22. Interest Rate Risk in the Banking Book (IRRBB)

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22.1 Introduction

Banks generate interest rate risk from their traditional balance sheet activities of deposit taking (and debt issuance) and lending, and from other off-balance sheet and trading activities. Given the various contracts entered into with specified future cash flows, changes in interest rates affect the present value of those cash flows and thus potentially the present value of the bank. An alternative way of thinking about this is to note that the need to replace maturing liabilities and/or assets will lead to different interest income or expense if there has been a change in interest rates by that date. Of course, banks also have the discretion to change interest rates charged or paid on variable rate loans or at-call deposits, and many contracts link the interest rate involved during the life of the contract to some market or indicator rate. This means that it is more important to focus on the repricing features of the contracts rather than their maturity.

As well as an effect on the present value of future income and expense cash flows, a change in interest rates will also affect current period earnings if the interest rates on assets and liabilities are differentially affected. Some banks may focus more on the current earnings effect, and others on the "economic value" effect – although both are generally considered (and important).

It has become common to separate interest rate risk into that involved in the banking book (IRRBB) and that involved in the trading book, as one component of the "market risks" managed there. (Other market risks include commodity, FX, equity risk etc).

One reason for this division is that large banks will typically "pass" unwanted interest rate risk from the banking book to the trading book to be managed by the relevant trading desk. Rather than changing the structure of loan and deposit interest rates to induce a change their maturity composition and repricing features and remove an undesired interest rate exposure, such transactions can be used to hedge the IRRBB. If the ALCO (or other entity responsible for managing IRRBB) decides to reduce interest rate exposure of the banking book, a transaction, such as an interest rate swap or FRA, will be undertaken between the banking book and the trading desk. The banking book has less interest rate exposure and the trading desk now has that exposure to manage. A second reason is that the nature of interest rate risk created by the trading desk arises from taking positions in the market which can be changed quickly, whereas the interest rate risk in the banking book is more "structural' in nature reflecting the banking business.

This does raise a potential issue for regulatory capital requirements, since deals between the banking book and the trading book convert IRRBB into market risk of the trading book. If the capital requirements are not consistent across the two activities there may be scope for regulatory arbitrage. Regulations associated with trading book activities (market risk) attempt to limit such regulatory arbitrage.

22.2 The Importance of IRRBB

Since the most basic business of banks is taking short term deposits and lending longer term, it might be thought that the exposure to interest rate risk associated with this is a major component of bank risk management. It is not unimportant, but nowhere near as important as credit, operational and market risk.

There are several reasons for this. One is that banks often make longer term loans at variable interest rates, and thus are not locked in to a fixed return on long term assets. Indeed, the majority of Australian housing mortgage loans have interest rates variable at the bank's discretion – which are generally varied when the bank's cost of funding changes - thus passing interest rate risk on to the customer. (But it can be important as the Savings and Loans institutions in the USA who made long term fixed rate loans discovered in the late 1980s S&L Crisis)[1]. A second reason is that bank internal arrangements will generally involve passing much of the interest rate risk from the banking book onto the trading book, such that it gets reflected in market risk. While it may be difficult to substantially alter the structural interest rate characteristics of the banking book in the short run (such as by substituting long term for short term deposits, or moving to floating rate rather than fixed rate loans), it is relatively easy to hedge interest rate exposures by transactions in derivatives either with the trading desk or with third parties. Interest rate swaps, futures contracts, forward rate agreements, and interest rate options are among the hedging tools available.

Australia was one of the earlier adopters of an IRRBB capital requirement (optional under Basel 3) for banks using the Internal Models approach to risk management. Other ADIs were not subject to and IRRBB charge, although changes announced in 2019 in a draft of APS 117 (originally to apply from 2022, but deferred to 2023) may alter that for some ADIs for whom APRA determines such a charge would be appropriate. Although no capital charge for IRRBB applied to most banks (ie those not accredited to use internal models), all were required to report to APRA on interest rate risk in the banking book using a standardised template.

One way to assess the relative importance of IRRBB is to consider how much it contributes to the bank's regulatory total RWA calculation (for those banks subject to an IRRBB capital charge)]. While IRRBB risk management models calculate a capital requirement by reference to interest rate exposure, the resulting capital amount can be converted into an equivalent RWA by multiplying by the inverse of the required capital ratio. If, for example, the bank (or regulator) determines that capital of 10 is required as a result of IRRBB and the capital/RWA requirement is 0.08, then 10 of capital is equivalent to having 125 of RWA.

[1] See Curry and Shibut (FDIC Banking Review, 2000) for an overview.

