208.

Balance Sheet Management

Course Code 208

Balance Sheet Management

Introduction

This module deals with the management of risks that arise from the balance sheet of a retail bank. In fact, the module titled Credit Loss Management in Retail Banking I presents an extensive discussion of credit risk, market risk and operational risk that arises from the financial intermediation and asset transformation roles of a retail bank. Hence, we review the role of information asymmetry underwriting risk, as well as the effect of the business cycle on the movement of credit risk over time.

Uncertainty can have a profound effect on the ability of savers (i.e., lenders) to efficiently allocate funds at the disposal of investors (i.e., borrowers). One source of this uncertainty is information asymmetry. There are generally two manifestations of asymmetric information. These are called adverse selection and moral hazard.

Adverse selection generally arises when one party to a transaction has hidden characteristics. For example, a borrower has not communicated certain facts about his/her true financial position and it remains hidden from the potential lender. This creates a problem for the bank underwriter since he/she cannot unambiguously differentiate between good quality and bad quality borrowers.

Let us assume that a lender cannot easily differentiate good quality borrowers from bad quality borrowers. The lender decides to charge the same rate to all borrowers. This is an average rate between the rate charged for good quality borrowers and the rate charged for bad quality borrowers. But this presents a problem. Good quality borrowers will find the borrowing rate too expensive, while the bad quality borrowers will see the borrowing rate as attractive when compared to their true risk status (only known to them). Hence good quality borrowers will go elsewhere. The lender will be left with only bad quality borrowers. This is called 'the lemons problem ' or adverse selection.

The other problem that can arise when asymmetric information exists between parties to a market transaction is called moral hazard. Moral hazard occurs after the transaction (i.e., monitoring stage). This problem arises because, in the presence of asymmetric information, borrowers of capital may engage in risky behaviour that puts the repayment of borrowed funds in greater doubt than previously expected. In other words, borrowers engage in unforeseen behaviour.

This problem has another important implication for a lender. The lender may charge a rate on a loan that reflects the lender's estimation of the borrower's credit risk. But if the borrower hides his/her true risky behaviour, the actual risk will be higher than the expected risk. The lender will have charged a rate that is too low (ex-post).The implication is that the market for loans would be less liquid because of the problem of asymmetric information and its associated manifestations of adverse selection and moral hazard.

Banks play a role in reducing these two problems. The bank acts as financial intermediary between savers (suppliers of funds) and consumers and companies (demanders of funds). Banks perform the due diligence required to estimate the credit risk of the prospective borrower. Through rigorous risk-evaluation procedures, banks reduce the degree of information asymmetry between lenders and borrowers and thereby reduce the likelihood of the lemons problem. We label this the 'bank-based' model.

What are the implications of a bank-based model?

First, the bank as intermediary assumes the credit risk of the borrower. This is because the bank borrows from the depositor and lends to the consumer or company (i.e., borrower). The depositor now has a relationship with the bank and not with the ultimate borrower. Similarly, the borrower has a direct relationship with the bank and not with the provider of the funds. The single transaction in the market-based model is now split into two transactions in the bank-based model, with the bank being on either side of each transaction. But there is still some degree of an asymmetric relationship between the bank and the final borrower. Hence, there is a chance that the lemons problem can still arise. To mitigate this, the bank must employ professional risk managers to evaluate the underwriting risk of the customer and to monitor the credit after the loan is granted.

Second, the bank as intermediary transforms short-duration liabilities (i.e., deposits) into longer-duration assets (e.g., loans) with varying features: fixed or variable interest rate, secured (i.e., with collateral) or unsecured, with embedded options or options-free. This creates a potentially complex balance-sheet risk structure and can lead to liquidity risk. To mitigate this problem, banks must conduct optimal asset-liability risk management, which is the subject of Chapter 2.

Before we end this chapter, we note that there is also an asymmetric information relationship between bank managers and depositors. Depositors' funds are placed at risk and banks create risky assets from these liabilities. Bank managers may be engaged in excessive risk-taking without the knowledge of depositors – a classic moral hazard problem because this action by managers is hidden from depositors. This is one justification for deposit insurance. This insurance guarantees the return of deposits (typically without interest income) to depositors in case there is a run on the bank. This insurance is normally provided by a government agency (e.g., Federal Deposit Insurance Corporation (FDIC) in the US) and so depositors can avoid this moral hazard problem (to an extent) at the expense of the provider of the deposit insurance, which is ultimately, the taxpayer.

As we have indicated in this Introduction, the bank, in its intermediation and transformational roles, faces several sources of risk. These risks are assumed mainly on the asset side of the balance sheet. But the consequences of risk-taking on the asset side can be transmitted to the liability side. In particular, wholesale funding and interbank funding may dry up – even before the depositors become anxious and create the potential for a bank run.

In summary, this Introduction shows that the bank-based system of financial intermediation reduces the high level of information asymmetry that is likely to exist in the market-based system. The bank-based system places the issues related to adverse selection and moral hazard squarely on the shoulders of bank managers. Furthermore, the process of transformation of short duration liabilities into longer duration assets (in the banking book) creates risks for the bank.

The rest of this module is organised as follows. In Chapter 1, we consider the Basel capital accords that set out new requirements for capital to buffer unexpected losses caused by the bank taking on risks in its balance sheet. Basel III also sets out new leverage and liquidity standards.

RETAIL BANKING II

Chapter 2 considers the fundamental issues in balance sheet management in terms of duration analysis and its impact on the bank's equity. Typical bank treasury functions that include liquidity management and securitisation are described with capital allocation for securitised assets explained. This module concludes with a summary and multiple choice questions.

