ASSET LIABILITY MANAGEMENT
Significance and Basic Methods

Dr Philip Symes
Introduction

- Asset liability management (ALM) is the management of financial assets by a company to make returns.
- ALM is necessary to maximise return on capital and deal with competition and risks
- A bankers job is to strike the right balance of risk and returns
  - Need to watch out for regulatory constraints

Liquidity
Safety

Profitability
Competitiveness
Contents

- The role of banks
- Risk management for ALM
- Interest rate methods
- Price sensitivities
- Gap management
- Use of swaps, caps and floors in ALM
Role of Banks

- Bank’s own capital provides the liquidity cushion between deposits and loans
- Disintermediation: withdrawal of funds from banks to invest directly

Diagram:

```
Banks

Funds borrowed by those who have a deficit

A

L

E

Direct

Funds saved by those who have a surplus
```
This example shows how banks generate a return on an equity:

- **Interest rates**
- **Gross margin**
  - lending rate
  - borrowing rate
- **Operating cost**
- **Asset utilisation**
  - revenue/assets
- **Net margin**
  - net income/revenue
- **Return on assets**
  - net income/assets
- **Financial Leverage**
  - assets/equity
- **Return on equity**
  - net income/equity
Return on Equity Example

simple example:

- Current LIBOR = 10%
- T2 cost = 10.75%
- **Bank** borrows at 12.5 bps above LIBOR
- Bank lends at 11.40%
- General expenses = 50bps

Revenue and expenses:

- Assets = 100;
- Time period = 1 yr.
- Revenue = income from lending
  
  \[
  = 100 \times (11.40\%)
  = 11.40
  \]

- Expenses = cost of T2 + cost of borrowing
  
  \[
  = 5 \times (10.5\%) + 88 \times (10\% + 0.125\%)
  = 0.525 + 8.91
  = 9.435
  \]

- Gross profit = 11.40 - .435
  
  = 1.965
Return on Equity Example

- Net profit =
  Gross profit - general expenses
  = 1.965 - 0.5
  = 1.465

- Net margin =
  Net profit / Revenue
  = 1.465 / 11.4
  = 0.1285

- Asset utilisation =
  revenue / assets
  = 11 / 100
  = 0.11

- Return on assets =
  Net margin * Asset utilisation
  = 0.1285 * 0.11
  = 0.01414

- Leverage =
  Assets / T1 capital
  = 100 / 7
  = 14.286

- Return on equity =
  Return on assets * Leverage
  = 0.01414 * 14.286
  = 0.20195
  = 20.2 %
Risk Management

- More details on risk types can be found in the *Introduction to Risk* presentation.
- The diagram shows the different types of risk in ALM.

Diagram:
- Regulatory requirements
- Liquidity
- Competition
- Commercial strategy
- Funding/Leverage
- Interest rate sensitivity
An effective organisational structure is essential for risk management

Risk Allocation

- Treasury & Capital market
  - Group Treasury
    - Term Funding
    - Liquidity
    - Short/Medium Term Interest Rate Risk
    - Long Term Interest Rate Risk
  - Treasury Markets
    - Group Services/Investor Relations
    - Capital markets/Derivatives
    - Money Markets
    - Corporate Marketing

Risk Reporting
Interest Rates

- There are different ways of calculating interest:
  - Simple interest
  - Compound interest
- Daycount conventions (ACT, etc.) can also be confusing
- Spot rates (zero coupon rates)
  - Used to calculate the time value of money
- Yields
  - Used for expressing the internal rate of return for fixed interest coupon bonds or loans
  - Used to produce yield curves
- Forward rates
  - Market’s expectation of loan rates in the future
Interest Rates

- Relationship between the different rates is shown.
- Bootstrapping is used to determine spot rates from yields.
Interest Rates

- The process of bootstrapping is explained in the Yield Curves presentation.
- A simple recipe for performing bootstrapping in a spreadsheet is:
  1) Calculate the one year spot rate;
  2) Calculate the one year discount factor;
  3) Calculate the running sum of discount factors, starting with year 1;
  4) Multiply the running sum of discount factors by the yield of year 2;
  5) Two year Spot rate is equal to \((1 + \text{two year yield})\) divided by the product of step (4);
  6) Repeat steps (3-5) for each successive year.
Interest Rates

- Equivalence principle is used to derive forward rates from spot rates.
- This principal states that a fixed rate loan made from today for a period of \( x \) years must earn the same interest as a loan made for \( y \) years (where \( y < x \)) and rolled over for the remaining \( x - y \) years.
- This method can be simplified using discount factors.

