

Advancing IRRBB behavioral modeling

In-depth analysis and industry insights
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Introduction

On 12 February 2025, the Hong Kong Monetary Authority (HKMA) published a circular on interest rate risk management ("the circular"), which provides further guidance on the disclosure of the capital adequacy ratios (CARs) adjusted for unrealized losses on debt securities investments, as well as the use of behavioral models for measuring interest rate risk in the banking book (IRRBB). The circular supplements the Supervisory Policy Manual IR-1 (SPM IR-1), which sets out the HKMA's regulatory expectations for IRRBB. For behavioral models, the circular outlines the industry good practices on the proper model governance framework and modeling approach, which include: (1) model governance and senior management oversight, (2) modeling approaches, (3) model performance monitoring and validation, (4) use of model outputs and (5) third-party vendor or group-level models.

The key topics covered in the circular and the good practices are summarized below:

A. Requirement: Disclosure of CARs adjusted for unrealized losses on debt securities investments

B. Good practices: Use of behavioral models for measuring IRRBB

Model governance and senior management oversight	<ul style="list-style-type: none">1 Well established policies and procedures (P&Ps)3 Comprehensive documentation	<ul style="list-style-type: none">2 Adequate senior management oversight4 Effective internal audit function (IAF)
Modeling approaches	<ul style="list-style-type: none">5 Granular segmentation for non-maturity deposits (NMD)6 Incorporation of forward-looking elements into modeling7 Scenario-specific modeling of interest rate effects on NMD	<p>Area of focus: Model revamp with enhanced methodologies is necessary to fulfill the industry good practices</p>
Model performance monitoring and validation	<ul style="list-style-type: none">8 Model performance monitoring and validation	<ul style="list-style-type: none">9 Ad hoc model review
Use of model outputs	<ul style="list-style-type: none">10 Comprehensive reporting to inform decision making	
Third-party vendor or group-level models	<ul style="list-style-type: none">11 Bank and jurisdiction-specific calibration and adaptations	<ul style="list-style-type: none">12 In-house independent validation and effective oversight

In this material, we will share EY's insights and recommendations in response to the circular with a focus on IRRBB behavioral modeling.

Disclosure of CARs adjusted for unrealized losses on debt securities investment

Two new requirements have been introduced by the HKMA:

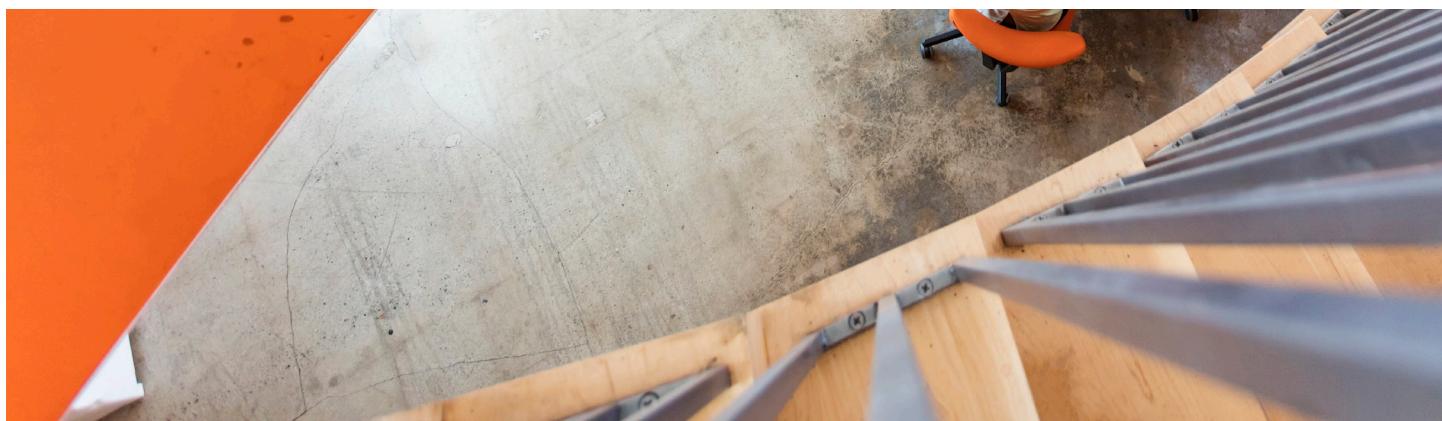
Adjusted CARs disclosure requirement:

