Annexes: Selected Issues

1. Rising Yield Curve Pressures and Banks' Resilience: A Disclosure-based IRRBB Stress Test for Japan [69]

The Japanese economy has been shifting toward a new normal of higher interest rates. While rising interest rates may help increase interest rate margin and improve banks' bottom-line profits in the short-run, upward movements in yield curves can also pose risks to bank balance sheets through mark-to-market losses on assets, which highlights the need to assess the banking sector's resilience to such interest rate risks. This Selected Issue examines how interest rate risks have evolved in recent years and the strategies employed by banks to mitigate these risks arising from their debt security holdings. A stress-testing exercise is conducted to quantify potential losses under adverse scenarios, drawing policy insights.

Observations from Interest Rate Risk Management at Major Banks

1. **Banks have used multiple strategies to mitigate the impact of rising interest rates on their securities portfolio over the past few years.** Major banks' capital adequacy ratio remains at a level that is well-above the required minimum ratio even when taking into account assets booked in the HTM account.[70] The healthy CAR indicates that the various strategies used by banks to manage interest rate risks have been effective. These strategies include i) reducing their holdings of debt securities, ii) moving debt securities from available-for-sale (AFS) to held-to-maturity (HTM) portfolio, iii) reducing the duration of debt security holdings, and iv) using swaps and "bear funds" to hedge losses due to rising interest rates.[71] According to BOJ (2025), the net yen interest rate risk in the banking book has declined through reductions in bond holdings and shorter portfolio durations. However, the recent volatility in markets also warrants a closer look at the debt security holdings of banks and the effect rising interest rates could have on the bank balance sheets. We use micro-level data from individual banks' financial statements to explore their strategies.

2. **While the gross holdings of debt securities in major banking groups[72] have reduced marginally, there has been a clear shift of holdings from AFS to HTM**

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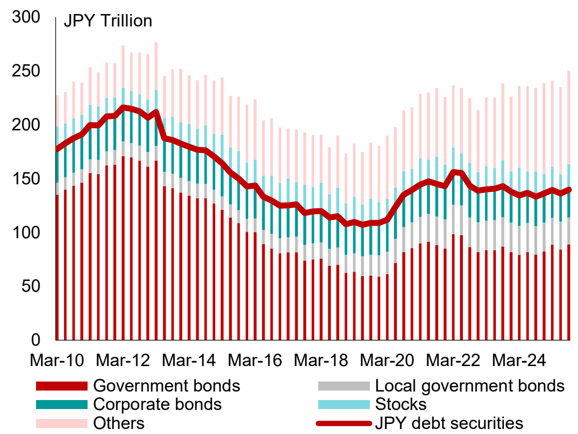
[69] Prepared by Prashant Pande, Senior Financial Specialist; and Shunsuke Endo, Senior Economist.
[70] Bank of Japan, *Financial System Report (October 2025)*, Chart VI-2-5: "Decomposition of capital adequacy ratio: Sensitivity analysis, upward shift in yen interest rates," 23 October 2025, p. 78 ("Chart VI-2-5"), Bank of Japan, https://www.boj.or.jp/en/research/brp/fsr/data/fsr251023a.pdf
[71] Bear funds are products provided by some securities companies and benefit from rising interest rates. These funds use a combination of pay positions in various tenors of interest rate swaps and short bond futures to provide the desired payout.
[72] We extract the maturity information on major asset classes from the consolidated statements of some banking groups – cumulatively referred as "major banking groups" in this selected issue. The data is available only on a consolidated basis and hence the results may include influences from non-banks which are a part of these banking groups. The major

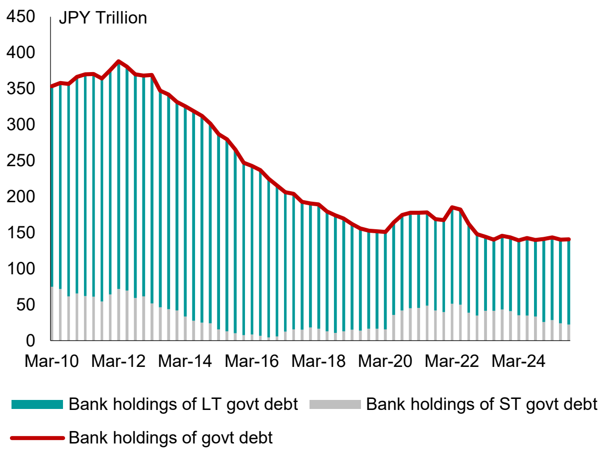
books. The bank holdings of overall investment securities and yen denominated bonds, rose during the pandemic. Since 2022, as expectations of a hiking cycle rose, the holdings of debt securities have dropped slightly. That said, debt security holdings are still higher than those seen before the pandemic. The trend is consistent across data from bank balance sheets (Figure A1.1) and the stock of debt holdings from flow of funds data (Figure A1.2). Though the reduction in yen denominated fixed income securities has not been significant when compared to pre-pandemic levels, banks have expedited the move of securities from AFS to HTM books. Considering the debt holdings of major banking groups, we find a clear shift towards the HTM holdings of yen denominated debt. The rise in the share of HTM holdings for local government bonds and JGBs (Figure A1.3) —especially in 5-to-10-year tenors (Figure A1.4) —shows that the major banking groups preemptively adjusted their positions to minimize the mark-to-market effects of rising interest rates.

