant for the business model.

82. If commercial margins and other spread components are excluded from economic value measures, institutions should (i) use a transparent methodology for identifying the risk-free rate at inception of each instrument; and (ii) use a methodology that is applied consistently across all interest rate sensitive instruments and all business units.

83. When calculating earnings measures, institutions should include commercial margins.

84. Institutions should consider non-performing exposures (net of provisions) as interest rate sensitive instruments reflecting expected cash flows and their timing.

85. When measuring their exposure to IRRBB, institutions should not purely rely on the calculation and outcomes of the supervisory outlier tests as described in section 4.5, or any additional outlier test developed by the competent authority, but should develop and use their own assumptions and calculation methods. However, the supervisory outlier tests should be fully integrated into the internal framework for the management of IRRBB and should be used as complementary tools for measuring exposure to IRRBB.

### 4.4.2 Methods for measuring IRRBB

86. Institutions should not rely on a single measure of risk but should instead use the range of quantitative tools and models that corresponds to their specific risk exposure. To that end, institutions should consider the application of the methods listed in Annex I but not limited to those, to ensure that various aspects of interest rate risk are captured adequately.

87. The limitations of each quantitative tool and model used should be fully understood by the institution, and these limitations should be taken into account in the IRRBB risk management

process. In assessing IRRBB, institutions should be aware of the risks that may arise as a consequence of accounting treatment of transactions in the non-trading book.

88. Institutions should identify and measure all components of IRRBB. In order to identify different components of IRRBB, institutions should at least consider those approaches as shown in Table 1.

**Table 1: Identification of sub-components of interest rate risk in the non-trading book**

<b>Component</b>	<b>Method</b>	<b>Focus</b>
<b>Gap risk</b>	Gap analysis	The volume of mismatches in different time bands
	Partial duration for yield curve risk	The dispersion and concentration of mismatches in different time bands
<b>Basis risk</b>	Inventory of instrument groups based on different interest rates	Use of derivatives and other hedging instruments in terms of different bases, convexity and timing difference neglected by gap analysis
<b>Option risk</b> (automatic and behavioural options)	Inventory of all instruments with embedded or explicit options	Behavioural options
		The volume of mortgages, current accounts, savings and deposits where the customer has the option to deviate from the contractual maturity; the volume of commitments with interest rate sensitive customer drawings
		Automatic interest rate options
		Caps, and floors embedded in assets and liabilities; swaptions or prepayment options embedded in wholesale assets and liabilities; and explicit caps, floors and swaptions

89. For measuring and monitoring of IRRBB, institutions should use at least one earnings-based measure and at least one economic value measurement method that, in combination, capture all components of IRRBB. Large institutions with cross-border activities, in particular institutions under categories 1 and 2 of the SREP Guidelines, and institutions with complex or sophisticated business models, should use multiple measurement methods, as further specified in Annex II.

#### **4.4.3 Interest rate shock scenarios for ongoing management**

90. Institutions should regularly, at least quarterly and more frequently in times of increased interest rate volatility or increased IRRBB levels, measure their exposure to IRRBB in terms of



changes in economic value and earnings under various interest rate shock scenarios for potential changes in the level and shape of the interest rate yield curves, and to changes in the relationship between different interest rates (i.e. basis risk).

91. Institutions should also consider whether to apply a conditional or unconditional cash flow modelling approach. Larger and more complex institutions, in particular institutions under categories 1 and 2 of the SREP Guidelines, should also take into account scenarios where different interest rate paths are computed and where some of the assumptions (e.g. relating to behaviour, contribution to risk, and balance sheet size and composition) are themselves functions of changing interest rate levels.

92. Institutions should assess exposures in each currency in which they have positions. For the material currency exposures, the interest rate shock scenarios should be currency-specific and consistent with the underlying economic characteristics. Institutions should include in their internal measurement systems methods to aggregate their IRRBB across different currencies. Where institutions make use of assumptions about dependencies between interest rates in different currencies, they should have the necessary level of skills and sophistication to do so. Institutions should take into account the impact of assumptions regarding dependencies between interest rates across different currencies.

93. When selecting interest rate shock scenarios, institutions should consider the following:

- (a) That their own internally developed interest rate shock scenarios be commensurate with the nature, scale and complexity of their activities as well as their risk profile, taking into account sudden and gradual parallel and non-parallel shifts and changes in the yield curves. Scenarios should be based on the historical movements and behaviour of interest rates, as well as simulations of future interest rates.
- (b) Interest rate scenarios that reflect changes in the relationships between key market rates in order to address basis risk.
- (c) The six prescribed interest rate shock scenarios set out in Annex III.
- (d) Any additional interest rate shock scenarios required by supervisors.

94. In low interest rate environments, institutions should also consider negative interest rate scenarios and the possibility of asymmetrical effects of negative interest rates on their interest rate sensitive instruments.

95. The results of shock scenarios should feed into the decision-making at appropriate management level. This includes strategic or business decisions, the allocation of internal capital, and risk management decisions by the management body or its delegates. The results should also be considered when establishing and reviewing the policies and limits for IRRBB.