According to Equivalence:

Future value via route A = Future value via route B

or

\[
(1 + S_2)^2 = (1 + S_1) \times (1 + 1F_1)
\]

or

\[
1F_1 = \frac{DF_1}{DF_2} - 1
\]

\[
= 1.0603 - 1
\]

\[
= 6.03\%
\]
Price Sensitivities

- The price of fixed income securities is sensitive to its yield (i.e. interest rates)
- The price-yield curve of most securities is convex:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield = Coupon rate</td>
<td>Price = Par value</td>
</tr>
<tr>
<td>Yield &lt; Coupon rate</td>
<td>Price &gt; Par value</td>
</tr>
<tr>
<td>Yield &gt; Coupon rate</td>
<td>Price &lt; Par value</td>
</tr>
</tbody>
</table>

Diagram:
- Price axis
- Par value point
- Yield axis
- Coupon rate point

Table:
- Price
- Yield
- Coupon rate
- Par value
Price Sensitivities

- Financial professionals need a quick measure for price sensitivity rather than using the price equation.

*Price Value of a Basis Point* is the simplest measure of sensitivity and the most widely used.

PVBP is the change in price for 1 bp rise in yield.

\[
PVBP = \text{Price at 1bp higher yield} - \text{Price at current yield}
\]

When Yield = 7.00% Price = $100
When Yield = 7.01% Price = $99.959

Therefore, PVBP = 99.959 - 100 = $-0.041
Price Sensitivities

- **Modified Duration** is another measure of sensitivity.
- It is better for securities whose price is not equal to par.
- Modified duration is the ratio of the relative change in price to the change in yield for a small yield change (i.e., 1bp).

When Yield = 7.00%  Price = 87.699
When Yield = 7.01%  Price = 87.662
ΔP  = (87.662 - 87.699) = 0.038
Δy = 1bp = 0.0001
Therefore  \( MD = \frac{\Delta P}{P} / \Delta y \)
= \( \frac{0.038}{87.699} \) / 0.0001
= 4.3
Price Sensitivities

- *Macaulay Duration* is widely used in ALM to balance the average lives
  - I.e. the asset and liability sides of the balance sheet
- Macaulay duration is the weighted average time to maturity of the cash flows of security; where the weights are equal to the present values of the cash flows

Macaulay duration can be seen graphically as the point in the life of the security about which the value of the present values of the cash flows are perfectly balanced.

Clear bar shows the cash flow and the shaded area is its PV.
As an example, consider the Macaulay duration of a 8% fixed rate bond, 5yr duration, yielding 10%.

This can be calculated in a spreadsheet as shown:

<table>
<thead>
<tr>
<th>Time (yrs)</th>
<th>Cash flow</th>
<th>PV of cash flow</th>
<th>Time * PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.00</td>
<td>7.27</td>
<td>7.27</td>
</tr>
<tr>
<td>2</td>
<td>8.00</td>
<td>6.61</td>
<td>13.22</td>
</tr>
<tr>
<td>3</td>
<td>8.00</td>
<td>6.01</td>
<td>18.03</td>
</tr>
<tr>
<td>4</td>
<td>8.00</td>
<td>5.46</td>
<td>21.86</td>
</tr>
<tr>
<td>5</td>
<td>108.00</td>
<td>67.06</td>
<td>335.30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>92.42</strong></td>
<td><strong>395.68</strong></td>
<td></td>
</tr>
</tbody>
</table>

Macaulay duration 4.28
Price Sensitivities

- Duration provides a linear estimation of the price change for a small change in yield.
- For large changes in yield it may be necessary to use convexity to find the change in price.

Actual curve: \( \Delta P = f(\Delta r) \)

\[ \Delta P = \text{duration} \times P \times \Delta r + \text{Convexity} \times P \times \Delta r^2 / 2 \]
Price Sensitivities

- As an example of convexity, consider a 5-year, fixed-coupon 4% bond, yielding 7%.