Figure A1.1. Breakdown of Banks' Investment Securities



Source: Japan Bankers Association via CEIC, AMRO staff estimates.

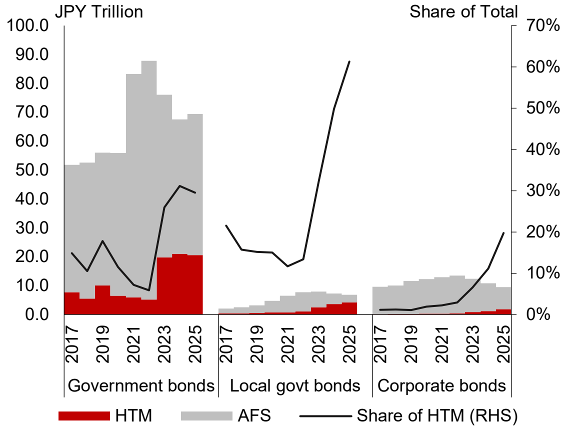
Figure A1.2. Flow of Funds Data for Bank Holdings for Government Debt Securities



Source: BOJ visa CEIC, AMRO staff estimates.
Note: LT = longer tenor debt with residual maturity greater than 1-year; ST = shorter tenor debt with residual maturity less than 1-year; govt = government

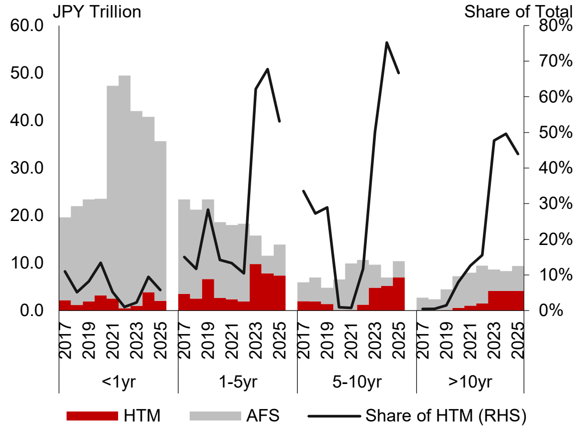
banking groups and their banking subsidiaries are MUFG Group (includes MUFG Bank, Ltd., Mitsubishi UFJ Trust and Banking Corporation, and the Master Trust Bank), Mizuho Group (includes Mizuho Bank, Ltd. and Mizuho Trust & Banking Co., Ltd.), SMBC (includes Sumitomo Mitsui Banking Corporation and SMBC Trust Bank Ltd.), Resona Holdings (Resona Bank Ltd., Saitama Resona Bank Ltd., Kansai Mirai Bank, and Minato Bank), Norinchukin Group (includes The Norinchukin Trust & Banking Co., Ltd), Fukuoka Group (includes The Bank of Fukuoka, Ltd., The Kumamoto Bank, Ltd., The Juhachi Shinwa Bank, Ltd, The Fukuoka Chuo Bank, Ltd., and Minna Bank, Ltd.), SBI Shinsei Bank Group (includes SBI Shinsei Bank and Shinsei Trust and Banking Co., Ltd.), and the Aozora Group (includes Aozora Bank Ltd, and GMO Aozora Net Bank, Ltd.). The trends discussed here are based on aggregated data for these banks.

Figure A1.3. Bank's Holdings for Yen-denominated Fixed Income Securities Classified as HTM.



Source: Public disclosures including annual reports, integrated reports, and financial results; AMRO staff calculations.
Note: The calculations are based on the data extracted from consolidated statements of major financial groups listed in footnote 72.

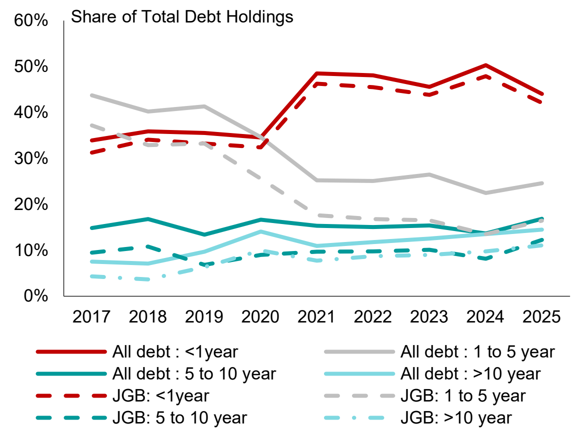
Figure A1.4. Bank's Holdings of JGBs Classified as HTM
(Trillions of yen, share of total)



Source: Public disclosures including annual reports, integrated reports, and financial results; AMRO staff calculations.
Note: The calculations are based on the data extracted from consolidated statements of major financial groups listed in footnote 72.