#### 4.4.4 Interest rate stress scenarios

96. IRRBB stress testing should be considered in the ICAAP, where institutions should undertake rigorous, forward-looking stress testing that identifies the potential adverse consequences of severe changes in market conditions on their capital or earnings, including through changes in the behaviour of their customer base. Stress testing for IRRBB should be integrated into institutions' overall stress-testing framework, including reverse stress testing, and should be commensurate with their nature, size and complexity, as well as their business activities and overall risk profile.
97. IRRBB stress testing should be performed regularly, at least annually and more frequently in times of increased interest rate volatility and increased IRRBB levels.
98. The IRRBB stress-testing framework should include clearly defined objectives, scenarios tailored to the institution's businesses and risks, well-documented assumptions and sound methodologies.
99. In enterprise-wide stress tests, the interaction of IRRBB with other risk categories (e.g. credit risk, liquidity risk, market risks), and any material second-round effects, should be computed.
100. Institutions should perform reverse stress tests in order to (i) identify interest rate scenarios that could severely threaten an institution's capital and earnings; and (ii) reveal vulnerabilities arising from its hedging strategies and the potential behavioural reactions of its customers.
101. In testing vulnerabilities under stressed conditions, institutions should use larger and more extreme shifts and changes in interest rates than those used for the purpose of ongoing management, including at least the following:
- a) substantial changes in the relationships between key market rates (basis risk);
  - b) sudden and substantial shifts in the yield curve (both parallel and non-parallel);
  - c) breakdowns of key assumptions about the behaviour of asset and liability classes;
  - d) changes in key interest rate correlation assumptions;
  - e) significant changes to current market and macro conditions and to the competitive and economic environment, and their possible development; and
  - f) specific scenarios that relate to the individual business model and profile of the institution.
102. The results of stress scenarios should feed into the decision-making at the appropriate management level. This includes strategic or business decisions, the allocation of internal

capital, and risk management decisions by the management body or its delegates. The results should also be considered when establishing and reviewing the policies and limits for IRRBB.

#### **4.4.5 Measurement assumptions**

103. When measuring IRRBB, institutions should fully understand and document key behavioural and modelling assumptions. These assumptions should be aligned with business strategies and be regularly tested.

104. Institutions should, in relation to both economic value and earnings-based measures of IRRBB, take into account assumptions made for the purpose of risk quantification in relation to at least the following areas:

- a) the exercise of interest rate options (automatic or behavioural) by both the institution and its customer under specific interest shock and stress scenarios;
- b) the treatment of balances and interest flows arising from NMDs;
- c) the treatment of fixed term deposits with risk of early redemption;
- d) the treatment of fixed rate loans and fixed rate loan commitments;
- e) the treatment of own equity in internal economic value measures;
- f) the implications of accounting practices for the measurement of IRRBB, and in particular hedge-accounting effectiveness.

105. As market conditions, competitive environments and strategies change over time, institutions should review significant measurement assumptions at least annually, and more frequently during rapidly changing market conditions.

##### **a) Behavioural assumptions for customer accounts with embedded customer optionality**

106. In assessing the implications of optionality, institutions should take into account:

- (a) The potential impact on current and future loan prepayment speeds arising from the interest rate scenario, underlying economic environment and contractual features. Institutions should take into account the various dimensions influencing the embedded behavioural options.
- (b) The elasticity of adjustment of product rates to changes in market interest rates.
- (c) The migration of balances between product types as a result of changes in their features, terms and conditions.

107. Institutions should have policies in place governing the setting of, and the regular assessment of, the key assumptions for the treatment of on- and off-balance-sheet items that

have embedded options in their interest rate risk framework. This means that institutions should:

- (a) identify all material products and items subject to embedded options that could affect either the interest rate charged or the behavioural repricing date (as opposed to contractual maturity date) of the relevant balances;
- (b) have appropriate pricing and risk mitigation strategies (e.g. use of derivatives) to manage the impact of optionality within the risk appetite, which may include early redemption penalties chargeable to the customer as an offset to the potential break costs (where permitted);
- (c) ensure that modelling of key behavioural assumptions is justifiable in relation to the underlying historical data, and based on prudent hypotheses;
- (d) be able to demonstrate that they have accurate modelling (back-tested against experience);
- (e) maintain appropriate documentation of assumptions in their policies and procedures, and have a process for keeping them under review;
- (f) understand the sensitivity of the institution's risk measurement outputs to these assumptions, including undertaking stress testing of the assumptions and taking the results of such tests into account in internal capital allocation decisions; and
- (g) perform regular internal validation of these assumptions to verify their stability over time and to adjust them if necessary.

**b) Behavioural assumptions for customer accounts without specific repricing dates**

108. In making behavioural assumptions about accounts without specific repricing dates for the purposes of interest rate risk management, institutions should:

- (a) Be able to identify 'core' balances, i.e. deposits that are stable and unlikely to reprice even under significant changes in interest rate environment, and/or other deposits whose limited elasticity to interest rate changes could be modelled by banks.
- (b) Modelling assumptions for these deposits should reflect depositor characteristics (e.g. retail/wholesale) and account characteristics (e.g. transactional/non-transactional). A high-level description of the above categories can be found below:
  - i. Retail transactional deposits include non-interest-bearing and other retail accounts whose remuneration component is not relevant in the client's decision to hold money in the account.