Banks are required to calculate and disclose adjusted CARs by reflecting losses on held-to-maturity (HTM) debt securities measured at amortized cost (AC) when such losses are significant. Relevant calculation examples can be found in Annex 1 of the circular.

Notifying the HKMA for huge unrealised losses:

If unrealized losses on HTM debt securities exceed 10% of the Common Equity Tier 1 capital, the banks concerned should notify and seek guidance from the HKMA as soon as reasonably practicable on the proposed timing and manner of the disclosure.

There would be no impact to the existing MA(BS)3 CAR reporting. Banks have to consider enhancements in the existing system to comply with the HKMA's new guidance on disclosing adjusted CARs for unrealized losses on HTM debt securities.



Overview of the key responsibilities in the good practices

The cooperation and clear responsibilities for the three lines of defense (LoD) are crucial to achieving a robust IRRBB and behavioral model governance framework. The circular outlines the roles of key parties in managing behavioral models for IRRBB across model pre and post implementation phases, which are illustrated in the below table. The circled numbers refer to the corresponding good practices items stipulated in the circular.

Relevant parties					
	1LoD - Business units	2LoD - Model development team	2LoD - Model validation team	3LoD - Internal audit	Senior management
Pre-implementation	To ensure the completeness of the model scope	To develop and maintain behavioral models	To perform pre-implementation model validation on the behavioral models before roll-out		To review reports on model outputs and performance, and critically challenge behavioral models
Post-implementation	To reflect the change of model scope	To perform regular and ad-hoc model monitoring	To perform regular validation on at least annual basis	To include controls over behavioral models as a regular item in annual audit plans	To integrate the model outputs into decision-making processes
Well-established and comprehensive policies and procedures and documentations					1 3 10

I Model governance and senior management oversight

Leading banks distinguish themselves by instituting robust governance structures supported by the following four aspects:

Well-established policies and procedures



A well-established P&P should cover the development, validation, monitoring and use of behavioral models. Roles and responsibilities of the relevant parties, including the three LoD should be clearly defined, and the P&Ps should be reviewed regularly (e.g., annually).

 EY can perform detailed independent review and revamp of the IRRBB governance framework, covering P&Ps and the relevant documentation.

Adequate senior management oversight



Senior management should actively be involved in the approval processes, rigorously reviewing reports on model outputs, performance, and related analyses, and critically challenging key aspects of behavioral models, including assumptions, limitations and the uncertainty surrounding modeled behavioral maturities.

 EY can provide targeted training sessions to senior management, covering mandatory concepts outlined in the SPM IR-1 and the relevant HKMA circular.

Comprehensive documentation



Model methodology documentation: Banks should maintain comprehensive model documentation, including methodologies and assumptions, data sources, options considered and choices made during the model development process, validation approaches and model limitations.

Ongoing documentation on model performance: Banks should also prepare detailed reports on model validation, ongoing monitoring, and keep proper records of senior management discussions and approvals.

 EY has in place documentation templates with a sufficient level of detail for model methodologies and model performance monitoring.

Effective internal audit function



The annual internal audit plan should cover controls over behavioral models. The IAF should have staff with relevant expertise (e.g., model development, validation and model risk governance) to perform such audit reviews. Engaging external auditors to support the review is also considered a good practice.

 EY can provide co-sourcing support to the IAF for the annual IRRBB audit or deliver training sessions to the IAF on the latest regulatory requirements.

II Modeling approaches

For banks that use or plan to use behavioral models for IRRBB measurement, due consideration should be given to the observations and industry good practices.

