2.2. Interest Rate Risk

Interest Rate Risk

- Definition: sensitivity of the P&L to interest rate shifts in different maturities (i.e. changes in the term structure of interest rates)

- Types of interest rate risk:

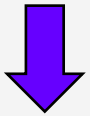
(i) Marked-to-market financial assets - market risk of interest rate-sensitive financial assets (e.g. bonds).

(ii) Non-marked-to market financial assets (e.g. loans and deposits) – balance sheet risks:

- Risk of fluctuation of the Net Interest Income of a bank stemming from the impact of interest rate changes on the cash-flows generated by assets and liabilities.
- Risk of optionality embedded in assets and liabilities, impacting on the volume of assets and liabilities that generate cash-flows, e.g. prepayment of loans and early redemption of deposits.

Interest Rate or Repricing Gaps

- Most assets and liabilities in the banking book are not marked-to-market.



- Their value does not change due to interest rate moves.
- Nonetheless, interest rate moves still impact on the Net Income (NI) of banks, because many of these assets and liabilities generate cash-flows that are sensitive to interest rates.
- These changes in the cash-flows impact on the Net Interest Income (NII, the difference between interest charged and interest paid by banks) => Δ NI.

Interest Rate Risk in the Balance Sheet

- Measurement:

(i) Interest Rate or Repricing Gap analysis:

- **Definition:** differences between assets and liabilities to be repriced in different time buckets (usually up to 1 year, with usual time bands being 1 week, 2 weeks, 1m, 2, 3, 6 and 12m).
- **Data:** All principal balances must be included in the gap report, along with interest flows. However, there is a trade-off between technical accuracy and practicality, as banks should include interest payments on tranches of principal that have not yet been repaid or repriced and the spread component of floating-rate instruments, but capturing and reporting this data is difficult.

For amortizing loans, installments should by allocated to the time period in which they are scheduled to occur, but in most cases, gaps are calculated using principal rather than interest flows.

- **Variable-rate products:** they are normally linked to a benchmark rate (e.g. 1m, 3m or 6m Libor or Euribor, being the 6m Euribor the most usual reference rate for residential mortgage loans in Portugal) and the repricing frequency often corresponds to the maturity of the reference rate chosen.

Interest Rate Risk in the Balance Sheet

- **Bullet repayment loans:** the entire principal balance should be allocated to a time bucket corresponding to their maturity.
- **Fixed rate retail bank products:** as these tend to be homogenous and face early repayments, banks usually build models to estimate the behavioral run-off profile of loans and deposits.
- **Non-interest rate bearing balance sheet items** (e.g. non-interest bearing deposits, fixed assets and capital, even though capital may be considered as a fixed rate liability) - banks often decide to represent a proportion (e.g. 20%) of non-interest bearing deposits as notionally repricing in the short term and spread the remainder between 1 month and 3 or 5 years.
- **Types of gaps:** static or dynamic and marginal or cumulative.
- **Management:**
  (i) banks usually impose internal limits on these gaps, at the bank's Asset and Liability Committee, expressed as an amount or percentage of NII, based on the bank's risk appetite.
  (ii) banks may decide to hedge against the interest-rate risk, by entering into interest-rate derivative transactions or by changing the pricing structure of their balance sheet (cash hedging), in order to mitigate their exposure.
  (iii) banks may also decide to keep their gaps (at least up to a given magnitude) if they expect to benefit from interest rate changes.

Interest Rate Risk in the Balance Sheet

Example 1

- The Bank is negatively impacted by interest rate increases.
- Impact of a change in the yield curve on the NI in the following year:

$$\Delta NI_{1y} = \sum_{j=1}^{k} \Delta i_j \cdot gap_j \cdot (12 - m_j)$$

being i the interest rate for the mid-point maturity of each gap (m), j the order number of the gap and k the total number of gaps up to 1y.