- ii. Retail non-transactional deposits include retail accounts (including regulated ones) whose remuneration component is relevant in the client's decision to hold money in the account.
  - iii. Wholesale deposits include accounts from corporate and other wholesale clients, excluding interbank accounts or other fully price-sensitive ones.
- (c) Assess the potential migration between deposits without specific repricing dates and other deposits that could modify, under different interest rate scenarios, key behavioural modelling assumptions.
- (d) Consider potential constraints on the repricing of retail deposits in low or negative interest rate environments.
- (e) Ensure that assumptions about the decay of core and other modelled balances are prudent and appropriate in balancing the benefits to earnings against the additional economic value risk entailed in locking in a future interest rate return on the assets financed by these balances, and the potential forgone revenue under a rising interest rate environment.
- (f) Not exclusively rely on statistical or quantitative methods to determine the behavioural repricing dates and the cash flow profile of NMDs. Further, the determination of appropriate modelling assumptions for NMDs may require the collaboration of different experts within an institution (e.g. risk management and risk control department, sales and treasury).
- (g) Have appropriate documentation of these assumptions in their policies and procedures, and a process for keeping them under review.
- (h) Understand the impact of the assumptions on the institution's own chosen risk measurement outputs and internal capital allocation decisions, including by periodically calculating sensitivity analyses on key parameters (e.g. percentage and maturity of core balances on accounts and pass-through rate) and the measures using contractual terms rather than behavioural assumptions to isolate the impact of assumptions on both economic value and earnings.
- (i) Undertake stress testing to understand the sensitivity of the chosen risk measures to changes in key assumptions, taking the results of such tests into account in internal capital allocation decisions.

**c) Corporate planning assumptions for own equity capital**

109. Where institutions decide to adopt a policy intended to stabilise earnings arising from their own equity, they should:

- (a) have an appropriate methodology for determining what elements of equity capital should be considered eligible for such treatment;

- (b) determine what would be a prudent investment maturity profile for the eligible equity capital that balances the benefits of income stabilisation arising from taking longer-dated fixed-return positions against the additional economic value sensitivity of those positions under an interest rate stress, and the risk of earnings underperformance should rates rise;
  - (c) include appropriate documentation of these assumptions in their policies and procedures, and include a process for keeping them under review;
  - (d) understand the impact of the chosen maturity profile on the institution's own chosen risk measurement outputs, including by regular calculation of the measures without inclusion of the equity capital to isolate the effects on both EVE and earnings perspectives; and
  - (e) undertake stress testing to understand the sensitivity of risk measures to changes in key assumptions for equity capital, taking the results of such tests into account in their IRRBB internal capital allocation decisions.
110. In deciding the investment term assumptions for equity capital, institutions should avoid taking income stabilisation positions that significantly reduce their capability to adjust to significant changes in the underlying economic and business environment.
111. The investment term assumptions used to manage the risks to earnings and economic value sensitivity arising from equity capital should be considered as part of the normal corporate planning cycle, and such assumptions should not be altered just to reflect a change in the institution's expectations of the path of future interest rates. Any use of derivative or asset portfolios to achieve the desired investment profile should be clearly documented and recorded.
112. Where an institution has not set explicit assumptions for the investment term of equity capital or sets assumptions that are explicitly short-term, the institution should make sure that its systems and management information can identify the implications of its chosen approach for the volatility of both earnings and economic value.

## 4.5 Supervisory outlier test

113. Institutions should regularly, at least quarterly, calculate the impact on their EVE of a sudden parallel +/-200 basis points shift of the yield curve. Institutions should report regularly, at least annually, to the competent authority the change in EVE that results from the calculation. Where the decline in EVE is greater than 20% of the institution's own funds, the institution should inform the competent authority immediately.
114. Institutions should regularly, at least quarterly, calculate the impact on their EVE of interest rate shocks, applying scenarios 1 to 6 as set out in Annex III. Institutions should report regularly, at least annually through the ICAAP report, to the competent authority the change in EVE that results from the calculation. Where the decline in EVE is greater than 15% of the institution's

Tier 1 capital under any of the six scenarios, the institution should inform the competent authority.