As NMD have no predefined maturity and allow depositors to withdraw funds at any time, banks must determine an appropriate way to allocate these balances within the IRRBB time buckets. According to the SPM IR-1, banks may either:

- Slot NMD into appropriate time bands according to the earliest date on which their interest rates can be adjusted;
- Develop behavioral models to slot NMD into time bands based on the behavioral maturity

5 Segmentation of NMD

Banks should consider more granular segmentations based on additional dimensions that could influence depositor behaviors when interest rates change to ensure portfolio risk characteristics are sufficiently distinguished.



Demographics



Business sectors



Deposit sizes



Account features



Transaction frequencies



Currencies of deposit



EY can help enhance NMD segmentation for IRRBB by increasing granularity and standardizing it in line with the good practices mentioned, including those applied in liquidity risk management.

6 Incorporation of forward-looking elements

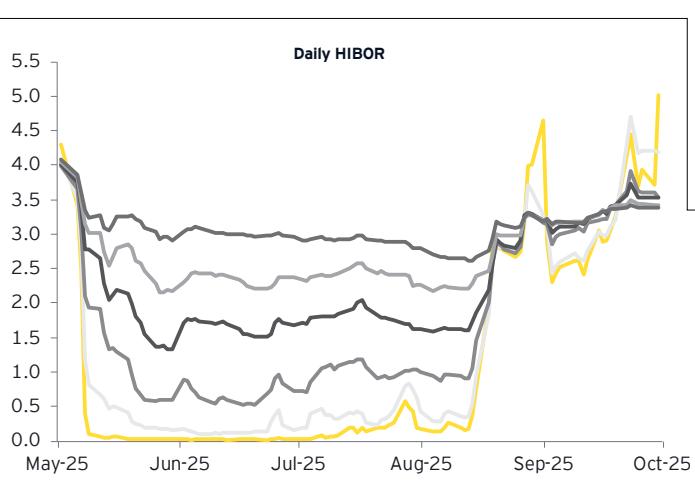
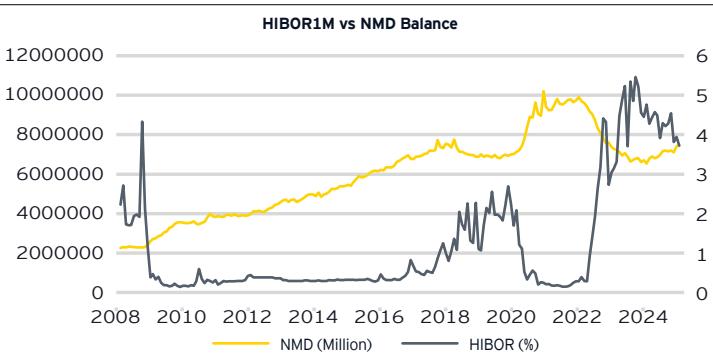
- During the initial adoption of IRRBB in Hong Kong in 2018, historical data under prolonged low interest rate environments were widely adopted for behavioral modeling. To address the limitation of the traditional approach, good practices have been observed among banks to incorporate forward-looking elements in the behavioral model estimation.
- The major considerations for forward-looking elements include market trends, macroeconomic trends and the penetration of digital banking. Besides, the competitors' actions and reactions, business strategies, changes in regulatory requirements and shifts in depositor preferences are also possible forward-looking considerations.
- Expert judgement can be applied to the behavioral model estimates where appropriate.

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Market and macroeconomic trends

Depositor behavior, especially in the retail segment, is closely tied to external economic situations. For instance, in times of rising interest rates or inflation, retail customers may reallocate funds toward higher-yielding investment products, affecting deposit retention rates. The two charts below illustrate how market conditions - both interest rate movements and broader macroeconomic factors - are closely linked to changes in deposit behavior.

The graph plotting Hong Kong NMD balance against Hong Kong Interbank Offered Rate (HIBOR) shows a clear inverse relationship, with balances tending to decline as market rates rise. This suggests that depositor behavior has become more rate-sensitive in recent years. Apparently, the trend of HIBOR would impact the deposit stickiness.