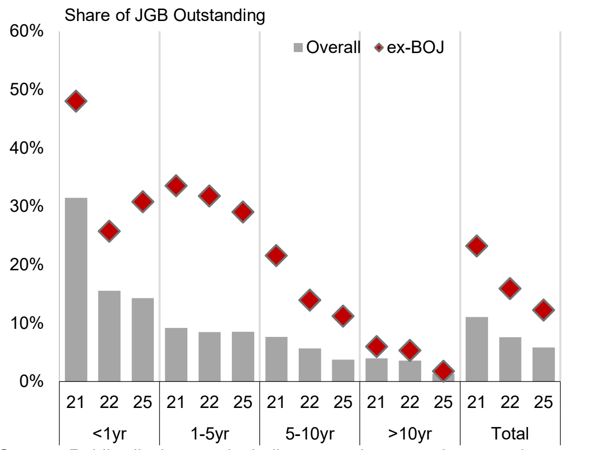
3. The major banking groups have reduced their holdings of bonds with residual maturities of between 1 to 5 years, while maintaining holdings of bonds maturing after 5 years, and increasing the share of less-than-1-year debt securities. The adjustments in maturity of bond holdings seem to have started in around 2021-2022. In addition, the major banking groups also increased their investments in bills. The share of less than 1-year maturity bills and bonds increased largely at the expense of the bonds in the 1-to-5-year tenors. Though the share of bonds in the 5-year and above segments has inched higher, the increase in holding of less than 1-year debt has effectively reduced the overall average maturity of debt holdings (Figure A1.5). Furthermore, the major banking groups have actively reduced their overall JGB holdings in 2022, which is not an outcome of the BOJ pushing banks out of these segments. This is reflected in a similar declining trend observed in the share of the major banking groups' holding of JGBs to total outstanding with and without the BOJ's holdings. (Figure A1.6).

Figure A1.5. Breakdown of Bank Holdings of Yen Denominated Debt Securities by Tenor



Source: Public disclosures including annual reports, integrated reports, and financial results; AMRO staff calculations.
Note: The calculations are based on the data extracted from consolidated statements of major financial groups listed in footnote 72.

Figure A1.6. Change in Bank's Positioning in the JGB Market (Including and Excluding BOJ's Holding)



Source: Public disclosures including annual reports, integrated reports, and financial results; AMRO staff calculations.
Note: The calculations are based on the data extracted from consolidated statements of major financial groups listed in footnote 72.

Model Setup and Key Considerations

4. **To assess interest rate risks, an analytical model is designed to capture changes in interest rate risk arising from shifts in the shape of the yield curve.** The analysis is carried out using publicly available data in a manner consistent with risk management practice. Japanese banks and authorities operate under the domestic application of the international framework for interest rate risk in the banking book (IRRBB).[73] Among the IRRBB metrics, a change in Economic Value of Equity (ΔEVE) measures how the economic value of a bank's balance sheet changes in response to interest rate movements and is widely used by banks and authorities as a key indicator of interest rate risk. In the following analysis, we examine the time-series behavior of observed ΔEVE and estimate the unknown system-wide key rate durations (KRDs) for Japanese banks using the model below, relying on publicly available data and necessary assumptions (see Box A1 for details).[74] While the coefficients of β_j and γ_j represent system-wide KRD and the additional sensitivity associated with specific banks, respectively, at a representative key rate maturity of bucket j ("node"), (τ_j), a positive coefficient leads to a decline in ΔEVE as the explanatory variable $X_{i,s,j}$ involves the negative sign. These estimates are then used for decomposition analysis and scenario-based stress-testing.

$$\Delta EVE_{i,s} \approx -\sum_{j=1}^{J}\left(KRD(\tau_j)\cdot NPV_i(\tau_j)\cdot \Delta r_s(\tau_j)\right)$$

$$\Delta EVE_{i,s} = \sum_{j=1}^{J}(\beta_j \cdot X_{i,s,j}) + \gamma_3 \cdot X_{i,s,3}\cdot Dummy_{i,3} + \varepsilon_{i,s},$$

$$where\ \beta_j = KRD(\tau_j)\ \text{and}\ X_{i,s,j} = -NPV_i(\tau_j)\cdot \Delta r_s(\tau_j)$$

[73] IRRBB refers to the current or prospective risk to the bank's capital (and earnings) arising from adverse movements in interest rates that affect the banks' banking book positions. When interest rates change, the present value and timing of future cash flows change. This in turn changes the underlying value of a bank's assets, liabilities and off-balance sheet items and hence its economic value. Excessive IRRBB can pose a significant threat to a bank's current capital base if not managed appropriately (BCBS 2016).
[74] The first equation in the main text is a first-order approximation, and the second equation is the empirical regression.

$\Delta EVE_{i,s}$	Change in the Economic Value of Equity (EVE) for bank i under scenario s.
j	Index of maturity buckets (nodes).
τ_j	Representative maturity (key rate) of bucket j.
$KRD(\tau_j)$	System-wide key rate duration at node j (sensitivity of EVE to a 1-unit change in the node-specific interest rate).
$NPV_i(\tau_j)$	Net present value of bank i's net cash flow (assets minus liabilities) in bucket j.
$\Delta r_s(\tau_j)$	Shock to the interest rate at node j under scenario s.
γ_3	Megabank-specific incremental KRD at node 3.
$Dummy_{i,3}$	Megabank-specific dummy variable at node 3.