Doing this type of calculation (for Australia's major banks) leads to an aggregate RWA contribution from IRRBB which has averaged around 3 per cent of RWA, although the numbers have historically varied quite a bit over time and between banks as reported in this KPMG document. Some of the changes proposed to APS 117 are designed to reduce that variability.

22.3 Sources of Interest Rate Risk

Vuillemey provides a relatively recent survey of theoretical and empirical work on interest rate risk in banking, with a particular emphasis on the extent to which banks rather than consumers (businesses) take on aggregate interest rate risk. He notes that banks pass on a lot of interest rate risk by use of variable rate loans, but do retain some interest rate risk – with a negative exposure (bank equity value falls when interest rates rise). Since banks also engage in maturity transformation (longer term assets than deposits) their stock prices should also be positively related to unexpected steepening of the yield curve (if term to repricing is related to maturity).

Interest rate exposures can be basically divided into two main types

Balance sheet mismatches - e.g. short term deposits, long term (fixed rate) assets etc., often referred to as "riding the yield curve". Note that even maturity matching can leave an interest rate exposure if the pattern of cash flows varies between assets and liabilities (e.g. due to interest frequency, principal repayment methods). The market value of each will respond differently to interest rate changes. (This can be thought of alternatively as the problem of "reinvestment rate" risk – and leads to a focus on *duration*).

"Off" balance sheet activities:

- Forward rate agreements (FRAs) where net payment from bank to customer is made at a future date depending on value of BBSW at that date relative to a contractual value.
- Interest Rate Swaps (like a string of FRAs)
- Interest Rate Options: both explicit option contracts written for customers and Implicit, e.g. prepayment options for fixed rate borrowers
- *"Real" exposures* - impact of high/low interest rates on loan defaults, loan demand, deposit supply etc.

"Riding the Yield Curve": Profits and Risks

Banks typically make longer term (duration) loans than their deposits (more precisely, exposure comes from a longer time to loan "repricing") such as 5 year fixed rate loans financed by 3 month deposits. Banks normally have an expected profit from "riding the yield curve" since there is generally a positive bias to the slope of the yield curve reflecting a term premium.

But it is important to note that if the *expectations hypothesis (EH)* held, there would be no expected profit from riding the yield curve. The EH states (in its simplest depiction for a two period world where 0 is the current date) that

$(1+{}_0r_1)(1+E_0({}_1r_2)) = (1+ {}_0r_2)^2$.

(Here, ${}_0r_1$ and ${}_0r_2$ are the one period and two period rates (p.a.) as at date 0, and $E_0({}_1r_2)$ is the expectation at date 0 of what the one period rate will be at date 1 (ie the rate for the period between dates 1 and 2). For example if the current 1 year rate (${}_0r_1$) = 0.05, and the current 2 year rate (${}_0r_2$) = 0.06, the EH implies an expected 1 year rate in 1 year $E_0({}_1r_2)$ = 0.07. If the EH held, then a two year investment at 6 per cent (p.a.) would generate the same amount as expected from a one year investment at 5 per cent (p.a.) followed by another one year investment at date 1 at the higher rate of 7 per cent expected to prevail at that time. Of course, the actual rate could turn out to be quite different!

While expectations are an important determinant of the yield curve slope, generally there is some "term (or risk) premium" in the yield curve. Typically this is positive, such that longer term rates are higher than implied by market expectations, generating some profit from riding the yield curve. But that is not always the case, and the term premium can vary over time such that there are risks involved in trying to achieve that expected profit.

Types of Interest Rate Exposure

In practice there are different types of interest rate exposure, and the Basel Committee identifies three types of interest rate risk for IRRBB. These are:

- Gap risk – arising from the term structure of assets and liabilities in the banking book, and risk will depend upon the type of change in the yield curve
- Basis risk – where instruments with the same tenor may be repriced according to different interest rate indices
- Option risk – where customers have implicit or explicit options which may be exercised in response to interest rate changes.

The BCBS also notes that Credit Spread Risk in the Banking Book (CSRBB) must be considered, since interest rate changes could alter PDs and LGDs.

22.4 Simple techniques for assessing interest rate exposure

There are two well known, long standing, relatively simple techniques for assessing IRRBB, known as gapping and the duration approach. They inform more modern approaches and are ingredients in the model used for reporting on IRRBB as required in ARS117, as well as the standardised model developed by the Basel Committee. The internal models used by accredited banks are much more complex but rely to some extent on the techniques involved in both approaches.

We thus discuss the two approaches before considering bank internal modelling and APS 177, ARS 117, and the Basel standardised model.