- Convexity is the ratio of the change in duration of the to the change in yield for a small change in yield (1bp), so:
  - When yield = 7.00%  Price = 87.699
  - When yield = 7.01%  Price = 87.662
  - When yield = 6.99%  Price = 87.737

- Thus when yield = 6.99 %,  Duration = 4.2986
  And when yield = 7.00%,  Duration = 4.3009

- Therefore Convexity = \((4.3009 - 4.2986) / 0.0001\)
  = 23.44
Price Sensitivities

- Fixed rate loans are like bonds and aren’t convex.
- Loan sensitivities can be described by duration:
  - directly on maturity (duration can’t exceed maturity);
  - directly on coupon rate;
  - inversely on yield.
Price Sensitivities

- Floating rate loans are effectively fixed rate loans for the current interest calculation period.

- On the next payment date the value of a floating rate loan is equal to the principal value:
  - Duration is an adequate measure of the sensitivity of a floating rate note;
  - Duration of a floating rate note is close to maturity.

- For example, mortgages and consumer loans can have embedded optionality:
  - Price sensitivity is based on duration and convexity;
  - Prepayment risk must be modelled and observed.
Price Sensitivities

- Different yield sensitive securities make up a portfolio:
  - The change in price of each security for one basis point move in yields will be depend on its duration;
  - So a change in the yield curve will securities differently.

- Yield curves move in the following ways:
  - 70% of the movement in yields can be explained by parallel moves alone;
  - Another 20-25% can be explained by including steepening moves;
  - 5% is accounted for by curvature shifts.

- See the *Yield Curves* presentation for more details.
Gap Management

- Gap management is the oldest and the most basic method of managing the balance sheet.
- The Gap is difference between the amount of assets and liabilities with interest rate sensitive cash-flows.
- A positive Gap exists when the assets exceed liabilities.
- Banks want to keep a positive Gap when interest rates are rising, and a negative Gap when they are falling.

Example:

<table>
<thead>
<tr>
<th>Interest sensitive assets</th>
<th>Interest sensitive liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td>1250</td>
</tr>
<tr>
<td>900</td>
<td>700</td>
</tr>
</tbody>
</table>

Gap = - 50
Gap Management

- The Gap method can be refined using maturity buckets: Bucket Gap Management.
- Maturity buckets are well defined time periods that a bank monitors on a regular basis.
- The assets and liabilities are separately clumped into these buckets (these can be fine tuned later).
- The Gap management techniques are then applied.

![Gap Management Diagram]

- Interest sensitive assets
  - 400
  - 500
  - 300
  - 900

- Interest sensitive liabilities
  - 600
  - 500
  - 150
  - 700
  - 150

- Negative Gap of 200 in 0 - 3 months
- Zero Gap in 3 - 6 months
- Positive Gap of 150 in 6 - 12 months
Gap Management

- Traditional Gap method focuses on the effect of changes in yield on the income margin.

- Duration Gap Management emphasises the effect of yield changes on the MtM value of assets and liabilities
  - I.e. capital gains and losses.

- The Duration Gap uses the Macaulay Durations of the assets and liabilities.
Gap Management

- Take an example of this:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Value</th>
<th>Duration</th>
<th>Liabilities</th>
<th>Value</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>150</td>
<td>0.00</td>
<td>Demand deposits</td>
<td>600</td>
<td>0.08</td>
</tr>
<tr>
<td>Short term government securities</td>
<td>300</td>
<td>0.91</td>
<td>Short term time deposits</td>
<td>500</td>
<td>0.35</td>
</tr>
<tr>
<td>Long term government securities</td>
<td>300</td>
<td>7.21</td>
<td>Long term time deposits</td>
<td>500</td>
<td>2.25</td>
</tr>
<tr>
<td>High quality floating rate loans</td>
<td>500</td>
<td>0.45</td>
<td>Bonds issued</td>
<td>200</td>
<td>3.52</td>
</tr>
<tr>
<td>Medium quality floating rate loans</td>
<td>400</td>
<td>0.27</td>
<td>Other borrowings</td>
<td>150</td>
<td>0.75</td>
</tr>
<tr>
<td>Fixed rate loans</td>
<td>400</td>
<td>6.87</td>
<td>Equity</td>
<td>150</td>
<td>10.00</td>
</tr>
<tr>
<td>Other assets</td>
<td>50</td>
<td>10.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2100</strong></td>
<td><strong>2.87</strong></td>
<td><strong>Total liabilities</strong></td>
<td><strong>2100</strong></td>
<td><strong>1.75</strong></td>
</tr>
</tbody>
</table>