5. **The stress-testing framework adopts a hybrid approach that combines top-down with bottom-up approaches.** As a first step, we estimate KRDs at the key rate maturity (node) level to quantify banks' sensitivity to changes in the slope and curvature of the yield curve. The subsequent system-wide IRRBB stress test applies common yield-curve shocks and common KRDs to the entire banking system in a top-down manner. The inputs to this stress test include (i) system-wide KRD estimates derived from the model; and (ii) bank-specific node-level NPVs and ΔEVE data obtained from public disclosures and discounted by market interest rates for NPVs. By integrating these elements, the analysis constitutes a hybrid framework that leverages both bottom-up exposure information and top-down shock design.[75]

6. **The estimation and stress-testing exercise necessarily rely on assumptions to compensate for the limitations of publicly available data.**[76] Specifically, node-level interest rate sensitivity (KRD), which is the critical parameter for evaluating ΔEVE under yield-curve shifts, must be estimated without access to banks' internal IRRBB models or currency-level breakdowns of cash flows underlying ΔEVE and NPV. Accordingly, the estimated KRDs should be interpreted as a practical system-wide measure of interest rate sensitivity rather than a precise representation of latent risk profiles. Although the model delivers intuitive estimates, it is essential to interpret the results with these caveats in mind (See Box A1 for more discussion of limitations).

Estimation Results

7. **The estimation results suggest that Japanese banks bear their interest rate risk in longer tenors of the yield curve.** The specification includes an interaction term for megabanks at node 3 (long-term segment) to capture structural differences in interest rate sensitivity between megabanks and the other sample banks. The system-wide short-term KRD (β1) is statistically insignificant in most years,[77] whereas the medium-, long-, and ultra-long-term KRDs (β2, β3, β4) are significantly positive except β2 in 2022 (Table A1.1). The relatively large coefficients on β3 and β4 indicate that increases in interest rates at longer tenors lead to substantial declines in the system's EVE, highlighting a

[75] See Čihák 2014 for a discussion about bottom-up and top-down approaches.
[76] 30 sample banks on a consolidated basis for which all necessary data are available (yielding roughly 100 usable bank–scenario observations per year). Sample banks in the analysis include Mitsubishi UFJ Financial Group, Sumitomo Mitsui Financial Group, and Mizuho Financial Group (megabanks); Saitama Resona Bank, Minato Bank, Iyogin Holdings, Chiba Bank, Bank of Nagoya, Hachijuni Bank, Gunma Bank, Shiga Bank, Toho Bank, North Pacific Bank, Musashino Bank, Mebuki Financial Group, Nishi-Nippon Financial Holdings, Kyushu Financial Group, Bank of Kyoto, Daishi Hokuetsu Financial Group, 77 Bank, San-in Godo Bank, and Hyakugo Bank (regional banks); Norinchukin Bank and Japan Post Bank (specialized banks); and Sumitomo Mitsui Trust Group, Resona Bank, Aozora Bank, GMO Aozora Net Bank, Master Trust Bank of Japan, and SMBC Trust Bank (other banks). The number of sample banks was determined by selecting, with reference to asset size, those banks for which the data required for the estimation were available for each target year, and then gradually increasing the number of banks until the estimation results became stable.
[77] Insignificant coefficients can be attributed to the disclosure treatment. While many banks classify demand deposits into short maturities of 1 year or less in the maturity analysis section of their disclosures, they rely on core-deposit models when measuring interest rate risk.

balance sheet structure that is particularly sensitive to longer maturities. By contrast, the megabank-specific long-term KRD (γ3) is negative and statistically significant throughout the sample years, suggesting that megabanks structurally maintain lower long-term interest rate exposure than the system average.[78]

Table A1.1. Estimated Node-level Key Rate Durations (KRDs)

	2022		2023		2024		2025	
Dependent variable: ΔEVE	**(1)**	Reference	**(2)**	Reference	**(3)**	Reference	**(4)**	Reference
c	—	-61406*	—	-53421**	—	-58906**	—	-62455***
	—	(35490)	—	(26411)	—	(25905)	—	(22891)
β1 (Short-term KRD)	**-0.225***	-0.228*	**0.061**	0.057	**0.075**	0.070	**0.054**	0.046
	(0.131)	(0.130)	(0.078)	(0.077)	(0.080)	(0.079)	(0.070)	(0.068)
β2 (Medium-term KRD)	**0.017**	-0.028	**0.684*****	0.646**	**0.927*****	0.893***	**0.751*****	0.721***
	(0.433)	(0.429)	(0.249)	(0.247)	(0.250)	(0.246)	(0.233)	(0.226)
β3 (Long-term KRD)	**5.984*****	5.902***	**3.671*****	3.605***	**4.695*****	4.607***	**3.135****	2.700*
	(0.769)	(0.763)	(0.589)	(0.582)	(0.767)	(0.754)	(1.410)	(1.379)
β4 (Ultra-long-term KRD)	**2.149****	1.994**	**2.610*****	2.466***	**2.033*****	1.904***	**2.212*****	2.177***
	(0.862)	(0.859)	(0.507)	(0.505)	(0.526)	(0.520)	(0.610)	(0.592)
γ3 (Megabank-specific incremental KRD at long-term maturity)	**-6.364*****	-6.160***	**-5.394*****	-5.214***	**-7.363*****	-7.155***	**-4.960*****	-4.537***
	(1.272)	(1.265)	(1.001)	(0.990)	(0.964)	(0.951)	(1.141)	(1.119)
Observations	108	108	113	113	115	115	112	112
R^2	0.456	0.472	0.384	0.407	0.445	0.470	0.350	0.393
Adj. R^2	0.435	0.446	0.362	0.379	0.425	0.446	0.326	0.364
Residual Std. Error (RSE)	367,503	363,997	280,581	276,650	279,313	274,164	244,243	237,205
F-statistic	—	18.212	—	14.690	—	19.365	—	13.725
Prob(F-statistic)	—	7.02×10^{-13}	—	5.92×10^{-11}	—	9.36×10^{-14}	—	2.50×10^{-10}