115. When calculating the change in EVE for the purpose of paragraphs 113 and 114, institutions should in particular apply the following principles:

- (a) All positions from interest rate sensitive instruments should be taken into account.
- (b) Small trading book business should be included unless its interest rate risk is captured in another risk measure.
- (c) All CET1 instruments and other perpetual own funds without any call dates should be excluded from the calculation of the standard EVE outlier test.
- (d) Institutions should reflect automatic and behavioural options in the calculation. Institutions should adjust key behavioural modelling assumptions to the features of different interest rate scenarios.
- (e) Pension obligations and pension plan assets should be included unless their interest rate risk is captured in another risk measure.
- (f) The cash flows from interest rate sensitive instruments should include any repayment of principal, any repricing of principal and any interest payments.
- (g) Institutions with an NPE ratio<sup>8</sup> of 2% or more should include NPEs as general interest rate sensitive instruments whose modelling should reflect expected cash flows and their timing. NPEs should be included net of provisions.
- (h) Institutions should consider instrument-specific interest rate floors.
- (i) The treatment of commercial margins and other spread components in interest payments in terms of their exclusion from or inclusion in the cash flows should be in accordance with the institutions' internal management and measurement approach for interest rate risk in the non-trading book. Institutions should notify the competent authority whether they exclude commercial margins and other spread components from the calculation or not. If commercial margins and other spread components are excluded, institutions should (i) use a transparent methodology for identifying the risk-free rate at inception of each instrument; (ii) use a methodology that is applied consistently across business units; and (iii) ensure that the exclusion of commercial margins and other spread components from the cash flows is consistent with how the institution manages and hedges IRRBB.
- (j) The change in EVE should be computed with the assumption of a run-off balance sheet.

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<sup>8</sup> Ratio of non-performing exposures (non-performing debt securities and loans and advances/total gross debt securities and loans and advances) calculated at the level of the institution.

- (k) A maturity-dependent post-shock interest rate floor should be applied for each currency starting with -100 basis points for immediate maturities. This floor should increase by 5 basis points per year, eventually reaching 0% for maturities of 20 years and more. If observed rates are lower than the current lower reference rate of -100 basis points, institutions should apply the lower observed rate<sup>9</sup>.
  - (l) Institutions should calculate the change in EVE at least for each currency where the assets or liabilities denominated in that currency amount to 5% or more of the total non-trading book financial assets (excluding tangible assets) or liabilities, or less than 5% if the sum of assets or liabilities included in the calculation is lower than 90% of total non-trading book financial assets (excluding tangible assets) or liabilities (material positions).
  - (m) When calculating the aggregate EVE change for each interest rate shock scenario, institutions should add together any negative and positive changes to EVE occurring in each currency. Positive changes should be weighted by a factor of 50%.
  - (n) An appropriate general 'risk-free' yield curve per currency should be applied (e.g. swap rate curves). That curve should not include instrument-specific or entity-specific credit spreads or liquidity spreads.
  - (o) The assumed behavioural repricing date for retail and non-financial wholesale deposits without any specific repricing dates (non-maturity deposits) should be constrained to a maximum average of 5 years. The 5-year cap applies individually for each currency. Non-maturity deposits from financial institutions should not be subject to behavioural modelling.
116. When computing the effects of the standard EVE outlier test, institutions should use the calculation methods set out under the economic value of equity headings in Annex I and Annex II.

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<sup>9</sup> The EBA might envisage revising this floor to ensure that the lower reference rate will be sufficiently prudent given future developments in the interest rates.



## Annex I – IRRBB measurement methods

Cash flow modelling	Metric	Description	Risks captured	Limitations of metric
	<p><b>Earnings-based:</b></p> <ul style="list-style-type: none"> <li>• Gap analysis: Repricing gap</li> </ul>	<p>Gap analysis allocates all relevant interest rate sensitive instruments into predefined time buckets according to their repricing or maturity dates, which are either contractually fixed or based on behavioural assumptions. It calculates the net positions ('gaps') in each time bucket. It approximates the change in net interest rate income ensuing from a yield curve shift by multiplying each net position with the corresponding interest rate change.</p>	<p>Gap risk (only parallel risk)</p>	<ul style="list-style-type: none"> <li>• The metric approximates the gap risk only linearly.</li> <li>• It is based on the assumption that all positions within a particular time bucket mature or reprice simultaneously.</li> <li>• It fails to measure basis and option risk.</li> </ul>
<p><b>Unconditional cash flows</b> (it is assumed that the <i>timing</i> of cash flows is independent of the specific interest rate scenario)</p>	<p><b>Economic value:</b></p> <ul style="list-style-type: none"> <li>• Duration analysis: Modified duration/PV01 of equity</li> </ul>	<p>The modified duration approximates the relative change in the net present value of a financial instrument due to a marginal parallel shift of the yield curve by one percentage point. The <i>modified duration of equity</i> measures the exposure of an institution to gap risk in its non-trading book. PV01 of equity is derived from the modified duration of equity and measures the absolute change of the equity value resulting from a 1 basis point (0.01%) parallel shift of the yield curve.</p> <p>The starting point is the allocation of all cash flows of interest rate sensitive instruments into time buckets. For each instrument type, an appropriate yield curve is selected. The modified duration of each instrument is calculated from the change of its net present value due to a 1 percentage point parallel shift of the yield curve. The modified duration of equity is determined as the modified duration of assets times assets divided by equity minus the modified duration of liabilities times liabilities divided by equity.</p>	<p>Gap risk (only parallel risk)</p>	<ul style="list-style-type: none"> <li>• The metric only applies to marginal shifts of the yield curve. In the presences of convexities, it may underestimate the effect of larger interest rate movements</li> <li>• It only applies to parallel shifts of the yield curve</li> <li>• It fails to measure option risk and captures basis risk at best partially.</li> </ul>