Note that exposure refers to the sensitivity of the variable under consideration to interest rate changes (such as the dollar value change per basis point change in interest rates).

Gapping

Consider the simple bank balance sheet below

Assets		Liabilities	
At call and overnight loans	$20	At call deposits	$10
Treasury notes maturing in 7 weeks	$30	Deposits due in five weeks	$20
Fixed rate 18 month loans	$50	Deposits due in 4 months	$60
		Shareholders funds	$10

The gapping approach involves grouping assets and liabilities into "resetting time buckets" - i.e. by the date at which the interest rate is first able to change. (N.B. this is not necessarily the same as maturity, a five year loan could have interest rates reset every six months for example). The precise "buckets" chosen will vary with the nature of the organisation.

For the example here, we use “buckets” of:

[0-1 month], [1-3 month], [3-6 month], [6-12 month], [12-24 month], [over 24 month]

This gives:

"Bucket" (months)	0-1	1-3	3-6	6-12	12-24	>24 (insensitive)
Assets	20	30	0	0	50	0
Liabs	10	20	60	0	0	10 (equity)
Gap	10	10	-60	0	50	-10
Cumulative Gap	10	20	-40	-40	10	0

Interpreting the Gap

Positive gaps in the [0-1] and [1-3] month buckets mean that if interest rates were to increase tomorrow (and stay at that level), net interest income (NII) would increase for the periods 0-1 month, and for 1-3 month. The reason is that more assets than liabilities have rates that reset at the higher yields over that period. (There are more **rate sensitive assets** than **rate sensitive liabilities** in that bucket). Likewise an interest rate increase any time before the end date of the bucket would have a similar, but smaller, effect on NII.

The negative gap for the [3-6] month gap means that the increase in interest rates would reduce net interest income in that period. The $60 of liabilities repricing in that period would involve higher interest rate costs. The cumulative gap at that point and subsequently indicates that if the increase in interest rates persisted, net interest income would fall over the period 0-6 months and 0-12 months. Note that this assumes the portfolio is not changed, and that after one month both the 20 of assets and 10 of liabilities have both repriced at the new interest rate level. Of course, redoing the gapping bucket in one month's time would require slotting those into the relevant bucket.

Problems with gapping

- Gapping only gives directional estimate of exposure - not very precise quantitative estimates. However, one can estimate the change in NII by using $\Delta NII = (Cum.Gap).\Delta r$ for some assumed change in interest rates at different tenors.
- Results may depend upon "buckets" chosen
- It is sometimes difficult to classify the repricing date of assets where the bank has discretion to reset the rate - but faces marketing/political constraints upon flexibility. Likewise, are retail deposits to be classed as rate sensitive or not - the interest rate can be changed, but quantity is not necessarily very sensitive to market movements. Typically such at-call deposits will be spread over repricing buckets as a way of indicating that, in the longer run, the rate paid will need to respond (to some degree) to interest rate changes, but not necessarily immediately.
- It takes the current balance sheet as given. It ignores "run-offs" from existing assets and liabilities in terms of interest payments and principal repayments which can be reinvested at new market interest rates.
- It ignores other sources of interest rate exposure (off balance sheet, "real" exposures)

- Focuses upon net interest income - not economic value (Value depends upon NPV of all future net interest income. An interest rate change could cause current and future NII to move in opposite directions).

The example given, does not incorporate any derivative positions in the banking book. These can be incorporated by replicating them as positions in the underlying assets. For example a position as a fixed rate payer in a $100 two year swap with the floating rate adjusting every six months can be replicated as being short a two year fixed rate $100 bond and long a six month $100 bond.

Duration and the Duration Gap Approach

Duration Definition

- Consider asset A with cash flows at date i of C_i, i = 1...m (where m is the maturity of the asset).
- Assume the yield curve is flat, at an interest rate of r
- The present value of C_i is $P_i = C_i/(1+r)^i$
- The market value of asset A, V_A is $V_A = \sum_{i=1}^{m} P_i = \sum_{i=1}^{m} \frac{C_i}{(1+r)^i}$
- The duration of A, D_A is $D_A = \frac{\sum_{i=1}^{m} i.P_i}{V}$
- The units of measurement of duration is time (e.g. years) - since the numerator is of dimension (time multiplied by PVs) and the numerator is of dimension (PVs).

Duration can be defined as a <u>weighted</u> average time to maturity of the cash flows of an asset. It also has particular economic significance as a measure of the interest sensitivity of an asset's price.