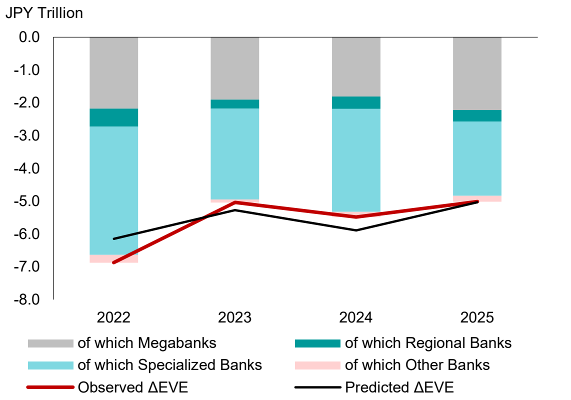
Source: Public disclosures including annual reports, integrated reports, and financial results; Bloomberg; AMRO staff calculations.
Note: SE in parentheses; * p<0.1, ** p<0.05, *** p<0.01. All regressions are estimated using ordinary least squares (OLS). In the theoretical model used in this regression, ΔEVE becomes zero when the interest-rate shock Δr is zero. Therefore, the specification is theoretically required to pass through the origin and to exclude an intercept term. Regressions with an intercept were estimated as robustness checks to confirm the stability of the coefficients. The key rate nodes are set at 0.5 <short-term>, 3 <medium-term>, 7.5 <long-term>, and 15 years <ultra-long-term>.

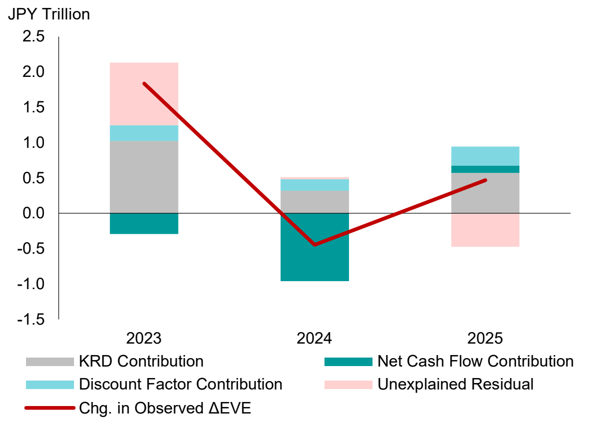
8. **The results suggest that Japanese banks have improved their resilience to rising interest rates, presumably by proactive ALM strategies and better risk management under IRRBB.** Under the parallel shock up scenario, observed ΔEVE in 2025 improved relative to 2022, indicating an improvement in resilience against interest rate shock (Figure A1.7). Across bank categories, non-megabank institutions reduced observed ΔEVE, whereas megabanks showed an increase in observed ΔEVE in 2025. While this could reflect possible differences in funding structures, business strategies, and/ or ALM strategies between megabanks and the other sample banks, one megabank points out increases in medium- to long-term positions.[79] System-wide predicted ΔEVE largely tracks these developments of observed ΔEVE. Decomposition shows that declining KRDs have been the primary driver of improvements in ΔEVE since 2022 (Figure A1.8). Net cash flows contributed to the decline in ΔEVE in 2024, reflecting purchases of JGBs by some institutions, while discount factor effects improved ΔEVE as interest rates increased during the sample period.

Figure A1.7. Observed and Predicted ΔEVE Under the Parallel Shock Up (PSU) Scenario

Figure A1.8. Decomposition of Changes in Observed ΔEVE over Time Under the PSU Scenario

[78] This can be interpreted as megabanks adopt more sophisticated ALM practices and hedging strategies at longer maturities.
[79] The maximum of ΔEVE increased from the previous year due largely to the composition of positions, namely the increase in medium and long-term positions and decrease in short-term positions (MUFG 2025).





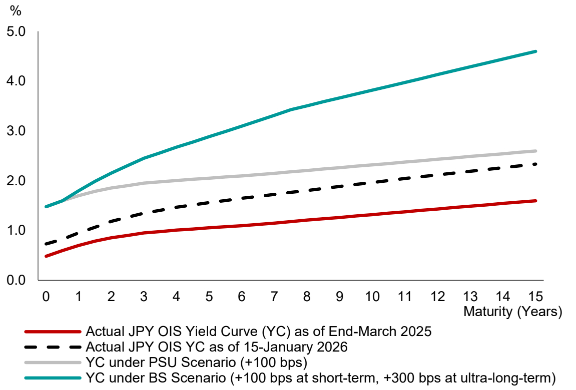
Source: Public disclosures including annual reports, integrated reports, and financial results; Bloomberg; AMRO staff calculations.
Note: Negative values of ΔEVE indicate declines in the Economic Value of Equity.

Source: Public disclosures including annual reports, integrated reports, and financial results; Bloomberg; AMRO staff calculations.
Note: Negative contribution values indicate a change that erodes the systemwide Economic Value of Equity (i.e., makes ΔEVE more negative). Unexplained residual consists of the decomposition residual and the prediction–observation gap.