Cash flow modelling	Metric	Description	Risks captured	Limitations of metric
	<ul style="list-style-type: none"> <li>Partial modified duration/partial PV01</li> </ul>	<p>PV01 of equity is obtained by multiplying the modified duration of equity by the value of equity (i.e. assets minus liabilities) and dividing by 10 000 to arrive at the value change per basis point.</p> <p>The partial modified duration of an instrument for a specific time bucket is calculated as the modified duration above, except that not the entire yield curve is shifted in parallel, but only the yield curve segment corresponding to the time bucket. These partial measures show the sensitivity of the market value of the banking book to a marginal shift of the yield curve in particular maturity segments. To each time bucket's partial measure a different magnitude of a shift can be applied, such that the effect of a change of the yield curve's shape can be computed for the entire portfolio.</p>	<p>Gap risk (parallel and non-parallel risk)</p>	<ul style="list-style-type: none"> <li>The metric only applies to marginal interest rate changes. In the presence of convexity, the metric may underestimate the effect of larger interest rate movements.</li> <li>It fails to measure the basis and option risk.</li> </ul>
<p><b>Cash flows partially or fully conditional on interest rate scenario</b> (it is assumed that the <i>timing</i> of cash flows of options, of instruments with embedded, explicit options and – in more sophisticated approaches – of instruments of which the maturity depends on clients' behaviour, is modelled conditional on the interest rate scenario)</p>	<p><b>Earnings-based:</b> Focus on net interest income (NII) component:</p> <ul style="list-style-type: none"> <li>Change of NII</li> </ul>	<p>The change of NII is an earnings-based metric and measures the change of the net interest income over a particular time horizon (usually 1-5 years) resulting from a sudden or gradual interest rate movement.</p> <p>The starting point is the mapping of all cash flows of interest rate sensitive instruments to (granular) time buckets (or using the exact repricing dates of individual positions in more sophisticated systems).</p> <p>The base scenario for the calculations reflects the institution's current corporate plan to project the volume, pricing and repricing dates of future business transactions. The interest rates used to calculate future cash flows in the base scenario are derived from forward rates, appropriate spreads or market expected rates for different instruments.</p> <p>In assessing the possible extent of NII changes, banks use assumptions and models to predict the path of interest rates, the run-off of existing assets, liabilities and off-balance-sheet items, and their potential replacement.</p>	<p>Gap risk (parallel and non-parallel), basis risk and, provided <i>all</i> cash flows are modelled scenario dependent, also option risk</p>	<ul style="list-style-type: none"> <li>Sensitivity of the outcome to the modelling and behavioural assumptions</li> <li>Complexity</li> </ul>

Cash flow modelling	Metric	Description	Risks captured	Limitations of metric
		<p>Earnings-based metrics can be differentiated according to the sophistication of projecting future cash flows: simple <i>run-off models</i> assume that existing assets and liabilities mature without replacement; <i>constant balance sheet models</i> assume that maturing assets and liabilities are replaced by identical instruments; while the most <i>complex dynamic cash flow models</i> reflect business responses to differing interest rate environments in the size and composition of the banking book.</p> <p>All earnings-based metrics can be used in a scenario or stochastic analysis. Earnings at risk (EaR) is an example of the latter, which measures the maximum NII change at a given confidence level.</p>		
	<p><b><u>Economic value:</u></b> Focus on economic value of equity (EVE) • Change in EVE</p>	<p>The change in EVE is the change in the net present value of all cash flows originating from banking book assets, liabilities and off-balance-sheet items resulting from a change in interest rates, assuming that all banking book positions run off.</p> <p>The interest rate risk can be assessed by the <math>\Delta</math>EVE for specific interest rate scenarios or by the distribution of <math>\Delta</math>EVE using Monte Carlo or historical simulations. Economic value at risk (EVaR) is an example of the latter, which measures the maximum equity value change for a given confidence level.</p>	<p>Gap risk (parallel and non-parallel), basis risk and, if <i>all</i> cash flows are modelled scenario dependent, also option risk</p>	<ul style="list-style-type: none"> <li>• Sensitivity of the outcome to the modelling and behavioural assumptions</li> <li>• Stochastic metrics, which apply distributional assumption, may fail to capture tail risks and non-linearities</li> <li>• Full revaluation Monte Carlo approaches are computationally demanding and may be difficult to interpret ('black-box')</li> <li>• Complexity</li> </ul>

## Annex II – Sophistication matrix for IRRBB measurement

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Institutions should apply at least the level of sophistication in their risk measures shown in the table below corresponding to their categorisation under the SREP Guidelines. Where the complexity or scope of an institution's business model is significant, the institution should, notwithstanding its size, apply and implement risk measures that correspond to its specific business model and adequately capture all sensitivities. All material sensitivities to the interest rate changes should be adequately captured, including sensitivity to behavioural assumptions.