Interpreting Duration

If security a has cash flows C_1, C_2,…. C_m, then its market value is

$V_a = C_1/(1+r) + C_2/(1+r)^2 + ...C_m/(1+r)^m$

Differentiating

$dV_a/dr = -1.C_1/(1+r)^2 – 2.C_2/(1+r)^3 - .... –mC_m(1+r)^{m+1}$

$= -(1+r)^{-1}[1.C_1/(1+r) + 2C_2/(1+r)^2 +...mC_m/(1+r)^m]$

Since the term in [..] is equal to $D_a.V_a$

$dV_a/dr = -(1+r)^{-1}[D_a.V_a]$

Hence $dV_a / V_a = - D_a dr/(1+r)$ and duration can be thought of as the elasticity of an asset's value w.r.t. (1+r) - since dr = d(1+r).

Modified Duration D* = D/(1+r) is often used instead giving

$dV_a/dr = -[D^*_a.V_a]$

The percentage change in an asset's price following a change in the interest rate can be obtained by multiplying its modified duration by the change in the interest rate. Figure 1 illustrates.

Examples

1. Zero coupon bond with $D_z = 4$. If r = .10 (i.e. 10%) and rises to .1010 (i.e. 10.10%), we have dV/V = - 4 (.0010)/1.10 = -0.0036, i.e. - 0.36%.

   Check: P_z @ r=10% = $100/(1.10)^4$ = 68.30; P_z @ r = 10.10% = 68.05

   % $\triangle P_z$ = -(.25/68.30)100 = -0.36%

2. 15% coupon 5 year bond, when r = 8%, has duration of 3.99 (say 4)

   If r increases to 9%, the bond value falls by 4(.01)/(1.08) = -0.037 = 3.7 %.

Convexity

Duration gives an accurate approximation for the change in a security's price for small changes in the interest rate. But due to the curvature of the price-yield relationship , the *convexity* of the security makes it only an approximation. See Figure 1.

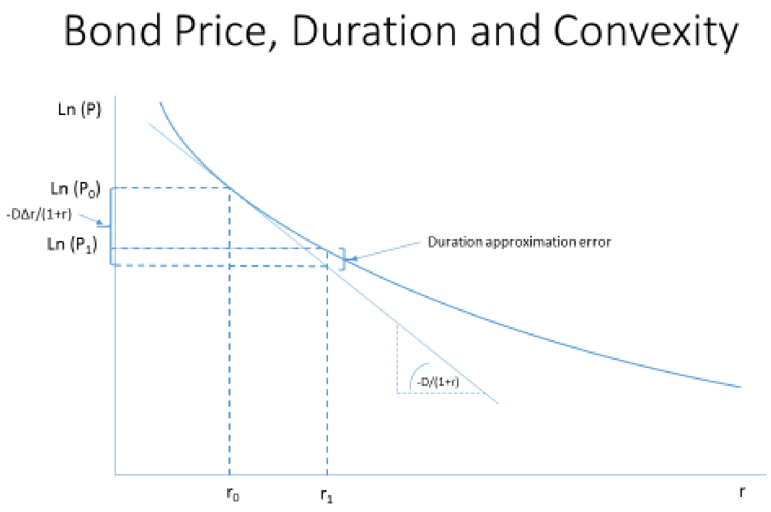

FIGURE 1: ASSET PRICE CHANGES AND DURATION AND CONVEXITY

Duration Gap of a Financial Institution

The reporting requirements of ARS 117 do not calculate the duration gap for the whole ADI, but rather calculate a duration gap for different time-bucket positions. This enables different interest rate change assumptions for different time-buckets to be used. Nevertheless, the aggregate duration gap is worth examining as an imperfect summary measure of interest rate exposure. One problem in its application is that it logically requires use of the market value of assets and liabilities rather than their book values.

From the **market value** balance sheet,

E = A - L, i.e. equity value = assets minus liabilities

Hence $\Delta E = \Delta A - \Delta L$. Thus if we can find the duration of assets and liabilities, we can calculate the impact of interest rate changes on equity value.

$\Delta A = -D_a.A.\Delta r/(1+r)$; $\Delta L = -D_l.L.\Delta r/(1+r)$

hence ΔE $= -[D_a.A - D_l.L]\Delta r/(1+r)$

$= -[D_a.- D_l.L/A].A.\Delta r/(1+r)$

$= -[D_a.- D_l.k].A.\Delta r/(1+r)$, where k = L/A (a measure of leverage)

Thus the impact of a change in interest rates on equity value can be broken down into three factors:

- the leverage adjusted duration gap $[D_a - D_l.k]$

- scale (A)
- the size of interest rate change

Note, to calculate the duration of a portfolio of assets (liabilities) we must weight the individual durations by market value. For example, if $A = A_1+A_2$, in market value terms, then $D_a = D_{a1}A_1/A + D_{a2}A_2/A$.