Chapter 1:

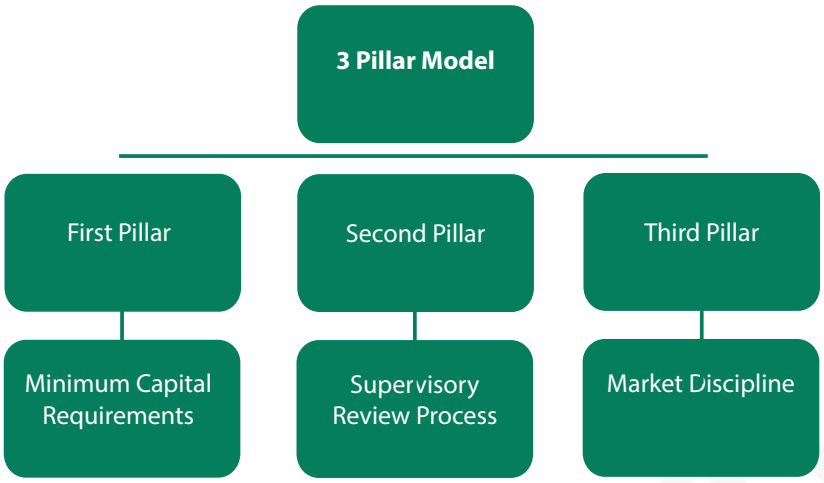
Basel Capital Accords

Let us review a brief history of the Bank of International Settlements (BIS) ending with the development of the Basel III capital accord. BIS was established in 1930 as part of the Young Plan that dealt with the reparation payments imposed on Germany as part of the Treaty of Versailles following the end of the First World War. BIS holds regular meetings of central bank governors in Basel, Switzerland, with a view to achieving monetary and financial stability. The Basel Committee on Bank Supervision (BCBS) was established in 1974 by central bank governors of the Group of Ten (actually 11 countries). Both the BIS and BCBS formed the Financial Stability Institute that has evolved into the Financial Stability Board (FSB), which "has been established to coordinate at the international level the work of national financial authorities and international standard-setting bodies and to develop and promote the implementation of effective regulatory, supervisory and other financial sector policies. It brings together national authorities responsible for financial stability in significant international financial centres, international financial institutions, sector-specific international groupings of regulators and supervisors, and committees of central bank experts."*

In January 1999, BCBS proposed the Basel II accord and it was initially introduced in June 2004† with the objective of guaranteeing a sound financial system. Specifically, an important objective is to ensure, insofar as possible, that banks are adequately capitalised with a robust risk management process. The 'Three Pillar Model' is the avenue to achieve this key objective. This model is stated as follows:

* Source: FSB website.

† Basel II: International Convergence of Capital Measurement and Capital Standards: a Revised Frame work, (June 2004).



208.1: The Three Pillar Model of Basel II

For credit risk, banks have three approaches for the calculation of minimum capital requirements. These are a) the Standardised approach, b) the Foundation Internal Ratings Based (FIRB) approach and c) the Advanced Internal Ratings Based (AIRB) approach. Banks, with the approval of their supervisor may choose either FIRB or AIRB where these approaches are based on the bank's internal assessment of their credit exposures.

In the FIRB approach, banks – with the approval of regulators – can develop probability of default models that provide in-house risk weightings for their loan books. Regulators provide the other 'assumptions' in these models, namely the loss given default, the exposure at default and the maturity risk of each type of asset.

The second internal rating-based approach, Advanced IRB, is essentially the same as Foundation IRB, except for one important difference: the banks themselves – rather than regulators – determine the assumptions of proprietary credit-default models. Therefore, only the largest banks with the most expertise and complex models can use this standard.

The standardised approach is usually chosen by banks with simple credit risk exposures and it is formula-driven.

In this module, we present only the standardised approach for all three main Basel risk categories. The corresponding IRB approaches are presented in Module 209.

The key principle underlying the standardised approach is as follows:

Key Principle

The bank's credit exposures are placed in categories where each category is assigned a risk weight.

Risk Weights convert the bank's Risk Exposures in each category into Capital Requirements.

The formula is as follows: Capital Requirement = (Risk Weight * Exposure * 8%) summed over all exposures.

This example concerns the risk weights for each risk category as defined by the credit rating of the sovereign. In this case, there are five categories of sovereign risk as defined by their credit rating. It is important to note that the risk weight is determined by the category of the borrower – sovereign or corporate or bank.

Below is an example of the fixed risk weights for sovereign debt – that is, the bank lends to a government with a debt rating that falls into one of the following categories. For example if a bank has all its sovereign exposures in the rating category, AAA to AA-, then the risk weight is zero and the capital requirement for this credit exposure is zero.

Sovereign debt rating	**Sovereign risk weight**
AAA to AA-	0%
A+ to A-	20%
BBB+ to BBB-	50%
BB+ to B-	100%
Below B-	150%
Unrated	100%

Comment

***a)* If a borrower is rated by two rating agencies, the bank (as lender) will choose the higher risk weight;**

***b)* If a borrower is rated by three or more rating agencies, the bank (as lender) will choose the higher of the two lowest risk weights;**

***c)* If a borrower is not externally rated, the applicable risk weight is 100%.**

Here is an example for corporate debt that is given a credit rating by, for example, Standard & Poor's credit rating agency. As shown in the table below, rated corporate exposures will be assigned to one of five risk buckets or categories (20 percent, 50 percent, 100 percent and 150 percent) depending on their external rating.

Corporate debt rating	**Corporate risk weight**
AAA to AA-	20%
A+ to A-	50%
BBB+ to BB-	100%
Below BB-	150%
Unrated	100%

Note that supervisory authorities may permit banks to risk-weight all corporate claims at 100 percent without regard to external ratings.