Institutions that offer financial products containing embedded optionalities should use measurement systems that can adequately capture the dependence of options to interest rate changes. Institutions with products that provide behavioural optionalities to clients should use adequate conditional cash flow modelling approaches to quantify IRRBB with regard to the changes in client behaviour that could occur under different interest rate stress scenarios.

The four categories referred to in the sophistication table below reflect the categorisation of institutions laid down in the EBA SREP Guidelines. The different categories reflect different size, structure and the nature, scope and complexity of activities of institutions; with Category 1 corresponding to the most sophisticated institutions.

<u>IRRBB metric and modelling</u>		Indicative supervisory expectations regarding IRRBB metric and modelling depending on the institution's sophistication category			
Cash flow modelling	Metric	Category 4 institution	Category 3 institution	Category 2 institution	Category 1 institution
<b>Unconditional cash flows</b> (it is assumed that the <i>timing</i> of cash flows is independent of the specific interest rate scenario)	<b>Earnings-based:</b> Gap analysis: <ul style="list-style-type: none"> <li>• Repricing gap</li> </ul>	Time buckets advised in the Basel Committee on Banking Supervision's Standards 'Principles for the Management and Supervision of Interest Rate Risk in the banking book' from April 2016 BCBS Standards).			<i>[Gap based on evolving size and composition of the banking book due to business responses to differing interest rate environments. Including projected commercial margins consistent with the interest rate scenario (see section 4.4, 'Measurement').]*</i>
	<b>Economic value:</b> Duration analysis: <ul style="list-style-type: none"> <li>• Modified duration/PV01 of equity</li> <li>• Partial modified duration/partial PV01</li> </ul>	Time buckets advised in BCBS Standards. Application of standard shocks. Yield curve model with tenors corresponding to the time buckets.	Time buckets advised in BCBS Standards, application of partial duration weights. Application of standard shocks and other interest rate shock and stress scenarios (see section 4.4, 'Measurement'). Yield curve model with tenors corresponding to the time buckets.	<i>[Partial duration computed per instrument type and time bucket. Application of standard and other interest rate shock and stress scenarios (see section 4.4, 'Measurement'). Yield curve model with tenors corresponding to the time buckets.]*</i>	<i>[Partial duration computed per transaction and time bucket. Application of standard and other interest rate shock and stress scenarios (see section 4.4, 'Measurement'). Yield curve model with tenors corresponding to the time buckets.]*</i>

**IRRBB metric and modelling**

**Indicative supervisory expectations regarding IRRBB metric and modelling depending on the institution’s sophistication category**

<p><b>Cash flows partially or fully conditional on interest rate scenario</b> (<i>timing</i> of cash flows of options, of instruments with embedded, explicit options and – in more sophisticated approaches – of instruments of which the maturity depends on clients’ behaviour, is modelled conditional on the interest rate scenario)</p>	<p><b><u>Earnings-based:</u></b> •Net interest income (NII)</p>	<p>Standard shocks applied to earnings under a constant balance sheet. Based on time buckets advised in the BCBS Standards.</p>	<p>Standard and other interest rate shock and stress scenarios for the yield curve (see section 4.4, ‘Measurement’) applied to earnings, reflecting constant balance sheet or simple assumptions about future business development.</p>	<p>Standard and other interest rate shock and stress scenarios for the yield curve and between key market rates separately (see section 4.4, ‘Measurement’) applied to earnings projected by business plan or constant balance sheet. Including projected commercial margins consistent with the interest rate scenario (see section 4.4, ‘Measurement’).</p>	<p>Comprehensive interest rate and stress scenarios, combining shifts of yield curves with changes in basis and credit spreads, as well as changes in customer behaviour, are applied to reforecast business volumes and earnings to measure the difference compared with the underlying business plan. Including projected commercial margins consistent with the interest rate scenario (see section 4.4, ‘Measurement’).</p>
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## IRRBB metric and modelling

### Indicative supervisory expectations regarding IRRBB metric and modelling depending on the institution's sophistication category

**Economic value:**

- Economic value of equity (EVE)

Application of standard and other interest rate shock and stress scenarios for the yield curve (see section 4.4, 'Measurement'), using time buckets as advised in the BCBS Standards; yield curve tenors corresponding to the time buckets.

Measure computed on transaction or cash flow basis. Application of standard and other interest rate shock and stress scenarios for the yield curve and between key market rates separately (see section 4.4, 'Measurement'). Adequate tenors in yield curves. Full optionality valuation.

Comprehensive interest rate and stress scenarios, combining shifts of yield curves with changes in basis and credit spreads, as well as changes in customer behaviour. Adequate tenors in all yield curves. Full optionality valuation. Scenario analysis complemented by Monte Carlo or historical simulations on portfolios with material optionality. Daily updating of risk factors.

\* For category 1 and category 2 institutions, unconditional cash flow modelling approaches do not reflect supervisory expectations

# Annex III – The standardised interest rate shock scenarios

## 1. Interest rate shock scenarios and shock sizes

The six interest rate shock scenarios for measuring EVE under the standard EVE outlier test are:

- (i) parallel shock up;
- (ii) parallel shock down;
- (iii) steeper shock (short rates down and long rates up);
- (iv) flattener shock (short rates up and long rates down);
- (v) short rates shock up; and
- (vi) short rates shock down.