- Macaulay duration of assets = 2.87
- Macaulay duration of liabilities = 1.75
- Duration gap = 1.12
  - Implies that the bank will benefit if interest rates go down.
- NB: there are wide duration gaps between asset and liabilities in different maturity buckets.
Gap Management

- **Savings & Loans Crisis** in USA.
- S&L offer:
  - deposit accounts to savers;
  - mortgages to home buyers.
  - Similar to building societies.
- During the early and mid 1980s about 900 Savings and Loans went bankrupt.
- The total bill for the US government was over $500 BN.
- What went wrong?

**A typical S&L:**

<table>
<thead>
<tr>
<th>Assets</th>
<th>Cash</th>
<th>Securities</th>
<th>Mortgages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>17</td>
<td>80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Demand deposits</th>
<th>Fixed deposits</th>
<th>Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
<td>32</td>
<td>8</td>
</tr>
</tbody>
</table>

NB: The assets are mostly fixed rate with a duration of 7.0 while a sizeable portion of liabilities is floating rate giving a duration of 3.0.
The duration gap became disastrous when interest rates increased.

During late 1970s and early 1980s interest rates were volatile and rose by about 3%.

Thus the value of S&L assets declined by about 20%:

\[ \Delta P(\text{assets}) = D \times \Delta y + \frac{1}{2} \times \text{Conv} \times \Delta y^2 \]

\[ = -7 \times 0.03 + 0.5 \times 22 \times 0.0009 = 0.20 = 20\% \]

But the value of the liabilities only went up by about 8%:

\[ \Delta P(\text{liabilities}) = D \times \Delta y + \frac{1}{2} \times \text{Conv} \times \Delta y^2 \]

\[ = -3 \times 0.03 + 0.5 \times 20 \times 0.0009 = 0.08 = 8\% \]

Thus our S&L suffered a capital loss of 12% which was more than its equity of 8% - and went bankrupt.
Use of Swaps, Caps & Floors in ALM

- A Swap is a contract between two counterparties to exchange specified streams of cash flows over a given period.
- Each exchange of cash flows in the swap can be seen as a forward contract.
- A plain vanilla swap is an exchange of a fixed interest stream for a floating interest stream (e.g. LIBOR).

E.g.: 2.5 yr swap where we receive 7% and pay 6mth LIBOR:

<table>
<thead>
<tr>
<th>Time(yr)</th>
<th>Fixed</th>
<th>Floating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
<td>(P \times 0.07 \times \Delta t)</td>
<td>(-P \times 6\text{mth L} \times \Delta t)</td>
</tr>
<tr>
<td>1.0</td>
<td>(P \times 0.07 \times \Delta t)</td>
<td>(-P \times 6\text{mth L} \times \Delta t)</td>
</tr>
<tr>
<td>1.5</td>
<td>(P \times 0.07 \times \Delta t)</td>
<td>(-P \times 6\text{mth L} \times \Delta t)</td>
</tr>
<tr>
<td>2.0</td>
<td>(P \times 0.07 \times \Delta t)</td>
<td>(-P \times 6\text{mth L} \times \Delta t)</td>
</tr>
<tr>
<td>2.5</td>
<td>(P \times 0.07 \times \Delta t)</td>
<td>(-P \times 6\text{mth L} \times \Delta t)</td>
</tr>
</tbody>
</table>
A bank can use a swap to change the duration of its assets or liabilities, e.g.:

Bank A is long a fixed rate asset with a duration of 3.5

Bank A goes short a swap with a duration of 3.5

As a result, Bank A reduces the duration of its asset to 0.4
Use of Swaps, Caps & Floors in ALM

- A swap can be valued as a series of cash flows.
- The MtM value the sum of the NPV of all cash flows, discounted at the swap rate.
- The value of a swap is the NPV of the fixed side cash flows, discounted at the swap rate.
- If the MtM value is non-zero, one of the counterparty is losing money.

