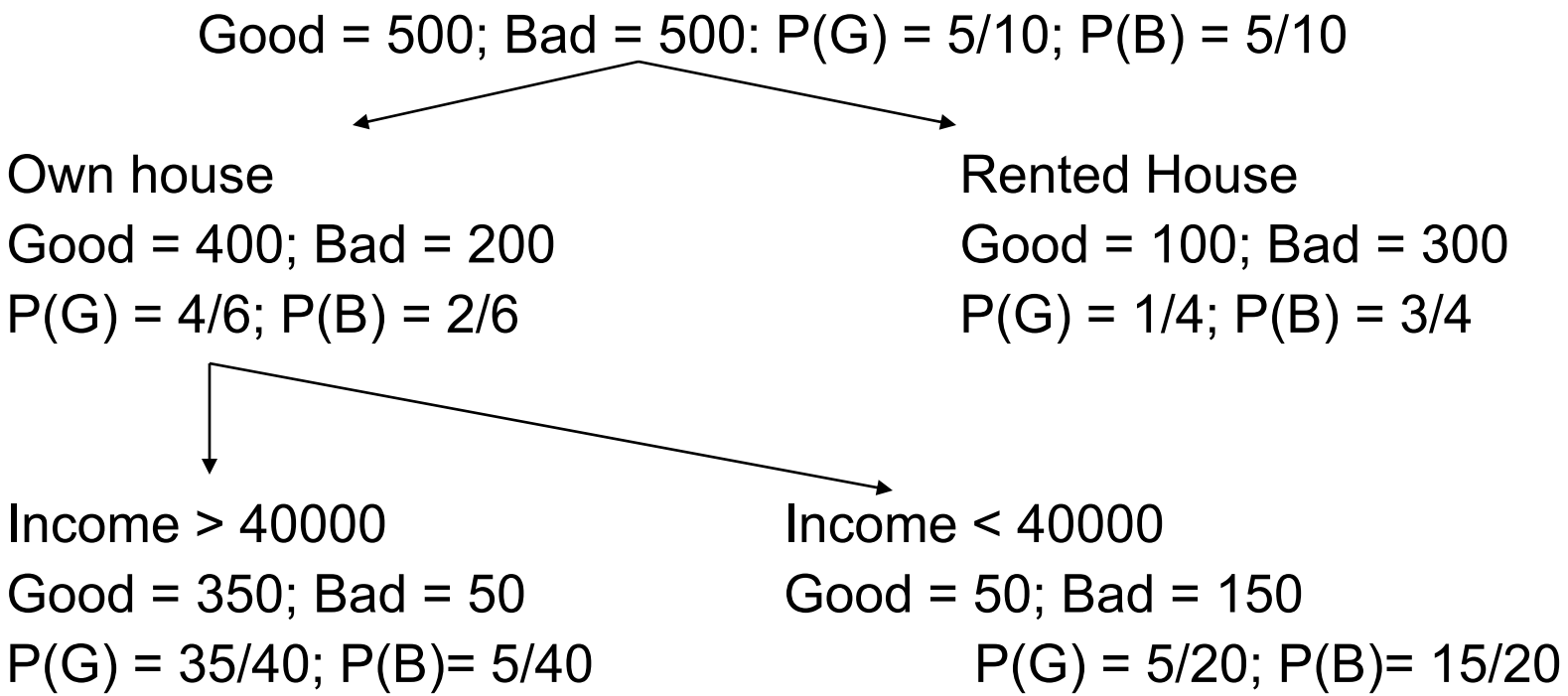
Consumer finance model

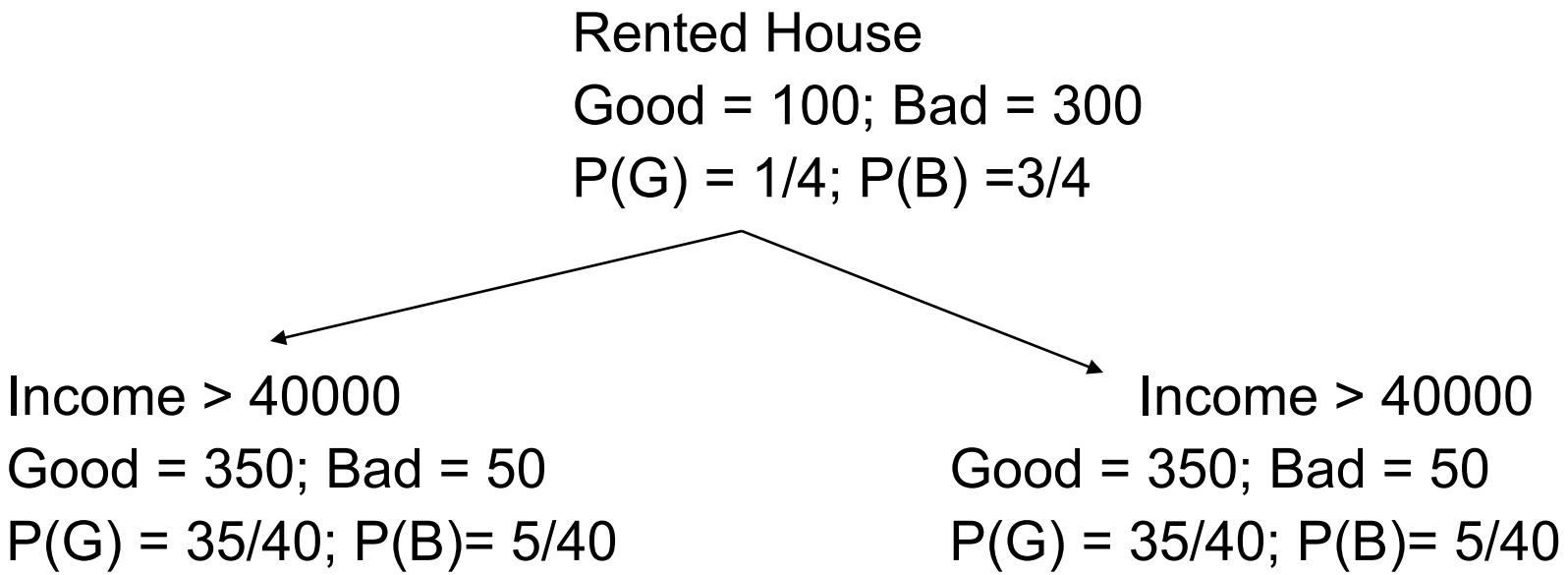
Decision Tree Models

The statistically developed credit scoring model has a counterpart in OR. It is the decision tree approach. In this method, an applicant′s attributes are partitioned off successively, from the most important to the least important. Let us consider the example given below

Consumer finance model



Consumer finance model



Consumer finance model

Advantages of Credit Scoring Models

- The models are objective.
- The models are consistent.
- It properly designed, they eliminate discriminatory practices.

Disadvantages of Credit Scoring Models

- Do not consider subjective analogy and experience of raters, which is important in many situations.
- The variables must follow the assumptions for statistical analysis, like normality, non-collinearity, etc.
- These models are static in nature and not dynamic. Now the question arises, what happens if we try to bring dynamic nature in the credit rating models? There are models in this area which we will not consider for the present.

Efficacy of credit models

Public companies generally provide structured and timely disclosures about their operations through earnings reports etc. In addition, continuous monitoring of their stock prices, provide a mechanism for observing their condition. Credit models have been modeled to take advantage of both these source of information. But for small companies information, as mentioned above, may not be readily available. Hence along with some financial ratios which may be readily available, credit rating agencies also combine the personal credit score for the principal owner(s) of the business. For the latter consumer lending models may be applied to rate the principal owner(s) of the business.

Credit models for small business, banks, FI

In commercial lending many institutions rely exclusively on judgmental credit screening. The following factors have been found to be important indicators of credit quality:

- Borrower's source of income
- Asset holdings
- Economic condition of the area: like unemployment, industry in the area etc.
- Type of products being manufactured or the services being provided and the demand of these in the market.

Credit models for small business, banks, FI

For commercial real estate lending judgmental methods continue to the main appraisal methodology. Prevailing market indexes for commercial property and simulations to project cash flow are used to estimate the collateral value are important factors/variables which are used for this type of credit rating. In the USA market, the following variables, taken from an expert system that identifies potential problem borrowers, seem to impact the ongoing credit risk of commercial real estate projects:

Credit models for small business, banks, FI

The factors/variables to be considered for such credit models are

- Debt coverage ratio
- Prospective criteria (e.g., major tenants not renewing lease)
- Real estate tax delinquency
- Revenue growth that is flat or worse
- Recent change in ownership
- Presence of secondary financing
- Refinancing
- Complicated financing structure
- Signs that property is neglected