Institutions should apply the six above-mentioned interest rate shock scenarios to capture parallel and non-parallel gap risks for EVE. These scenarios are applied to IRRBB exposures in each currency separately for which the institution has material positions<sup>10</sup>.

The shock size for the six interest rate shock scenarios is based on historical interest rates. More precisely, for capturing the local interest rate environment and cycle, a historical time series ranging from 2000 to 2015<sup>11</sup> for various maturities is used to calculate the parallel, short-end ('short') and long-end ('long') shocks for a given currency. However, deviations from the above-mentioned 16-year period are permitted if they better reflect a particular jurisdiction's idiosyncratic circumstances.

Table 1 displays the values calculated for the parallel, short and long interest rate shocks for selected currencies. The shocks capture the heterogeneous economic environments across the jurisdictions. These are then used to calculate the shocks for different maturities of the yield curve to create the interest rate shock scenarios as per the methodology explained below.

Table 1. Specified size of interest rate shocks  $\bar{R}_{\text{shocktype},c}$

	ARS	AUD	BRL	CAD	CHF	CNY	EUR	GBP	HKD	IDR	INR
Parallel	400	300	400	200	100	250	200	250	200	400	400
Short	500	450	500	300	150	300	250	300	250	500	500
Long	300	200	300	150	100	150	100	150	100	350	300

	JPY	KRW	MXN	RUB	SAR	SEK	SGD	TRY	USD	ZAR
Parallel	100	300	400	400	200	200	150	400	200	400
Short	100	400	500	500	300	300	200	500	300	500
Long	100	200	300	300	150	150	100	300	150	300

<sup>10</sup> Material positions are defined in section 4.5, 'Supervisory outlier test'.

<sup>11</sup> The EBA may envisage a recalibration in due course.



## 2. Calibration of other currencies

For calibrating interest rate shock sizes for further currencies, the following proceeding shall be applied:

### *Step 1: Calculation of the daily average interest rate*

Collect a 16-year time series of daily ‘risk-free’ interest rates for each currency  $c$  for the maturities 3M, 6M, 1Y, 2Y, 5Y, 7Y, 10Y, 15Y and 20Y. Then, calculate the overall average interest rate for each currency  $c$  across all observations in the time series and for all maturities. The result is a single measure per currency.

### *Step 2: Applying the global shock parameters*

Apply the global shock parameters on the average interest rate, as per Table 2 below, to each currency  $c$ .

Table 2. Baseline global interest rate shock parameters

Parallel	$\bar{\alpha}_{parallel}$	60%
Short	$\bar{\alpha}_{short}$	85%
Long	$\bar{\alpha}_{long}$	40%

Applying the global shock parameters from Table 2 to the average interest rates calculated in step 1 results in revised interest rate shocks by currency for the different segments of the yield curve, i.e. for the parallel, short and long shocks.

### *Step 3: Applying the caps and floors*

The proposed interest rate shock calibration can lead to unrealistically low interest rate shocks for some currencies and to unrealistically high interest rate shocks for others. In order to ensure a minimum level of prudence and a level playing field, a floor of 100 bps as well as variable caps (denoted as  $\Delta\bar{R}_j(t_k)$ ) are set as 500 bps for the short-term shock, 400 bps for the parallel shock and 300 bps for the long-term shock, respectively.

The change in the ‘risk-free’ interest rate for shock scenario  $j$  and currency  $c$ , at time bucket tenor midpoint  $t_k$  can be defined as:

$$|\Delta\bar{R}_{j,c}(t_k)| = \max\left\{100, \min\{|\Delta R_{j,c}(t_k)|, \Delta\bar{R}_j\}\right\},^{12}$$

where  $\Delta\bar{R}_j = \{400, 500, 300\}$ , for  $j = \{parallel, short \text{ and } long\}$ , respectively. Applying the caps and floors to the shocks calculated in step 2, and rounding to the nearest 50 bps, results in the final set of interest rate shocks by currency as shown in Table 1.

### *Step 4: Adjustments for further currencies that are not shown in Table 1*

As jurisdictions might have experienced major economic changes within the period 2000 to 2015, the proceeding in steps 1 to 4 might not be adequate for some of them. This is particularly the case if the interest rates during the first years of the period differ considerably from the interest rates in the more recent years.

For currencies that are not mentioned in Table 1, the time series to be used to calculate the average interest rate as per step 1 is determined using the following principle: If the average interest rate calculated as per step 1 for the period 2000 to 2006 is greater than 700 bps, then data from the

<sup>12</sup> In the case of rotation shock scenarios,  $\Delta\bar{R}_{j,c}(t_1)$  cannot exceed 500 bps, and  $\Delta\bar{R}_{j,c}(t_K)$  cannot exceed 300 bps, whereby  $t_1$  denotes the time bucket with the lowest maturity and  $t_K$  the time bucket with the highest maturity.

most recent 10 years (i.e. 2007 to 2016) or until when data is available shall be used; *otherwise* the full time series of data from 2000 to 2015 shall be used.