Stress-testing Exercise

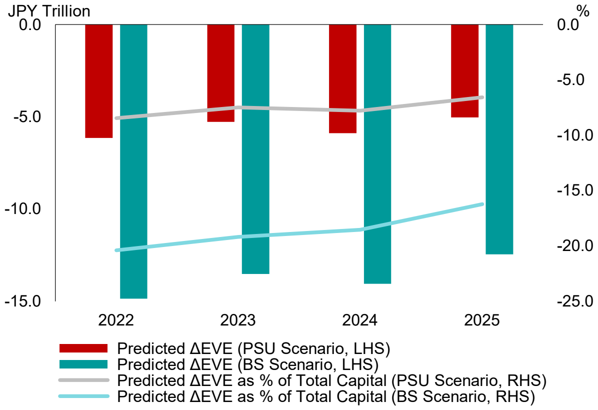
9. The stress test evaluates the resilience of the Japanese banking system under a bear-steepening scenario, applying node-level KRDs estimated earlier. The scenario assumes: (i) a +100 bps shock to short-term rates; and (ii) a more severe +300 bps shock to ultra-long-term rates, reflecting both the ongoing upward trend in short-term policy rates and the recent steepening of the yield curve relative to March 2025 data (Figure A1.9). In practice, bear-steepening scenarios are particularly suitable to assess interest rate risk when duration mismatches are present.

Figure A1.9. Yield Curves Under Stress Scenarios



Source: Public disclosures including annual reports, integrated reports, and financial results; Bloomberg; AMRO staff calculations.
Note: PSU stands for Parallel Shock Up, and BS stands for Bear-Steepening.

Figure A1.10. Stress Test Results



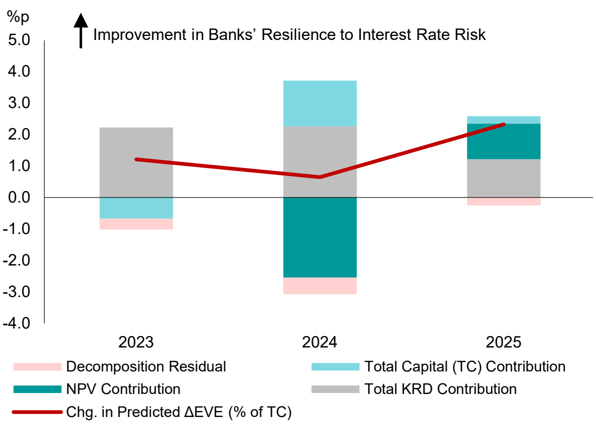
Source: Public disclosures including annual reports, integrated reports, and financial results; Bloomberg; AMRO staff calculations.
Note: PSU stands for Parallel Shock Up, and BS stands for Bear-Steepening. In estimation, discount factors are not updated under the shocked curve. This is consistent with the definition of KRD as a first-order sensitivity around the baseline term structure and ensures internal consistency of the linear ΔEVE approximation.

10. The stress test results indicate that banks have improved their resilience to bear-steepening. The projected ΔEVE-to-total-capital ratio improves steadily from

2022 to 2025 (Figure A1.10). Bear-steepening shocks typically produce larger ΔEVE losses than parallel shifts due to their heavier impact on longer-tenor exposures, underscoring the need for banks to remain particularly vigilant should such shocks materialize. That said, the system as a whole improves to the level complying with the 20 percent supervisory threshold applied individually to domestic-standard banks, even under a relatively severe +300 bps shock at the ultra-long end. While this threshold is not intended for system-wide assessment and some individual banks may remain vulnerable to interest rate shocks, it is notable that system-wide resilience to the bear-steepening scenario has been on an improving trend.[80]

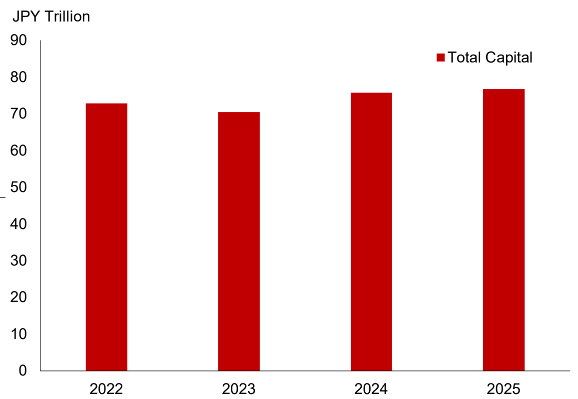
11. **Improvements in system-wide resilience to bear-steepening are explained by both declining KRDs and the accumulation of capital.** The decomposition of predicted ΔEVE shows that reductions in KRDs have consistently contributed to higher resilience since 2022 (Figure A1.11), especially at the long- and ultra-long-term nodes, reflecting enhanced ALM practices following the 2019 implementation of the IRRBB framework. Rising capital levels also contributed to improvements in the ΔEVE-to-capital ratio in 2024 and 2025 (Figure A1.12).

Figure A1.11. Decomposition of Stress Test Results over Time Under the Bear-Steepening Scenario



Source: Public disclosures including annual reports, integrated reports, and financial results; Bloomberg; AMRO staff calculations.

Figure A1.12. Evolution of Total Capital



Source: Public disclosures including annual reports, integrated reports, and financial results; AMRO staff calculations.