Repricing Bucket	Assets	Liabilities	Interest Rate Gap	Cumulative Gap
Currency (£m)				
0 – 1 month	500	4,600	–4,100	–4,100
1 – 2 months	443	324	119	–3,981
2 – 3 months	156	1,781	–1,625	–5,606
3 – 4 months	342	430	-88	–5,694
4 – 5 months	213	24	189	–5,505
5 – 6 months	224	69	155	–5,350
6 – 9 months	356	17	339	–5,011
9 – 12 months	324	46	278	–4,733
12 – 15 months	614	32	582	–4,151
15 – 18 months	459	123	336	–3,815
18 – 24 months	875	275	600	–3,215
2 years – 3 years	1,365	135	1,230	–1,985
3 years – 4 years	845	86	759	–1,226
4 years – 5 years	725	58	667	–559
5 years – 6 years	413	0	413	–146
6 years – 7 years	45	0	45	–101
7 years – 10 years	89	0	89	–12
10 years +	12	0	12	0
Total	8,000	8,000		

Source: Choudhry, Moorad (2018) "The Moorad Choudhry Anthology: Past, Present and Future Principles of Banking and Finance", Wiley.

Interest Rate Risk in the Balance Sheet

- The sensitivity of NII to interest rate shocks are usually based on parallel yield curve shifts.
- **1y impact of a 1 pp upward parallel shift in the yield curve = -48.1m£.**
- Problems with this calculation:

(i) Bank balance sheets are not constant over time, namely due to option risks (e.g. prepayments, revolving loans);

(ii) Parallel shifts in the yield curve are rare;

(iii) Some assets and liabilities won't reprice by the exact amount of the shock in rates and on the exact dates assumed;

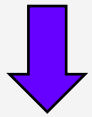
(iv) Basis risk – assets and liabilities often have different benchmark rates at the same tenor or the same benchmark rate at different tenors.

Repricing Bucket Currency (£m)	Interest Rate Gap	IR Gap x Rate Shock x Remaining Months/12		(£m)
0 – 1 month	–4,100	–4,100 × 1% × 11.5/12	=	–39.29
1 – 2 months	119	119 × 1% × 10.5/12	=	1.04
2 – 3 months	–1,625	–1,625 × 1% × 9.5/12	=	–12.86
3 – 4 months	–88	–88 × 1% × 8.5/12	=	–0.62
4 – 5 months	189	189 × 1% × 7.5/12	=	1.18
5 – 6 months	155	155 × 1% × 6.5/12	=	0.84
6 – 9 months	339	339 × 1% × 4.5/12	=	1.27
9 – 12 months	278	278 × 1% × 1.5/12	=	0.35
12 – 15 months	582			
15 – 18 months	336			
18 – 24 months	600			
2 years – 3 years	1,230			
3 years – 4 years	759			
4 years – 5 years	667			
5 years – 6 years	413			
6 years – 7 years	45			
7 years – 10 years	89			
10 years +	12			
				–48.10

Source: Choudhry, Moorad (2018) "The Moorad Choudhry Anthology: Past, Present and Future Principles of Banking and Finance", Wiley.

Interest Rate Risk in the Balance Sheet

- This calculation could be simplified if only the cumulative interest rate or repricing gap (CGAP) is considered, getting a rougher but faster estimate.
- In this example, the cumulative 1y gap = -4.733 m£



- 1y impact of a 1 pp upward parallel shift in the yield curve =-4.733x0,01=47,33.
- This figure is very close to the one obtained by using the several marginal gaps.

Interest Rate Risk in the Balance Sheet

Example 2:

- For the 1st gap in the table below, the impact of a 1 pp increase in interest rates is:

$$\Delta NII_i = (-\$10 \text{ million}) \times .01 = -\$100{,}000$$

	(1) Assets	(2) Liabilities	(3) Gaps	(4) Cumulative Gap
1. One day	$ 20	$ 30	$−10	$−10
2. More than one day–three months	30	40	−10	−20
3. More than three months–six months	70	85	−15	−35
4. More than six months–twelve months	90	70	+20	−15
5. More than one year–five years	40	30	+10	−5
6. Over five years	10	5	+5	0
	$260	$ 260		0

Source: Saunders, Anthony and Marcia Millon Cornett (2018), Financial Institutions Management – A Risk Management Approach, 9th Edition, McGraw-Hill International.