The risk weights for claims on banks are based on the sovereign ratings of the respective country. Here is an illustration:*

Risk Weight for Claims of Banks in Country A						
Sovereign rating for Country A	AAA to AA-	A+ to A-	BBB+ to BBB-	BB+ to B-	Below B-	Unrated
Bank debt	20%	50%	100%	100%	150%	100%

* This is the so-called Option 1. Option 2 is based on the external rating of the bank itself.

Open Question #1

Do you see a problem where the risk weights for claims on banks are dependent on the sovereign risk rating of the country?

Discuss.

So how do we calculate the minimum credit risk capital using the standardised approach? Here is an example of a simple bank loan book.

Suppose the bank holds $2m in US Treasury Bonds with zero risk weight; $100m in loans to small- and medium-sized businesses with 100 percent risk weight and $50m in residential mortgages with a risk weight of 35 percent. Then the risk-weighted assets (RWA) of the bank are:

*$2m * 0 + $100 m * 1.0 + $50m * 0.35 = $0 + $100m + $17.5m = $117.5m.*

So minimum regulatory total capital = *8% * RWA = 0.08 * $117.5m = $9.4m.*

From a retail banking perspective, it is important to highlight the risk weights for common retail banking elements. Here is a sample for common retail banking products. Note that the exposure is to a person or persons or to a small business.

Retail Exposures	Risk Weight
Credit cards, lines of credit, overdraft, instalment loans, auto loans and leases, student loans, education loans, personal finance, small business facilities. **Note:** ***a)*** bonds and equities are excluded here; ***b)*** constraints on concentration risk e.g., maximum monetary value of all exposures to a single counterparty must be limited to a maximum of €1 million; the maximum total exposure to a single counterparty must not exceed 0.2% of the total value of the retail portfolio	75%
Lending that is secured by residential assets (whether occupied by the borrower or will be rented)	35%
Lending that is secured by commercial real estate	100%

Finally, we summarise those credit exposures that have risk weights of 150% by perusing the tables listed above.

Exposures with Risk Weights of 150%
1. Sovereign exposure with rating below B-
2. Bank exposure (option 1) with rating below B-
3. Corporate exposure with rating below BB-
4. Past due loans by more than 90 days
5. Note that asset securitisation may lead to 150% or more risk weights. This is considered in Chapter 2.

Market Risk

Banks typically measure market risk in their portfolios by a measure called Value at Risk (VaR).

VaR estimates the predicted loss at a specified level of confidence (e.g., 99 percent) over a given period (e.g., one day). So if a one-day VaR level is $10m, there is a 99 percent chance that the bank's portfolio will lose less than $10m the next day.

Note that VaR does not describe the worst-case loss – only the worst-case loss for a given level of confidence.

It can be shown that an n-day 99% VaR = √n * 99% 1-day VaR.

This means that if you calculate the 1-day VaR = $5m, then the 10-day 99% VaR = √10 * $5m† = $15.81m.

As shown in the footnote, Rahman and Samir have found that this procedure of deducing the 10-day VaR – as recommended by BCBS – is biased and may be unsuitable for estimating market risk in banks' investment portfolios.

Value at Risk approaches are considered in extensive detail in Module 209.

Operational Risk

The Basel II Committee has allowed a degree of flexibility in the way banks allocate capital for operational risk. There are three different approaches:

1) The basic indicator approach (BIA)

2) The standardised approach (SA) and

3) The advanced measurement approach (AMA)

As we go from BIA to SA to AMA, the approach is more sophisticated, more flexible and hence more costly to implement. The BIA is described as follows:

Basic Indicator Approach

This approach is simple to implement and probably does not properly measure operational risk – likely only indirectly.

> The bank's required operational risk capital = alpha * (average gross income of the three previous years where in calculating this average, adjustments are made to both the numerator and denominator for negative and zero values).

Alpha = 15 percent is a fixed percentage set by BCBS. Also if the bank earned zero or negative gross income for a particular year, the sample value is omitted from the denominator and numerator.

So if the average three-year gross income for a bank (assuming all positive values) is $50m, the capital that will be allocated for operational risk is 15% * $50m = $7.5m.

† This method is called the 'square root of time' formula and is the method recommended by banking supervisors (see the Basel Committee on Banking Supervision, 1996), and is widely used throughout the financial industry. But VaR has not just found prominence via the external Basel regulations, it has effectively become a cornerstone of internal risk-management systems in financial institutions, following the success of the JP Morgan Risk Metrics system. But Rahman and Samir have shown that this method is biased. See "Evidence of Non-Stationary Bias in Scaling by Square Root of Time: Implications for Value-at-Risk", *Journal of International Financial Markets, Institutions and Money*, Vol 18, No 3, (2008).

The main problem with the BAI is that it assumes that the bank with a higher average of gross income will experience higher operational risk – in a fixed proportional manner. This can be misleading since operational risks depend on the type of business that a bank engages in. A bank may have a relatively lower average of gross income and yet have a relatively higher level of operational risk.

The Standardised Approach

The standardised approach is similar to the BIA, except that SA deals with lines of business rather than the bank's gross revenue as a whole. The standard approach recognises that operational risk varies by business unit.

Here is a table of beta factors for each line of business:

Business unit	Beta factor (fixed percentage)
Corporate finance	18%
Payment and settlement	18%
Trading and sales	18%
Agency services	15%
Commercial banking	15%
Asset management	12%
Retail banking	12%
Retail brokerage	12%

The Advanced Measurement Approach

The third approach is the Advanced Measurement Approach (AMA), which is highly mathematical and sophisticated and is accordingly subject to rigorous supervision. Clearly, this is a more realistic approach to estimating the actual operational risk but the mathematical complexity could be opaque. A test of the appropriateness of the model chosen by the bank is a test of credibility. This is where the supervisor will compare operational capital requirements with peer banks using similar models.