Policy Discussion

12. **The results of the stress testing exercise indicate an improvement in Japanese banks' resilience to interest rate risks over time, while also underscoring the need for continued close monitoring and prudent risk management.** This Selected Issue estimates system-wide durations at key rate maturities using publicly available data and evaluates banks' resilience to interest rate risks through a hybrid stress-testing framework. The adoption of a bear-steepening scenario is timely, reflecting both the realistic need to incorporate the recent rise in longer-term yields and the prospect of further gradual increases in policy rates. The analysis reveals that (i) Japanese banks' resilience to bear-steepening shocks has

[80] While internationally active banks are subject to a Tier 1-based 15 percent threshold, this analysis uses total capital for comparability across different bank categories.

improved since 2022; and (ii) this improvement has been driven by the shortening of durations at key rate maturities and the accumulation of capital. Moreover, the observed enhancement in interest rate resilience is broadly consistent with banks' management strategies, particularly the reduction of interest rate exposures along with hedging tools in the securities portfolio, discussed in the earlier section, even though such strategies cannot be explicitly captured within the model. Nevertheless, the stress-testing exercise indicates that a bear-steepening shock to the yield curve warrants close monitoring and requires banks to continue guarding against such a shock.

13. These findings suggest several policy considerations for safeguarding the resilience of the banking system against interest rate shocks:

- **Banks may need to continue strengthening their ALM practices as they adapt to a higher interest rate environment.** In particular, effective management of duration and cash-flow profiles would benefit from further improvements in modeling core-deposit behavior and prepayment risk, as well as prudent use of hedging instruments within a sound risk-management framework. Maintaining capital levels commensurate with risk profiles remains important. More broadly, after an extended period of low interest rates, banks would benefit from continued efforts to build institutional capacity suited to operating in a rising interest rate environment.

- **On securities, in particular, banks need to monitor circumstances under which the hedging tools may be less effective.** We see that the bond swap spread has widened over the past few months, i.e. bond yields rose more than the swaps. Thus, assuming equal sensitivity to interest rates at hedge initiation, the losses in bonds would likely be only partially offset by the gains in interest rate swaps. Similarly, the JGB futures implied yield and JGB yield spread has compressed, likely due to higher selling pressures in the futures— which would make the hedge less effective. Banks need to pay attention to these dynamics while managing their hedging positions.

- **Authorities should maintain close dialogue with banks on interest rate risk, considering the evolving interest rate environment.** By leveraging adequately granular information from regulated entities, it remains important to deepen analysis and monitor interest rate risk through both macro- and micro-prudential lenses. As with banks, strengthening supervisory expertise for periods of rising interest rates would also help safeguard financial stability.

Box A1. Estimation Methodology for Node-level Interest Rate Sensitivities

This box provides an overview of the estimation model used in the main text to quantify banks' interest-rate risk exposures. The model is designed to measure the Japanese banking system's resilience to interest rate shocks using limited publicly available information. The Box also highlights several important caveats underlying the approach.

1. Model Definition

For each maturity bucket j, which aggregates net cash flows (NCF) between asset and liability occurring within a specific time bucket, we define a representative key rate maturity τ_j ("node"). For bank i, the net present value (NPV) at node τ_j is computed as NCF, discounted to the present:[81]

$$NPV_i(\tau_j) = NCF_i(\tau_j) \cdot DF(\tau_j), \text{where } DF(\tau_j) = e^{-\tau_j \cdot r(\tau_j)} \; and \; NCF_i(\tau_j) = CF_i^{Asset}(\tau_j) - CF_i^{Liability}(\tau_j)$$

The Economic Value of Equity for bank i (EVE_i) is then defined as the sum of $NPVs$ across all nodes:

$$EVE_i = \sum_{j=1}^{J} NPV_i(\tau_j) \qquad \text{(A1.1.)}$$

2. Approximation

The post-shock interest rate at node τ_j under scenario s can be written as:

$$r_s(\tau_j) = r(\tau_j) + \Delta r_s(\tau_j)$$

Using a first-order Taylor expansion of ΔEVE around the baseline yield curve and equation (A1.1), ΔEVE can be approximated as:[82]

$$\Delta EVE_{i,s} \approx \sum_{j=1}^{J} \frac{\partial EVE_i}{\partial r(\tau_j)} \cdot \Delta r_s(\tau_j) = \sum_{j=1}^{J} \frac{\partial NPV_i(\tau_j)}{\partial r(\tau_j)} \cdot \Delta r_s(\tau_j) \qquad \text{(A1.2.)}$$

We define the node-level interest rate sensitivity, i.e., the key rate duration (KRD), as the sensitivity of $NPV_i(\tau_j)$ to the yield at node τ_j ($r(\tau_j)$):

$$KRD_i(\tau_j) = -\frac{1}{NPV_i(\tau_j)} \cdot \frac{\partial NPV_i(\tau_j)}{\partial r(\tau_j)}$$

Substituting this definition into equation (A1.2) yields:

$$\Delta EVE_{i,s} \approx -\sum_{j=1}^{J} \left(KRD_i(\tau_j) \cdot NPV_i(\tau_j) \cdot \Delta r_s(\tau_j) \right) \qquad \text{(A1.3.)}$$