Example:
Consider: A =$100, L = $90, E = $10, D_a = 5, D_l = 3, r = 10%.
What effect will an increase in r to 11% have?
ΔE = -[5 - 3(.9)]100(.01)/1.1 = -$2.09, i.e. almost 21% of net worth.

22.5 IRRBB Approaches used by Major Australian Banks

An important issue in assessing interest rate risk is that of whether the focus should be upon the effects of interest rate changes on current earnings or on the present value of the banking book (reflecting changes in both current and future earnings). They will not always give the same message and it is possible to construct examples of balance sheet structures where an increase in interest rates reduces current earnings but increases the present value of the banking book. Such examples are not common, and both approaches generally indicate the same directional effect. But focusing solely on one may lead to poor risk management strategies. For example, if a future change in interest rates is likely to excessively impact current earnings, one response could be to change interest rates offered to induce a switch into in long term fixed rate deposits and out of short term deposits. That could remove the sensitivity of current earnings to interest rate changes but possibly increase the sensitivity of future earnings, and thus the present value of the banking book, to interest rate changes.

Common metrics for considering a change in economic value include:

- *PV01*: present value of a single basis point change in interest rates based on gap anaylsis;
- *EVE*: economic value of equity. This takes the balance sheet as given and ignores possible future changes, and uses the balance sheet identity that equity is the balance sheet residual. Changes in EVE are then the difference between changes in the market value of assets and liabilities.

- *EVaR*: economic value-at-risk.

The four major Australian banks report on their IRRBB in their Basel 3 disclosures. In measuring and monitoring IRRBB they all report using similar methods (but expressed differently) – see Table 1. The metrics considered can be summarised as:

Risk measures

- Economic value sensitivity (change in EVBB (economic value of the banking book) due to specific moves in yield curve)
- Earnings at Risk (EaR) or Net interest Income at Risk (NIIS), estimated for some holding period (eg a quarter) at a specified confidence interval. The assumed probability distribution of future interest rates could be based on historical data, or the figures could be calculated for some specific movement in interest rates (eg 200 a bp parallel movement in the yield curve).
- VaR – 99% confidence level estimate of interest rate change impact on EVBB
- Stress Testing outcomes

Relevant metrics

- Market Value (PV of all known future cash flows)
- Market value loss limits
- Embedded Value (Market value less book value of current balance sheet) which is incorporated into the capital position.

Vuillemey discusses repricing gap, duration and factor approaches to measuring and assessing the consequences of interest rate risk, arguing that empirical evidence indicates that income gap is a satisfactory measure since bank profits and stock price sensitivity to interest rates are related to the repricing gap.

Public Reporting

In the quarterly Basel 3 dislosures all of the banks generally report only what is required by APRA. This is the change in EVE from +/- 200bp parallel shift of the yield curve, the RWA equivalent of that change in EVE and consequent capital required for IRRBB. (It is perhaps worth noting that in its April 2016 Standards Document the Basel Committee includes a principle that disclosure should include both the EVE effect and the effect on earnings, as well as other disclosures.

TABLE 1: IRRBB APPROACHES OF MAJOR AUSTRALIAN BANKS (FROM BASEL DISCLOSURES)

	Westpac	ANZ	CBA	NAB
Objective	Reasonable stability of NII	controlling the potential impact that changes in market interest rates can have on the net interest income and balance sheet fair value	stable and sustainable net interest income in the long-term	optimise and stabilise the NAB Group's economic value and earnings over an investment horizon.
Constraints Specified	Net interest income at risk (NaR) limit, VaR limit, structural limits	Board approved risk appetite and limit framework		Board approves the risk appetite for IRRBB, and sets the overall limits for VaR and Earnings at Risk (EaR).