- 1y CGAP:

$$CGAP = (-\$10) + (-\$10) + (-\$15) + \$20 = -\$15 \text{ million}$$

- Assuming a parallel upward shift in the yield curve up to 1y :

$$\Delta NII_i = (CGAP)\,\Delta R_i$$
$$= (-\$15 \text{ million})\,(.01) = -\$150{,}000$$

Interest Rate Risk in the Balance Sheet

- **Main problems with gap analysis:**

(1) ignores the coupons and cash flows on all assets and liabilities;

(2) typically uses accounting values of assets and liabilities, not market values;

(3) time buckets typically used are very focused on short-term maturities, when the real large risks to the institution often lies in long-term maturities;

(4) ignores options.

Interest Rate Risk in the Balance Sheet

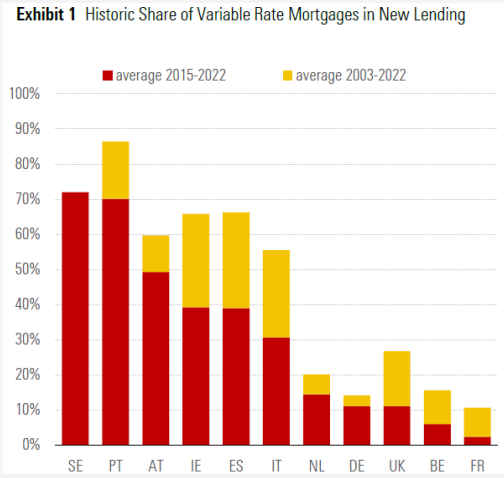
(ii) Earnings-at-risk (EaR) – impact on earnings - NI or Economic Value of Equity (EVE) - from several very unfavorable scenarios for interest rates:

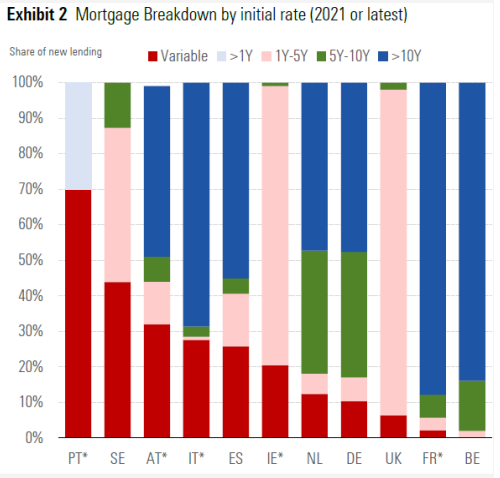
- EVE sensitivity calculation is also based on interest rate gaps, by computing the sum of the PV of each bucket gap, assuming the current interest rates and then assessing the impact of different shifts in the yield curve, assuming a stressful rate environment both plausible and severe.
- Key steps:

(i) Develop a bottom-up forecast of NII for the next 1–5 years;
(ii) Capture assumptions for all conceivable interest rate environments on:
  (a) How all products would be repriced;
  (b) New business volumes;
  (c) Forecast prepayments / early redemptions;
  (d) The level of loan defaults.
(iii) Run a simulation to evaluate the impact of multiple different interest rate paths on NII and EVE;
(iv) Review the distribution of NII and EVE outputs;
(v) Focus on extreme losses and if these are of concern to management, set strategies to implement, in order to reduce the exposure.

Interest Rate Risk in the Balance Sheet

- Portuguese banks usually have positive interest rate gaps, as credit rates are mostly indexed to money market rates (e.g. Euribor), while among liabilities only bonds issued are usually indexed, as term deposits are mostly short term liabilities (though may be renewed) with interest rates fixed by the bank => short term interest rate increases are, *ceteris paribus*, favorable to banks.
- However, we must also bear in mind that higher rates may increase credit risk, being Portugal one of the countries with the highest % of variable rate loans, namely in residential mortgage loans.





Source: DBRS (2022), " European Banks Face an Increase in Residential Mortgage Risks as Interest Rates Rise".