This approach is considered in relatively greater detail in Module 209.

We now consider the new capital accord, Basel III.

Basel III in a Nutshell

Prior to Basel III, banks were required to hold a capital reserve ratio of two percent in different types of equity. This number has been increased to a total Core Tier I ratio of seven per cent.*†‡

- Basel III substantially raises the quality and quantity of capital, with a much greater focus on common equity, the highest-quality component of a bank's capital.

- Core Tier 1 capital is, from a regulator's point of view, a measure of a bank's financial strength primarily composed of common stock and retained earnings.

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* Basel III and beyond, Remarks of Nout Wellink, Chairman, Basel Committee on Banking Supervision, President, De Nederlandsche Bank, Kuala Lumpur, Malaysia, (17 January 2011).

† 'Basel III: Towards a Safer Financial System', speech by Mr Jaime Caruana, General Manager of the Bank for International Settlements, Madrid, (15 September 2010).

‡ Basel III – Financial Risk, Hugo Nordell, (November 2010).

- According to Basel III, the final requirements for common equity and tier 1 capital will be 4.5 percent and six percent respectively, beginning in 2015.

- The requirement to keep a minimum reserve buffer of 2.5 percent so as to be able to withstand future periods of stress will bring the total common equity requirements to seven percent.

- Capital buffers help protect the banking sector against credit bubbles and can be drawn down during times of stress. This could also help moderate upward pressure on real estate prices, for example, which in parts of Asia are a mounting concern.

Basel III also introduces a new countercyclical capital buffer composed of common equity in the range of zero to 2.5 percent of total capital.

The main purpose of this buffer is to provide a countervailing force to credit bubbles. If regulators see signs of a credit bubble they can levy a countercyclical buffer of up to 2.5 percent of assets, which will be made up of common stock or some other equally loss-absorbing instruments. Under national supervisory discretion, these buffers potentially add to the complexity of cross-border operations. This means that the actual percentage values will be set in accordance with national circumstances and will only be in effect during times of excessive credit growth and a build-up of systemic risk. There will be a progressive phase-in, starting in January 2016, and it won't be fully effective until January 2019.

We summarise the main proposals for capital ratios in Basel III.

	Common equity ratio (after deductions)	Tier 1 capital ratio	Total capital ratio
Minimum	4.5%	6.0%	8.0%
Conservation buffer	2.5%		
Minimum + conservation buffer	7.0%	8.5%	10.5%
Countercyclical range	0-2.5%		

Liquidity

Liquidity is at the heart of the BCBS's analysis of regulatory failings. The importance of liquidity management in banks cannot be overestimated. Here is an excerpt of a report from *Lafferty Retail Banking Insider:*

> A key characteristic of the financial crisis was the inaccurate and ineffective management of liquidity risk. As a result, international banks are under regulatory pressure to demonstrate they have a clear strategy in terms of liquidity risk management, with much attention being given to Spain's countercyclical provisioning model.
>
> Proposals published by the Basel Committee in December 2009 aimed at strengthening global capital and liquidity regulation are likely to significantly affect banks worldwide, and a fully calibrated set of standards is expected to be phased in.
>
> The proposals include the introduction of a global minimum-liquidity standard for internationally active banks that includes a 30-day liquidity-coverage-ratio requirement underpinned by a longer-term structural liquidity ratio. The framework also includes a common set of monitoring metrics to assist supervisors in identifying and analysing liquidity risk trends at both the bank and system-wide level.

Here are the two liquidity ratios aimed at forcing banks to hold more liquid and higher quality assets: the liquidity coverage ratio (LCR), which is a short-term measure, and the net stable funding ratio (NSFR).

Liquidity Coverage Ratio (BCBS Consultative Document, 16 April 2010)

Objective
This metric aims to ensure that a bank maintains an adequate level of unencumbered, high-quality assets that can be converted into cash to meet its liquidity needs for a 30-day time horizon under an acute liquidity-stress scenario specified by supervisors. At a minimum, the stock of liquid assets should enable the bank to survive until day 30 of the proposed stress scenario, by which time it is assumed that appropriate actions can be taken by management and/or supervisors, and/or the bank can be unwound in an orderly way.

Eligible assets include two levels:

- Level 1 assets comprising cash, central bank reserves and high-quality government debt.
- Level 2 assets include high-quality (AA- and better) corporate and covered bonds. Level 2 assets are subject to 15 percent haircuts and limited to 40 percent of LCR eligible liquid assets.

Asset-backed securities (ABS) are excluded from LCR, making them less attractive for banks – especially versus covered bonds. LCR = (stock of high-quality liquid assets) divided by (net cash outflows over a 30-day time period) ≥ 100 percent.

Total net cash outflows

The denominator of the LCR is total net cash outflows. It is defined as total expected cash outflows, minus total expected cash inflows, in the specified stress scenario for the subsequent 30 calendar days. Total expected cash outflows are calculated by multiplying the outstanding balances of various categories or types of liabilities and off-balance sheet commitments by the rates at which they are expected to run off or be drawn down. Total expected cash inflows are calculated by multiplying the outstanding balances of various categories of contractual receivables by the rates at which they are expected to flow in. Total cash inflows are subject to an aggregate cap of 75 percent of total expected cash outflows, thereby ensuring a minimum level of high-quality liquid assets holdings at all times.