APRA outlined its expectations of risk management modelling and management for banks to obtain approval to use their internal models for determining IRRBB capital requirements in APS 117. Such models are required to incorporate repricing and yield curve risks (and deal explicitly with positions which do not have contractual repricing dates) and (generally) basis risk and optionality risk. "Embedded losses" in the banking book from past interest rate changes which have not been marked to market must be incorporated. Some of the key elements include:

- interest rates modelled must include at least one yield curve
- observation history of interest rates…must be at least six years
- Correlations between interest rates on the same and different yield curves must be recognised and included in internal model
- ADI's internal model must measure the maximum potential change in the economic value of the banking book (EVBB), as a consequence of changes in interest rates, for a 99 per cent confidence level and over a one-year holding period
  - ΔEVBB is difference between PV at current yield curve discount rates and one year hence simulated yield curve rates
  - Additional earnings offset =value of notional twelve-month, equally weighted, monthly moving average portfolio of recipient in fixed for floating interest rate swaps on notional principal equal to sum of book value of banking book

The bank is required to be able to document how its modelling derives its IRRBB including: rationale for assumptions; analytics and theory behind modelling; specific yield curve modelling (incorporating correlations between points on the same and different yield curves). Regular functionally independent reviews are required (on at least a three-year basis), and historical monitoring of model performance is required.

The capital requirement is based on estimation of a 99 per cent confidence interval for the change in the economic value of the banking book (EVBB) with a one-year holding period. The economic value is the NPV of expected future cash flows at the start of that holding period (with discount rates being actual (date 0) and simulated (date 1) wholesale market rates. Thus the calculation is the 99th percentile of EV0 – EV1 where each are calculated based on the outstanding balances (and repricing schedules) as at date 0. Both EV0 and EV1 incorporate an "earnings offset", and the discount rate used at date 1 must be consistent with the bank's yield curve modelling.

Each major bank will have a different internal model consistent with the APRA requirements. However, as indicated earlier, there is considerable variability across banks and over time in the resulting IRRBB capital requirement. While that may result from differences and changes in balance sheet composition, or use of hedging instruments, some part may also reflect different modelling approaches. One of the reasons behind the development of a new draft APS 117.0 issued in September 2019 (to be finalised in 2022 and apply from 2024) is to reduce the apparent variability in IRRBB capital requirements. Among those changes (see here for more detail and explanations) were:

- the placing of restrictions on repricing assumptions regarding "core" at-call deposits, and on optionality risk calculations.
- The basis risk capital add-on is also to be removed.
- Use of a 97.5th percentile expected shortfall measure rather than 99th VaR
- A requirement to use absolute interest rate shocks (rather than/ in addition to relative shocks)
- Calculation of the IRRBB capital charge as the maximum of the average calculated over the last three months and as calculated at the end of the quarter.
- Restrictions upon modelling assumptions including using at least eight (rather than six) years of past data for estimating interest rate volatility and correlations

22.6 IRRBB Regulation

Regulatory capital requirements for IRRBB were considered by the Basel Committee in the early 1990s but not pursued at that time. Some national regulators had their own domestic regulations, but it was not until Basel 2 that Basel standards for IRRBB were introduced. However, these were proposed as "Pillar 2" features, meaning that it was at the discretion of national regulators whether to implement such regulations. As common in Basel 2, there were alternative approaches suggested for large banks who could be accredited to use internal models for assessing IRRBB and consequent capital requirements, and for smaller banks who might be required to follow a standardised "template" approach.

One feature of the Basel approach was the recognition that:

> "While the economic value and earnings-based measures share certain commonalities, the Committee observes that most commercial banks primarily utilise the latter for IRRBB management, whereas regulators tend to endorse the former as a benchmark for comparability and capital adequacy."

The Basel Committee has developed a standardised approach to determining capital requirements for IRRBB, but has not mandated that capital requirements should be applied as part of Pillar 1. Rather, IRRBB is considered under Pillar 2 (supervisory processes). Australia is among the few countries that has imposed a capital requirement for banks – and has only done so for banks accredited to use the Internal Models Approach. The Basel Committee's standardised approach specifies calculation of the risk to a bank's capital and earnings under a range of interest rate scenarios involving different types of shifts in the yield curve.

22.7 Reporting IRRBB

Even though there is not a capital charge for most banks, and those approved to use internal models would not use this template to calculate their capital charge, all ADIs are required to regularly calculate and report to APRA an interest rate exposure using the template provided in ARS 117. That template combines concepts of *gapping* and *duration* and assumptions about the size of possible interest rate movements to estimate the exposure of the *economic value* of the banking book to interest rate changes. The *economic value* is the Net Present Value of the assets and liabilities and derivative positions held in the banking book.

The ARS 117 IRRBB Reporting Template

The template used for reporting IRRBB by ADIs involves three main components.

1. Allocate assets and liabilities and derivative positions in the banking book by their time to repricing into time buckets specified by APRA.
2. Calculate the gap in each time bucket.
3. Apply weights (based on duration for that time bucket and an assumed interest rate change for that time bucket) to the gap and sum across all buckets.

Steps 1 and 2 have already been covered in the preceding discussion of gapping, APRA specifies time buckets which are shown in Table 2.