3. Assumption of a System-wide KRD and Estimation Equation

The objective of this analysis is to estimate the key rate sensitivities at node τ_j ($KRD(\tau_j)$) that represent the interest rate sensitivity of the Japanese banking system as a whole. Although each bank i has its own $KRD_i(\tau_j)$, we assume that banks are effectively exposed to a common, system-wide key rate duration $KRD(\tau_j)$. Under this assumption, the approximation becomes:

$$\Delta EVE_{i,s} \approx -\sum_{j=1}^{J} \left(KRD(\tau_j) \cdot NPV_i(\tau_j) \cdot \Delta r_s(\tau_j) \right) \qquad \text{(A1.4.)}$$

Let β_j denote the system-wide KRD at node τ_j ($KRD(\tau_j)$), and let γ_j capture the additional sensitivity associated with specific banks at node τ_j. Define the explanatory variable as $X_{i,s,j} = -NPV_i(\tau_j) \cdot \Delta r_s(\tau_j)$. Substituting these definitions into equation (A1.4) yields the following linear regression model:[83]

[81] Given the scope of this box, we abstract from currency-by-currency details for simplicity.
[82] For clarity, ΔEVE denotes the change in EVE, where a decline in EVE resulting from an interest rate increase is expressed as a negative value.
[83] Note that the intercept is theoretically zero, as ΔEVE must be zero when the interest rate shock is zero. Regressions including an intercept were estimated as robustness checks to verify the stability of the β coefficients.

$$\Delta EVE_{i,s} = \sum_{j=1}^{J} \left(\beta_j \cdot X_{i,s,j} + \gamma_j \cdot X_{i,s,j} \cdot Dummy_{i,j}\right) + \varepsilon_{i,s} \quad \text{(A1.5.)}$$

4. Overview of Estimation and Data

For each target year, cross-sectional regressions based on equation (A1.5) were estimated using the following dataset:

Box Table A1.1. Overview of Data

ΔEVE	Scenario-specific losses under Interest Rate Risk in the Banking Book (IRRBB) as disclosed by each bank. Scenario observations not reported by a bank were excluded from the sample.
τ_j	Based on the common granularity available in public disclosures, maturity buckets were consolidated into four categories: (1) up to 1 year; (2) 1–5 years; (3) 5–10 years; and (4) over 10 years. The key rate nodes are defined as the midpoint of each bucket (0.5 years <short-term>, 3 years <medium-term>, 7.5 years <long-term>), with the final long-term node set at 15 years <ultra-long-term>.
NPV	For each bank, the cashflow difference between assets (sum of maturity information on major asset classes at each node) and liabilities (available time-deposit information in maturity profiles for major funding sources) was multiplied by the discount factor to obtain NPV.
DF	The JPY OIS curve is used as a proxy discount curve. Ideally, discount rates should be specified by currency of denomination, but cashflows by currency are not available in public disclosures.
Δr	The interest rate shock matrix on the right used in this analysis is assumed in accordance with Basel Committee on Banking Supervision (2016, 2024) and applied to all sample years.
$Dummy$	Since estimation results indicate that node-3 sensitivity differs substantially for megabanks, a dummy interaction term for megabanks at node 3 is included. Significant coefficients could be interpreted as reflecting factors unique to megabanks, such as advanced ALM and hedging in the long-term zone.
Sample	Banks on a consolidated basis, for which all necessary data are available in each target year.

Scenarios	node 1	node 2	node 3	node 4
Parallel shock up	0.0100	0.0100	0.0100	0.0100
Parallel shock down	-0.0075	-0.0075	-0.0075	-0.0075
Steepener shock	-0.0100	-0.0050	0.0075	0.0125
Flattener shock	0.0100	0.0040	-0.0060	-0.0120
Short rates shock up	0.0200	0.0100	0.0040	0.0010
Short rates shock down	-0.0150	-0.0070	-0.0030	-0.0010

5. Caveats

This model and the associated estimation exercise are designed to assess the resilience of the Japanese banking system to interest rate shocks using the limited publicly available information only. The estimated key rate durations (β_j) provide a practical indicator of system-wide interest rate sensitivity to changes in the shape of the yield curve. At the same time, because the analysis necessarily relies on the granularity of public disclosures and lacks certain structural information, the estimated coefficients may embody not only statistical uncertainty but also model misspecification and measurement errors arising from coarse reporting. Accordingly, the estimator of β_j should be interpreted with appropriate caution and in cognizance of several underlying assumptions and constraints, including, but not limited to, the following.

(i) Bank-specific IRRBB internal model features, such as core deposit models and hedging strategies, are unobservable and therefore omitted from the estimation model.

(ii) Currency-level detail for $\Delta EVE_{i,s}$, CF, and related items is not disclosed, so interest rate shock parameters are assumed, and the JPY OIS curve is used as a proxy discount curve.[84]

(iii) Cash-flow structures within each maturity bucket are approximated by zero-coupon equivalents, which may introduce non-negligible approximation errors, particularly for longer maturity buckets.

(iv) The reliance on a first-order approximation means that nonlinear features of balance-sheet cash flows are not modeled explicitly, and results should be viewed as indicative rather than precise point estimates, particularly when large interest-rate shocks are applied, as approximation errors can increase materially.

[84] Although JPY OIS does not perfectly represent a multi-currency portfolio, its use can be justified by: (i) the large share of yen-denominated assets and liabilities in the Japanese banking system; (ii) the fact that the yen is the base currency for IRRBB management at Japanese banks; and (iii) the presence of meaningful cross-currency correlations in OIS rates across key maturities.

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