LCR Update

Level 2 assets are divided into two classes – level 2A and level 2B. The original level 2 class (see box above) are now called level 2A. The new class (level 2B) include certain residential mortgage –backed securities (RMBS) rated AA or higher but subject to 25 percent haircut); corporate bonds that do not* meet level 2A requirements but which have external ratings from A+ to and including BBB- which are subject to 50 percent haircut and certain equities which are subject to 50 percent haircut. These Level 2B assets cannot be more than 15 percent of the total high-quality liquid assets (HQLA); they are also part of the 40 percent cap on total level 2 assets.

Finally, there have been changes in the calculation of net cash flows (in the denominator of the LCR ratio). For example, fully insured (i.e., stable) deposits now have a run-off rate of three percent instead of the previous five percent.

Finally, there is a new planned graduated introduction of LCR requirements. The following table shows that the LCR will be introduced as planned on 1 January 2015, but the minimum requirement will be set at 60 percent and will rise in equal annual steps to reach 100 percent on 1 January 2019.

* Basel III – Financial Risk, Hugo Nordell, (November 2010).

Date	1 January 2015	I January 2016	1 January 2017	1 January 2018	1 January 2019
Minimum LCR	60%	70%	80%	90%	100%

The other liquidity ratio is the net stable funding ratio (NSFR).

Net Stable Funding Ratio

The net stable funding ratio (NSFR) measures the amount of longer-term, stable sources of funding employed by an institution relative to the liquidity profiles of the assets funded and the potential for contingent calls on funding liquidity arising from off-balance sheet commitments and obligations. The standard requires a minimum amount of funding that is expected to be stable over a one-year time horizon, based on liquidity risk factors assigned to assets and off-balance sheet liquidity exposures. The NSFR is intended to promote longer-term structural funding of banks' balance sheets, off-balance sheet exposures and capital markets activities.

The objective is to create an incentive for a bank to fund illiquid assets with stable funding.

NSFR = (available amount of stable funding) divided by (required amount of stable funding) ≥ 100 percent.

The required amount of stable funding is calculated as the sum of the value of the assets held and funded by the institution, multiplied by a specific required stable funding (RSF) factor assigned to each particular asset type, added to the amount of off-balance sheet(OBS) activity (or potential liquidity exposure) multiplied by its associated RSF factor. The RSF factor applied to the reported values of each asset or OBS exposure is the amount of that item that supervisors believe should be supported with stable funding. Assets that are more liquid and more readily available to act as a source of extended liquidity in the stressed environment identified above receive lower RSF factors (and require less stable funding) than assets considered less liquid in such circumstances and which, therefore, require more stable funding.

Basel III also introduced a leverage constraint.

Open Question #2

What are the implications of Basel III for the bank's profitability?

Discuss.

Leverage

The new minimum gross leverage ratio (i.e., a ratio of Tier 1 capital to non-risk-weighted assets) of three percent is not scheduled to be binding until 2018. A leverage ratio of three percent of Tier 1 is to be tried before a mandatory leverage ratio is introduced in January 2018.

Note that a leverage ratio of three percent means that (by inverting the ratio) banks may create assets up to 33 times Tier 1 capital.

Objectives:

1. Put a floor under the build-up of leverage in the banking sector.

2. Introduce additional safeguards against model risk and measurement error by supplementing the risk-based measure with a simpler measure that is based on gross exposures. This may

prove a more important constraint for many banks, depending on how particular assets – for instance securitisations – are captured. There are objections to the proposed leverage ratio in that it is not based on risk-weighted assets.

The governor of the Reserve Bank of New Zealand today blasted the leverage ratio required under Basel III as 'not credible'.

In a speech detailing policy instruments under the accord, Alan Bollard admitted the ratio is an area where the central bank was 'likely to adapt' aspects of the standard. The requirements detail that banks must hold a leverage ratio of three percent. However, Bollard argued that because this system is not risk-based, the ratio would be redundant.

New Zealand is not a member of the G20 group orchestrating the changes, which means it will not have to comply with full Basel III requirements.

"With regard to the Basel III leverage ratio, it is not risk-based, so it can give a misleading picture of risk, and a single leverage ratio implies that one size fits all banks, which is not credible," he told the audience in Sydney, Australia.

Source: Global Financial Strategy News, 25 March 2011, <www.gfsnews.com/article/1449/1/>

Chapter 2:

Interest-Rate Sensitivity in the Balance Sheet of a Retail Bank

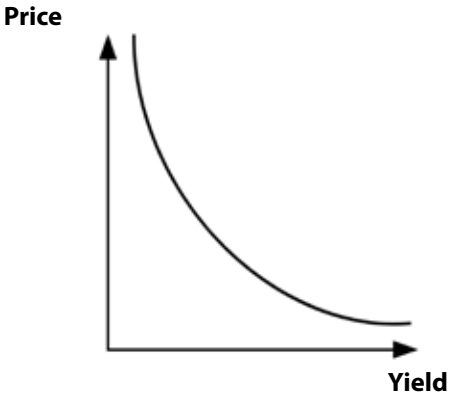
In this chapter, we develop some fundamental understanding of bond dynamics and the role of interest rate sensitivity. This will bring us to a consideration of an important treasury function, asset-liability management (ALM). The role of interest rate risk is significant.

Interest-rate risk is present in both the banking book and the trading book of the bank. This is the risk of an unexpected change in the value of the bank's portfolio due to an unexpected change in interest rates. An unexpected change in interest rates is one of the most important sources of market risk in that it affects the price of bonds (assets for the bank), share prices, estate prices, exchange rates through the interest rate parity (IRP) relationship. Clearly, it also affects the price that the bank must pay for deposits.