Also shown is a modified duration figure for each time bucket – which is a bit lower value than the midpoint of the time bucket. (That reflects an assumption about the likely spread of repricing dates across the time bucket and the cash flow pattern up until time to repricing). When combined with an assumed interest rate change for that time bucket, a weight for that bucket is derived. Each of those weights is based on an assumption of a 200 basis point parallel movement in the yield curve (ie dr = 200 bp), and derived from:

$dV_a/dr = -[D^*_a.V_a]$

or

$dV_a = -[dr.D^*_a.]V_a$ = - weight x position

It can be seen that the weights are twice the modified duration for each bucket. Taking the 2-3 year bucket as an example, if interest rates increased by 200 bp then the value of a $100 asset in that bucket would fall by approximately 4.5 per cent (two times the modified duration of 2.25), or $4.50. Conversely the value of a $100 liability would rise by the same amount. So, using the difference in the value of assets and liabilities in that bucket gives the net position which is going to be affected by the interest change, and summing across all buckets gives the total effect.

TABLE 2: ARS 117 TIME BANDS (BUCKETS): SOURCE: *APRA* ARS 117.0

Time band	Middle of time band	Proxy of modified duration (years)	Weighting factor[12] (%)
0 to <1 month	0.5 months	0.04	0.08
1 to < 3 months	2.0 months	0.16	0.32
3 to < 6 months	4.5 months	0.36	0.72
6 to < 12 months	9.0 months	0.71	1.43
1 to < 2 years	1.5 years	1.38	2.77
2 to < 3 years	2.5 years	2.25	4.49
3 to < 4 years	3.5 years	3.07	6.14
4 to < 5 years	4.5 years	3.85	7.71
5 to < 7 years	6.0 years	5.08	10.15
7 to < 10 years	8.5 years	6.63	13.26
10 to < 15 years	12.5 years	8.92	17.84
15 to < 20 years	17.5 years	11.21	22.43
20 or more years	22.5 years	13.01	26.03

22.8 The Basel Standardised Approach

In 2016, the Basel Committee specified a standardised approach for IRRBB, as part of its specification of standards and updating of principles, but there is no obligation for national regulators to impose it upon banks. The Basel approach also recognises that there can be changes in credit spread risk in the banking book (CSRBB), which vary in importance for mark to market positions and non-market deposit and loan (amortised cost) positions as shown in Figure 2. It does not incorporate CSRBB into the standardised model but notes that it "needs to be monitored and assessed".

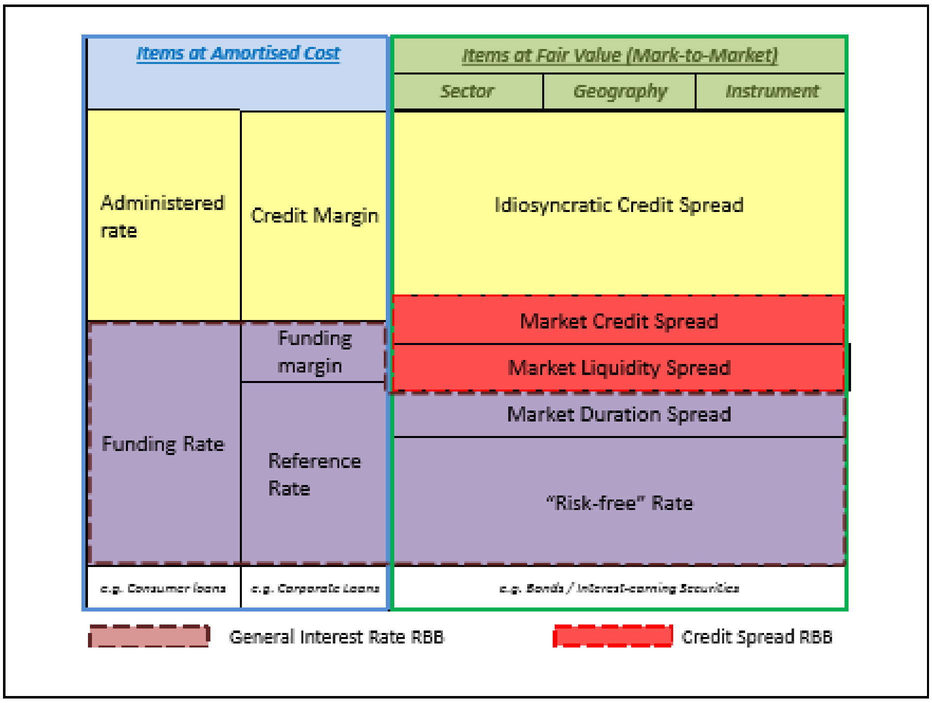

FIGURE 2: BCBS DEPICTION OF COMPONENTS OF INTEREST RATES. SOURCE: BASEL COMMITTEE

The Basel approach is based on EVE (Economic Value of Equity). Banks using this approach would:

- Allocate asset and liability and off balance sheet item positions to categories of: amenable; less amenable; not amenable to standardisation
- Slot cash flow by repricing maturities for amenable positions into prescribed time "buckets"
- Allocate NMDs (no-maturity deposits) to buckets via a core/non-core approach
- Use a prescribed BCBS table for incorporating behavioural options into allocations
- Measure ΔEVE (Economic Value of Equity) for six prescribed interest rate shock scenarios
- Apply add-ons to ΔEVE for automatic interest rate options involved in positions
- Take maximum reduction in EVE across six prescribed shocks
    - Shocks involve (for AUD) 400bp for parallel shift; 500bp for short end; 300 bp for long end and are parallel, short up or down (and shaped to no LR change); rotation shocks

The Basel approach specifies 19 time buckets (as per ARS 117 requirements in Table 2

For fixed rate instruments, coupon and principal cash flows are allocated to the relevant bucket. For floating rate instruments, coupon and are principal allocated to the next repricing bucket.[2] NMDs (non market deposits) are divided into retail & wholesale and by core / non-core features and slotted as follows:

- non-core are treated as overnight, core slotted at assumed average maturity (up to limits prescribed of 4 (for wholesale) or 5 (for retail) years)

Conditional prepayment risk is specified by BCBS for loans, and early redemption rate for term deposits also specified.

Calculation of EVE risk measure;

- Take net position of cash flows in each bucket for each specified interest rate shock scenarios, discount according to rates implied in that scenario, sum to get EVE under that scenario. Calculate difference from current EVE for each scenario.
- Maximum negative difference is the risk measure

22.8 Managing IRRBB

Bank risk management systems should identify how much IRRBB is acceptable given the bank's risk appetite. This is highly unlikely to be zero, but rather some range seen as acceptable and within which the relevant committee or responsible individual can elect to choose based on their view of potential risk and reward. In doing so, expectations about future interest rate movements will be relevant, particularly to the extent that they differ from those implied in the current yield curve.

One consideration in managing IRRBB is that consideration also needs to be given to funding requirements of the bank. For example, taking actions aimed at reducing the maturity of fixed rate borrowings on issue can reduce interest rate risk, but can create a need for replacement funding earlier than would have otherwise been the case. There may also be significant costs in attempting to change the structural characteristics of the banking book, given the maturity and interest rate preferences of the bank's customers.

Hence, while interest rate adjustments to influence deposit and loan maturity and repricing features are an option, it is often simpler to adjust IRRBB by transactions using interest rate derivative

[2] This reflects the fact that (absent changes in credit spreads) the interest rate sensitivity of a multi-period floating rate note is the same as a one-period security.

securities to achieve a desired IRRBB position. For large banks with trading desks, this will typically involve internal transactions between the banking book and the trading book, with the latter then engaging in external transactions to pass on that risk to third parties if the resulting market risk position is not desired. For smaller institutions, the bank treasury department will do such transactions directly with the market.

There are a range of interest rate derivatives which can be used to adjust IRRBB. These include interest rate swaps, interest rate futures, forward rate agreements, interest rate options – as well as more esoteric derivatives. In principle, their use is relatively straightforward. Suppose that the current position is that Economic Value of the banking book will decrease by $1 million for every one basis point increase in interest rates (and conversely for a decrease), and the preferred exposure is a sensitivity of $0.5 million per basis point. It is then necessary to select a derivative transaction which has a value which would increase by $0.5 million per basis point increase, such that the overall sensitivity is at the preferred level. This could be a position as a fixed rate payer in a two year swap with notional principal of $X million, or in a longer term swap with a smaller notional principal. (If interest rates increase, the swap will increase in value due to the higher floating rate payments received).

There is a wide range of derivative positions which could be undertaken. Some, such as a long position in an interest rate option, can enable the risk manager to take a position which reflects their view on the likely direction of interest rate changes, for the cost of the premium paid for an option. Choosing between the various alternatives will come down to considerations of cost as well as the credit risk associated with the counterparty. Moreover, the risk manager will need to reassess the position at regular intervals, as the banking book changes and interest rates change, and adjust the hedging position appropriately. Regular reporting as per the bank's risk management policies is also required.