Using this principle allows us to identify high interest rate environments and periods of significant structural change before the financial crisis. Further, this principle aims at finding those currencies that exceed the cap ( $700 \text{ bps} \cdot 0.6 = 420 \text{ bps} > 400 \text{ bps}$ ) in the first years of the period considered and fosters a stronger consideration of more recent observed interest rates.

Table 3 shows the results of applying steps 1 to 4 on EU currencies that are not covered in Table 1. Interest rate shock sizes for other currencies can be similarly retrieved by applying the methodology outlined in this section.

Table 3. Specified size of interest rate shocks  $\bar{R}_{\text{shocktype},c}$  for additional EU currencies

	BGN	CZK	DKK	HRK	HUF	PLN	RON
Parallel	250	200	200	250	300	250	350
Short	350	250	250	400	450	350	500
Long	150	100	150	200	200	150	250

### 3. Parameterisation of the standardised interest rate shock scenarios

Given for each currency  $c$  the specified size of the parallel, short and long instantaneous shocks to the ‘risk-free’ interest rate, the following parameterisations of the six interest rate shock scenarios should be applied:

- (i) *Parallel shock for currency c*: A constant parallel shock up or down across all time buckets:

$$\Delta R_{\text{parallel},c}(t_k) = \pm \bar{R}_{\text{parallel},c}$$

- (ii) *Short rate shock for currency c*: Shock up or down that is greatest at the shortest tenor midpoint. That shock, through the shaping scalar  $S_{\text{short}}(t_k) = e^{-\frac{t_k}{x}}$ , where  $x = 4$ , diminishes toward zero at the tenor of the longest point on the term structure<sup>13</sup>. Where  $t_k$  is the midpoint (in time) of the  $k^{\text{th}}$  bucket and  $t_K$  is the midpoint (in time) of the last bucket  $K$ ):

$$\Delta R_{\text{short},c}(t_k) = \pm \bar{R}_{\text{short},c} \cdot S_{\text{short}}(t_k) = \pm \bar{R}_{\text{short},c} \cdot e^{-\frac{t_k}{x}}$$

- (iii) *Long rate shock for currency c*: This shock is only applied to rotational shocks. The shock is greatest at the longest tenor midpoint and is related to the short scaling factor as  $S_{\text{long}}(t_k) = 1 - S_{\text{short}}(t_k)$ :

$$\Delta R_{\text{long},c}(t_k) = \pm \bar{R}_{\text{long},c} \cdot S_{\text{long}}(t_k) = \pm \bar{R}_{\text{long},c} \cdot \left(1 - e^{-\frac{t_k}{x}}\right)$$

- (iv) *Rotation shocks for currency c*: Involving rotations to the term structure (i.e. for *steepeners* and *flatteners*) of the interest rates, whereby both the long and short rates are shocked and the shift in interest rates at each tenor midpoint is obtained by applying the following formulas to those shocks:

$$\Delta R_{\text{steepener},c}(t_k) = -0.65 \cdot |\Delta R_{\text{short},c}(t_k)| + 0.9 \cdot |\Delta R_{\text{long},c}(t_k)|;$$

<sup>13</sup> The value of  $x$  in the denominator of the function  $e^{-\frac{t_k}{x}}$  controls the rate of decay of the shock.

$$\Delta R_{flattener,c}(t_k) = +0.8 \cdot |\Delta R_{short,c}(t_k)| - 0.6 \cdot |\Delta R_{long,c}(t_k)|.$$

*Examples:*

*Short rate shock:* Assume the bank uses  $K = 19$  time bands and  $t_k = 25$  years (the midpoint (in time) of the longest tenor bucket  $K$ ), where  $t_k$  is the midpoint (in time) for bucket  $k$ . For  $k = 10$  with  $t_k = 3.5$  years, the scalar adjustment for the short shock would be:  $S_{short}(t_k) = e^{\frac{-3.5}{4}} = 0.417$ . Banks would multiply this by the value of the short rate shock to obtain the amount to be added or subtracted from the yield curve at that tenor point. If the short rate shock was +250 bps, the increase in the yield curve at  $t_k = 3.5$  years would be 104.2 bps.

*Steeper:* Assume the same point on the yield curve as above,  $t_k = 3.5$  years. If the absolute value of the short rate shock was 250 bps and the absolute value of the long rate shock was 100 bps (as for the euro), the change in the yield curve at  $t_k = 3.5$  years would be the sum of the effect of the short rate shock plus the effect of the long rate shock in basis points:  $-0.65 \cdot 250 \text{ bps} \cdot 0.417 + 0.9 \cdot 100 \text{ bps} \cdot (1 - 0.417) = -15.3 \text{ bps}$ .

*Flattener:* The corresponding change in the yield curve for the shocks in the example above at  $t_k = 3.5$  years would be:  $+0.8 \cdot 250 \text{ bps} \cdot 0.417 - 0.6 \cdot 100 \text{ bps} \cdot (1 - 0.417) = 48.4 \text{ bps}$ .