It is typical for banks to have interest-rate-sensitive liabilities and interest-rate-sensitive assets. In fact, as we know from Retail Banking I, net interest margin and net interest spread are both indicators of bank profitability, and net interest margin is the dominant proportion of a retail bank's income. To get a full picture of the bank's balance sheet interest-rate sensitivity, we must understand the concept of duration.

Macaulay Duration

The Macaulay duration is a measure of the interest-rate risk in a debt instrument such as a bond. We know that bond yields and bond prices move in opposite directions, all else being equal - they are negatively correlated. But the relationship being negative is not linear. Actually it is convex. Here is a graph of this relationship.



208.2: Relationship between bond yields and bond prices

The inverse relationship between the price of a bond and the yield of the bond is clear. But we are looking for the answer to the following question: if the yield of the bond increases by one basis point, we know that the price of the bond will likely fall, but the question is, by how many basis points?

The answer is determined by the slope of the graph shown above. The slope of this curve is called the Macaulay duration.

In this sense, the Macaulay duration is a measure of interest-rate risk in the bond. The higher the value of the Macaulay duration, the higher the interest-rate risk.

There are some important properties of the Macaulay duration.

a. The Macaulay duration of a zero-coupon bond is equal to its term to maturity. So a 10-year zero coupon bond has a Macaulay duration of 10 years.

b. All else being equal, a bond with a higher coupon rate has a lower Macaulay duration. So consider the following two bonds:

Bond A: *10-year 3 percent coupon bond yielding 5 percent*

Bond B: *10-year 7 percent coupon bond yielding 5 percent*

Bond B has a lower Macaulay duration and hence lower interest-rate risk

c. All else being equal, a bond with a lower yield will have a higher Macaulay duration and hence will have higher interest-rate risk.

Consider the following two bonds:

Bond C: *10-year 3 percent coupon bond yielding 4 percent*

Bond D: *10-year 3 percent coupon bond yielding 5 percent*

Bond C has a lower yield and so a higher Macaulay duration, and hence a higher interest-rate risk.

d. All else being equal, a bond with a longer term to maturity will have a higher McCaulay duration.

Consider the following two bonds:

Bond E: *10-year 3 percent coupon bond yielding 6 percent*

Bond F: *15-year 3 percent coupon bond yielding 6 percent*

Bond F has a higher interest-rate risk since it has a higher Macaulay duration. We can now summarise these relationships about Macaulay duration.

The bond with the highest level of interest-rate risk is the bond with the highest Macaulay duration, which – according to the relationships stated above – is the bond with the longer term to maturity, lower coupon rate and lower yield.

We conclude this section on duration with a slightly different version – the modified duration. This is the version that is used by professionals. It is calculated as follows:

Modified duration = Macaulay duration / (1+ yield). Here is an example:

Consider a six-year zero-coupon bond yielding five percent. We know that the Macaulay duration is six years. Hence the modified duration is six years / (1+.05) = 5.71 years.

We now come to our main result:

If interest rates (or yields) are expected to change by one basis point, then the price of the bond is expected to change in the opposite direction (in basis points) by the value of the modified duration (MD).

Stated in a formula: $\Delta\%P = -MD * \Delta r$ where r = interest rate.

Note that when we use the Macaulay duration instead, we obtain the following formula:

$\Delta\%P = -\frac{DUR}{1+r} \times \Delta r$ where DUR = Macaulay duration.

Going back to our example, we see that the modified duration is 5.71 years. So if it is forecast that interest rates will increase by one basis point, then the value of the bond is expected to fall by 5.71 basis points.

This information on bond dynamics allows us an understanding of a key treasury function: ALM.

Treasury Functions

Asset Liability Management (ALM) is a core treasury function. ALM in banking is best described as the function that manages risks related to changes in interest rates, the mix of assets and liabilities on the retail bank's balance sheet. Treasury also manages liquidity requirements and capital adequacy, as well as the optimal holding of foreign currencies and the use of derivatives. Optimal treasury functions also have a positive impact on the bank's earnings. The general definition of treasury management leads to four main sub-categories:

- Interest rate management
- Liquidity management
- Capital management
- Foreign exchange management
- Cash market instruments (bills, bonds)
- Derivatives instruments (swaps, futures, forwards, options)

Interest rate risk has important effects on the bank's operations. Interest rate risk is defined as the

exposure of a bank's financial condition to adverse movements in interest changes. Clearly, there could be negative effects on the retail bank's net interest margins (income statement effect) as well as impacts on the present values of cash flows from the bank's assets and liabilities (balance sheet effect). Both these effects can have important effects on the bank's capital base.

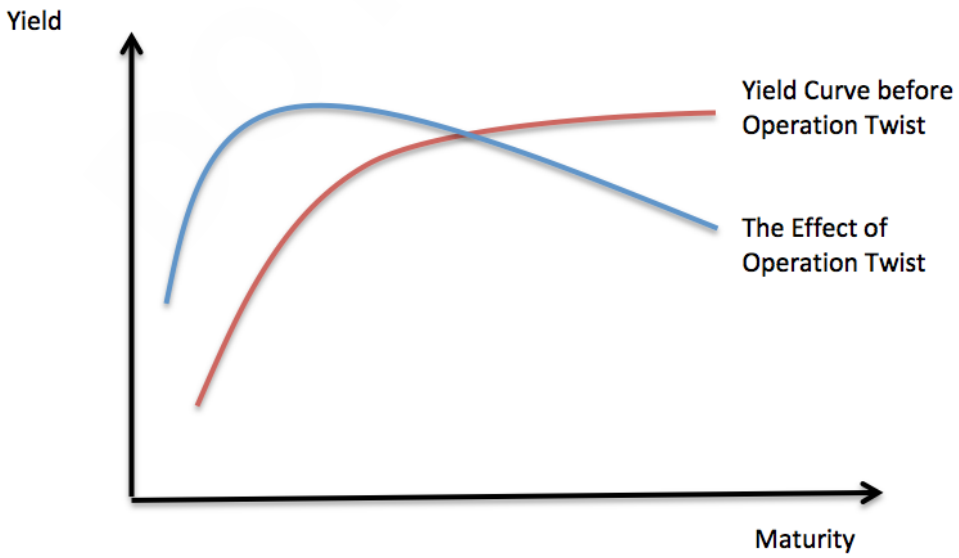
The sources of interest rate risk are as follows:

Re-pricing risk

Consider the case where a bank funds a long-term fixed rate with short-term deposit. Since interest paid on the deposit is variable, an increase in interest rates would lead to a higher cost of funding but the cash flows that the bank earns on the loan would be unchanged. This negatively affects the bank's net interest result. For example, if the bank funds a 3-year fixed rate loan that is priced at a rate of 5% with a retail deposit that pays 3%, then the gross interest margin is 2%. The retail deposit is priced at the national bank rate. Suppose that the bank rate is increased by 50 basis points; then deposits will be re-priced by up to 50 basis points higher while the loan rate is unchanged. Hence, the net interest result will be negatively affected and could decline to 1.5%. This 're-pricing mismatch' can also lead to liquidity risk. There is also a risk to the underlying value of the bank's equity since the higher duration assets are more interest rate sensitive than the lower duration liabilities. Clearly, re-pricing risk affects underlying balance sheet value as well as the timing of cash flows.

Yield curve risk

This risk arises when the bank is exposed to unanticipated changes in the shape and slope of the yield curve. Recall that the calculation of duration assumes only parallel shifts in the yield curve. To illustrate how this risk affects the profitability of banks, consider a policy implemented by the U.S. Federal Reserve (Fed) called 'Operation Twist.' In this programme, the Fed sold short-term bonds and bought long-term bonds. By purchasing long-term bonds, the excess demand drives up bond prices and so lowers bond yields. Similarly, by selling short-term bonds, prices will fall and yields rise. We show the effect on the yield curve below:



208.3: Yields and 'Operation Twist'

Operation Twist has caused short-term yields to rise and long-term yields to fall. The yield has changed shape and slope and experienced a non-parallel shift. Since banks typically issue fixed rate loans that are funded by short-term liabilities (e.g., deposits), the effect is to reduce the net interest income the bank earns.

Basis Risk

Basis risk in ALM arises when changes in interest result in the re-pricing of interest-earning assets that are different from the re-pricing of interest-bearing liabilities. This results in an imperfect correlation in the adjustment of assets and liabilities to changes in interest rates. This creates an asset-liability mismatch*. Basis risk is also called 'spread risk'. As an illustration, suppose that a bank lends at the prime rate and borrows at the LIBOR rate. Assume that the historical spread between the Prime rate and LIBOR is 100 basis points. Suppose that the spread unexpectedly narrowed. Then the bank incurs basis risk or spread risk.

Optionality risk

Banks typically issue fixed-rate mortgages on residential property giving the borrower an option to prepay the mortgage without penalty†. For these mortgages, if interest rates fall sufficiently, the option to prepay increases in value and the borrower may exercise his/her right. Optionality risk refers to the uncertain exercise of the option by the owner, resulting in higher variability of cash flows attached to the underlying instrument. In the case of the mortgage, it is uncertain whether the mortgage holder will prepay. This leads to higher uncertainty for the lender with respect to the expected cash flows attached to the mortgage.

Example

Based on the duration concept, we can now assess the interest-rate sensitivity of the bank's bond portfolio. Let's begin with a simple example.

Suppose that the Macaulay duration of the bank assets is five years and the Macaulay duration for the bank's liabilities is 4.5 years. We clearly have a mismatch of duration between assets and liabilities. If interest rates rise, the market value of assets will likely fall faster than the market value of liabilities and the bank's equity - which is the difference between the bank's assets and its liabilities - will likely fall in value. Suppose that interest rates are expected to increase by 25 basis points from its current value of five percent, we would like to know the expected percentage change on the current market value of the bank's equity.

Assume that the market value of assets is $300m and the market value of interest-sensitive liabilities is $290m. Equity is $10 million. Then we see that for an expected 25 basis points increase in interest rates, assets will likely fall by 5 X $300 m *(0.0025/(1.05)) = $3.57m and the liabilities will also likely fall by 4.5 X$290 m X (0.0025/1.05) = $3.11m

But then equity is expected to decline by $0.46 m. As a percentage of equity, this decline is $0.46m / $10m = 4.6%.

We can get this result if we use the following formula:

$$Duration\ (Equity) = \frac{Assets}{Equity} * Duration\ (Assets) - \frac{Liabilities}{Equity} * Duration\ (Liabilities)$$

Since assets = $300m and liabilities = $290m, then equity = $10m. Also the duration of the assets = five years and the duration of the liabilities = 4.5 years. Entering these values into the above equation gives the duration of the bank's equity as 19.5 years. So if interest rates are expected to rise by 25 basis points, then the effect on the equity value is equal to 19.5 *(0.0025/1.05) = 4.6% as shown above.

This leads to the concept of duration gap.‡

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* In the hedging literature, basis risk refers to the imperfect correlation between changes in the underlying asset and the hedging instrument.

† Some banks do specify some penalty for prepayment.