Example:
7 yr swap of notional amount of 100, where we receive 10.5% semi-annually and pay 6mth LIBOR - 50 bps.
Current 7 year swap rate is 9%.
PV of floating side = -100 + PV of 50 bps over 7 yrs
= -100 + 2.55 = 97.45

Coupon of fixed side = 10.5%
Yield of fixed side = 9%
Maturity = 7 yrs
PV of fixed side = 107.67

NPV of swap = -97.45 + 107.67 = 10.22
Caps and floors are derivative contracts where the owner can receive the difference between a strike interest rate and the level of an index, e.g. LIBOR.

- A cap is like a series of options where the owner has a right to exchange fixed for floating interest payments.
- A floor is like a series of options where the owner has a right to exchange floating for fixed interest payments.

NB: Cap and floor are shown from the owner’s perspective.
Use of Swaps, Caps & Floors in ALM

- A bank can limit the interest expense of a floating rate liability by buying a cap.
- The expense of capping a floating rate liability can be reduced by selling a floor.

```
<table>
<thead>
<tr>
<th>Floating Rate Liability</th>
<th>Cap</th>
<th>Floor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expense</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash inflow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIBOR</td>
<td></td>
<td>LIBOR</td>
</tr>
<tr>
<td></td>
<td>Sc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sf</td>
<td>LIBOR</td>
</tr>
</tbody>
</table>
```

“Collared” Floating Rate Liability

```
<table>
<thead>
<tr>
<th>Expense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sf</td>
</tr>
<tr>
<td>Sc</td>
</tr>
<tr>
<td>LIBOR</td>
</tr>
</tbody>
</table>
```
Use of Swaps, Caps & Floors in ALM

- A long cap and a short floor can make a costless collar:
  - A swap is a kind of costless collar.
- Caps and floors are series of distinct interest rate options.
- Value of an interest rate option is composed of two parts:
  - Intrinsic value: the gain from exercising the options today (depends only on current level of interest rates);
  - Time value: the potential gain due to future movements in interest rates up to option expiry
    - depends on volatility of rates.
- Various models are available for modelling interest rate options:
  - Analytical models such as Black-Scholes;
  - Numerical methods: binomial, trinomial,…
Use of Swaps, Caps & Floors in ALM

- There are several reasons for using derivatives in ALM:
  - Hedge: reduction of a part or all of a bank’s exposure;
  - Arbitrage: exploitation of arbitrage opportunities;
  - Speculate: creation of new exposures for market oriented hedging;
  - Portfolio management: de-linking maturity and duration.

- If you believe rates will rise (above market expectation) or that the yield curve will steepen, go short on swaps.

- Vice-versa - increase the duration of assets and decrease duration of liabilities, i.e. go long on swaps.
Use of Swaps, Caps & Floors in ALM

- But, if you’re not sure about the rates but want to hedge, buy an option to switch, e.g.:

  - Floating rate debt
  - Expense vs. Interest rate

  - Buying a cap for protection
  - Expense vs. Interest rate

  - Selling a cap to subsidise the first one
  - Expense vs. Interest rate

  - Selling a floor to subsidise the cap: collar
  - Expense vs. Interest rate
Use of Swaps, Caps & Floors in ALM

- Application of a non-generic swap:

- A diff swap is a contract to exchange two streams which are based on indices in two different currencies:
  - E.g. GBP LIBOR and USD LIBOR;
  - NB: The payments are in the same currency.

- This swap is used to bet on the relative steepness of swap curves in the two currencies.

![Diagram showing a diff swap between Bank A and Bank B. Bank A pays USD LIBOR +325bps in return for GBP LIBOR from Bank B.]
Use of Swaps, Caps & Floors in ALM

- Derivatives can be used to add value in several ways.
- Derivatives are cheaper than physical transactions.
- Derivatives are off balance sheet.
- Derivatives can reduce taxes and hence add value for shareholders
  - hedging debt reduces risk;
  - the cost of hedging is usually tax deductible;
  - lower interest rate risk means that the firm can increase other types of risk:
    - Leveraged to enhance returns for shareholders.
Summary

- ALM is the management of assets and liabilities in banks to add value to portfolios.
- Interest rates are a major factor in the value of many financial instruments.
- Price sensitivity is how much a change in yield changes the price, and this depends on duration.
- Gap analysis is the management of the balance sheet to simply protect portfolios.
- Derivatives can be used to leverage positions, hedge risk and add value to portfolios.