Moreover, macroeconomic factors like money supplies and exchange rates can significantly influence market rates and, in turn, customer behavior. In May 2025, amid tariff tensions and HKD appreciation, investment inflows into Hong Kong increased following the HKMA's intervention to defend the HKD-USD currency peg. This resulted in a broad-based decline across all HIBOR tenors, with rates dropping to near-zero levels for an extended period and the curve flattening markedly. Shorter tenors, particularly overnight and 1-week, exhibited higher volatility during the subsequent recovery phase.

- These observations highlight that deposit behavior is increasingly influenced by both short-term market rate dynamics and broader macroeconomic developments. Therefore, a risk-based econometric model that incorporates forward-looking market and macroeconomic factors should be developed to better capture and anticipate changes in deposit stability.

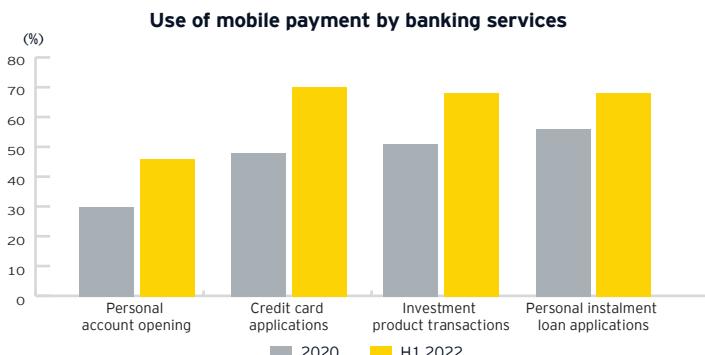
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Penetration of digital banking

While the evolution of digital tools (e.g., the faster payment system (FPS) rolled out in 2018) enhances convenience, they also introduce behavioral volatility. Depositors now have instant access to withdraw, transfer, or reallocate funds, reducing the deposit stickiness traditionally associated with branch-based banking.

- The survey results conducted by the HKMA showed an increasing trend in the use of digital channels for retail banking services¹ (the HKMA, 2022). The growing digitalization of banking services impacts customers behaviour and may increase market sensitivity.
- To mitigate the limitation of historical data, the penetration of digital banking should be considered in the modeling process so that the latest penetration level can be incorporated into the model to yield a more up-to-date behavioral parameter estimate.
- A common challenge observed among banks is the extraction of internal historical transaction-level data to quantify the degree of penetration of digital banking. In such cases, external data from census sources, the HKMA publications (e.g., FPS usage), studies carried out by regulatory authorities in other jurisdictions or other surveys can be leveraged for modeling and benchmarking.

1. The HKMA (2022) Opportunities and Challenges Brought About by Rapid Growth of Digital Banking Transactions. Available at: <https://www.hkma.gov.hk/eng/news-and-media/insight/2022/04/20220419/>.



The data for the graph is sourced from the Hong Kong Monetary Authority's 2022 Year-end Review and Priorities for 2023

EY can design tailored solutions based on banks' existing model design to incorporate forward-looking elements into the modeling process, with a focus on market and macroeconomic trends and the penetration of digital banking to enhance model robustness and predictive accuracy benchmarking could also be considered as an option..

7 Scenario-specific modeling of interest rate effects on deposit balance

Customer preference for the type of deposit products (NMD and term deposits (TD)) may vary under different interest rate environments. The potential reallocation of deposits under the standardized interest rate scenarios set out in the SPM IR-1 should be considered.

EY can support the adjustment of the deposit mix to reflect shifts between TD and NMD under varying interest rate shock scenarios. In a rising rate environment, deposits are expected to migrate from NMD to TD, while in a declining rate scenario, the movement would likely reverse, with funds shifting from TD to NMD.

III Model performance monitoring and validation

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Effective model performance monitoring and validation are essential to ensure the ongoing reliability of behavioral models, particularly in a rapidly changing operating environment.