‡ Maturity Gap Analysis is considered in Module 210 on Financial Management.

The duration gap between the interest-sensitive asset side and interest-sensitive liability side of a bank portfolio is given by the formula:

$$DUR_{Gap} = DUR_A - \left(\frac{L}{A}\right) \times DUR_L$$

where L = market value of Liabilities, A = market value of assets; DUR_A = average duration of assets; DUR_L = average duration of liabilities.

Using the values from example, we see that $DUR_{Gap} = 5.0 - \frac{\$290m}{\$300m} \times 4.5 = 0.65$

But we see that the formula for the duration gap is related to the formula for the duration of equity that is presented above. Specifically,

$$DUR_{Equity} = \frac{Asset}{Equity} \times DUR_{Gap}$$

So the duration of equity = ($300 m / $10 m) X 0.65 = 19.5, the same value obtained above.

Note that advanced techniques in ALM and other treasury functions are considered in the Retail Banking III module titled Risk and Capital Management. We have already seen another important role of the bank treasury – funds transfer pricing (FTP) in the module on Performance Management.

In the spirit of this module's objective in dealing with standardised capital allocation method, we conclude this section by considering the standardised risk weights for securitised products as proposed by the Basel Accords.

Securitisation

Securitisation is the process of grouping together debt obligations into a pool in a special purpose vehicle (SPV); dividing the pool into smaller units, which are then sold to investors as securities. In Module 102, it is shown how a pool of residential mortgages are packaged and sold as residential mortgage-backed securities (RMBS). This process is sometimes called 'originate to distribute' as opposed to 'originate and hold' where, in the latter case, the bank creates the asset and holds to maturity.

The main objective of securitisation by a bank is to create additional liquidity, a point that is recognised by BCBS for certain RMBS for inclusion in level 2B assets in the calculation of LCR. They are, however, subject to relatively higher risk weights in the standardised approach. The general rule is as follows: If a bank retains or acquires a position in a securitisation or has an off-balance sheet position in a securitisation, it is required to hold capital against these interests. The risk weights that correspond to external ratings are as follows:

External Rating	AAA to AA-	A+ to A-	BBB+ to BBB -	BB+ to BB- (Investors only)
Risk Weights	20%	50%	100%	350%

For external ratings below B+, the entire asset amount is deducted from capital. This is also the case for an unrated interest.

Summary

This module dealt with issues of adverse selection and moral hazard that arise from the typical financial intermediation process. There was also a discussion of the capital allocation process (standardised approach) that is required under Basel III. We considered the risk weights for credit, operational and market risk as well as for securitised assets. We also introduced the fundamental properties of Macaulay duration, which is a measure of interest rate risk. The impact of interest rate risk on the bank's equity is conducted through a duration gap analysis. The implication for a bank's profitability while meeting the requirement of more and higher quality capital for the same level of risk, maximum asset-to-capital ratio (leverage ratio) as well as new liquidity standards were also highlighted.

Multiple Choice Questions

1. Suppose that your bank calculates a 1-day 99 percent VaR = $30 million for its investment portfolio. The equivalent 10-day 99 percent VaR for this portfolio is closest to:

a) $30 million
b) $300 million
c) $90 million
d) $95 million

2. Which bond has the highest interest rate risk?

a) 10-year 3 percent coupon bond yielding 5 percent
b) 10-year 3 percent coupon bond yielding 7 percent
c) 10-year zero-coupon bond yielding 5 percent
d) 10-year zero-coupon bond yielding 3 percent

3. A bank has an investment bond portfolio where the Macaulay duration is four years and the portfolio yield is 5 per cent. Suppose that the interest rate is expected to fall by one basis point, what is the expected percentage change in the bank's portfolio?

a) 4 basis points
b) 3.81 basis points
c) 3.29 basis points
d) 5 basis points

4. The risk that arises from mismatches in maturity and interest rate changes in a bank's assets and liabilities is called:

a) Repricing risk
b) Yield-curve risk
c) Basis risk
d) Options risk

5. Asset liability management is not directly concerned with:

a) Interest rate risk management
b) Capital management
c) Liquidity management
d) Securitisation

6. Which action is most identified with the concept of moral hazard?

a) Borrower taking on more unsecured loans than was expected by the first lender
b) Borrower did not reveal the full extent of private borrowing from family members to the loan officer
c) Lender not requiring full financial information as in subprime lending
d) Lender refusing to grant the loan

7. Which statement is incorrect?

a) Banks typically measure market exposure by Value at Risk (VaR)
b) If a one-day VaR is equal to $5 million, then a 10-day VaR is equal to $50 million
c) If a one-day VaR is equal to $5 million, then there is a 95 percent chance that the bank will lose less than $5 million the next day
d) VaR describes the worst-case loss for a given level of confidence

8. Suppose that the three-year average income for a retail bank is $500 million, then according to the basic indicator approach (BIA), the capital required for operational risk for this bank is:

a) $75 million
b) $90 million
c) $36 million
d) $50 million

9. A retail bank's balance sheet shows that assets = $50 billion; liabilities = $40 billion; average asset duration = 4.5 years and average liability duration = 4 years. Then the equity duration is:

a) 0.5 years
b) 4.5 years
c) 6.5 years
d) 6.2 years

10. Which of the following statements is incorrect?

a) Leverage ratio is based on non-risk-weighted assets
b) Basel II requires a minimum total capital ratio of 8 percent
c) Core Tier 1 capital comprises equity, retained earnings and some high-quality hybrids
d) The minimum Tier 1 capital ratio is 6 percent

Answers

1	2	3	4	5	6	7	8	9	10
d	d	b	a	d	a	b	a	c	c