Aspect	Regular monitoring	Independent validation
Purpose	To detect deterioration in model performance or shifts in depositor behaviors and take timely remediation actions when necessary	To assess the appropriateness, accuracy and relevance of model assumptions, methodologies and outputs, both at model inception and on an ongoing basis
Coverage	Back-testing and sensitivity analysis (e.g., how IRRBB measurements shift as model assumptions or outputs change)	Full model review including assumptions, methodologies, limitations and outputs
Recommended frequency	Quarterly for regular monitoring; Ad hoc review is applicable when there are significant market/idiosyncratic events and material changes in assumptions	At least annually for validation; Ad hoc review is applicable when there are significant market/idiosyncratic events and material changes in assumptions

EY can support the comprehensive enhancement of the IRRBB governance framework which incorporates annual validation, ongoing performance monitoring (covering back-testing and sensitivity analysis), corresponding frequencies, clearly defined performance indicators, tolerance thresholds and corresponding remedial actions.

IV Use of model outputs

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Banks with strong model governance are more confident in leveraging model outputs beyond regulatory reporting, integrating them into business strategies. These banks put in place a framework to integrate the model outputs into their decision-making processes and provide in-depth, comprehensive analysis reports to senior management to provide insights on business strategy formulation.

- A potential approach is to incorporate model outputs such as behavioral maturity, term deposit redemption rate and conditional prepayment rate to provide deeper insights into customer responses to changing economic conditions.

EY can assist the banks in designing the reporting framework that integrates the model outputs such as sensitivity analyses into their decision-making processes.



Third-party vendor or group-level models

The HKMA observed that some banks adopted behavioral models developed by their head offices or leveraged third-party models in measuring behavior for IRRBB. In both cases, banks should demonstrate a solid understanding of the models they have adopted, whether developed internally or externally:

Bank-specific considerations:

To use the bank's internal data to calibrate the behavioral models

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Jurisdiction-specific considerations:

To ensure compliance with the SPM IR-1, and consider competitive environment and market conditions

In-house independent validation:

In-house validation team to challenge the model assumptions, methodologies and outputs

12

Effective oversight:

To perform reviews, performance monitoring and audits for models provided by the group and vendors



EY can offer proven solutions to support banks in adapting and calibrating such models, helping ensure regulatory compliance, local relevance and enhanced model accuracy.

How can EY teams help?

Behavioral and option pricing model development

- Develop or revamp behavioral models in response to interest rate hikes and industry trends, addressing shifts in customer deposit behaviors.
- Develop option pricing models and perform model decomposition for automatic interest rate options, including stress scenarios and equivalent data generation for MA(BS)12A IRRBB Return reporting.



Model performance monitoring

- Develop or revamp behavioral model monitoring frameworks, including back-testing, sensitivity analysis and documentation, with defined triggers for ad hoc reviews and interpretation guidance.



Model Validation (Behavioral & Option Pricing)

- Perform behavioral and option pricing model validation to ensure accuracy in the current interest rate environment, compliance with the HKMA's IR-1, alignment with the bank's practices and standards and consistency of market data, while replicating results and analyzing variances.



IRRBB return generation

- Develop an automated return generation tool (e.g., VBA, Python or Alteryx) based on MA(BS)12A IRRBB Return Completion Instructions. Conduct review on the return generation logics for existing tools.



IRRBB compliance review

- Conduct an independent review on IRRBB processes and controls, in compliance with the HKMA's IR-1. Help ensure compliance across key areas including internal controls, regular evaluations, periodic reviews and detailed reporting.



Training sessions for senior management and IAF

- Provide training to senior management on overseeing behavioral models, including reviewing outputs, challenging assumptions, approving changes and understanding limitations, to support compliance with the SPM IR-1 and strengthen risk governance.
- Provide training to the internal audit function on auditing behavioral model controls, including governance, validation and development, to enhance experience and help ensure compliance with the SPM IR-1.



Co-sourcing service for annual IRRBB internal audit

- Support internal audit reviews of behavioral model controls under the SPM IR-1 by designing and executing audits that assess model governance effectiveness, monitoring, validation and approval, as well as identifying recommendations and areas for improvement.

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