- Property that in not near a strong economic center

Credit models for small business, banks, FI

Bank Models: Because banks perform an important public function by operating the payment system and acting as a vehicle for the exercise of monetary policy, they are highly regulated by the government. Consequently, they are required to submit detailed financial reports to the regulatory agency, which is RBI. The following elements are used in assessing a bank's solvency.

- Asset quality
- Management
- Outline and peer group comparison by studying different types of financial ratios of the banks
- Multivariate or composite measurements
- Market value based measurements

Credit models for small business, banks, FI

1) **Asset quality**: It is of primary focus for the regulators and investors. Risk based capital standards for banks are expressed in terms of asset quality (i.e., credit quality of various asset classes). A bank's assets are examined and classified into several categories of risk, i.e., loss, doubtful, substantial etc. By assigning weights to these different types of losses we can attempt to find the solvency of the banks.
2) **Management**: (a) Uninformed or inattentive board of directors as evident from poor loan policies, inadequate supervision of employees, inadequate systems to identify problem loans, decision of one dominant individual, etc. (b) Overly aggressive activity by board or management as evidenced by inappropriate lending policies, excessive loan growth in relation to abilities of management, undue reliance on volatile loans. (c) Fraud. (d) Economic environment.
3) **Outline and peer group comparison by studying different types of financial ratios of the banks**: After analyzing the critical ratios of the banks, we can compare these ratios with other banks in a particular peer group depending on size, area of operations, type of loans disbursed, type of deposits made etc. One important thing to be noted is that Data Envelopment Analysis (DEA) method has been extensively used to study the performance of banks in a group. DEA is a non-parametric methods and is very easy to work on.
4) **Multivariate or composite measurements**: By analyzing the different ratios which are important indicators for the performance of banks we try to use multiple component analysis to come up with a model, so that we are able to quantify the risk for different banks.
5) **Market value based measurements**: Analyzing the stock prices of the banks, the beta values can also be used to find some sort of quantitative models for credit risk gauging of banks.

Efficacy of credit models

The efficacy of the credit rating models can be judged if it

1) Reinforces a strong credit culture.
2) Reduces the high fixed costs associated with credit analysis.
3) Establishes consistency in assessing and pricing credit risk.

Efficacy of credit models

4) Assists in active portfolio management
5) Is mathematical/statistical based. Note, for statistical models we should be cautious of Type I error, Type II error, forecast horizon (time), missing data if any, size of companies etc.
6) Evaluates not only during the design phase but also after it has been put into operation.

Attributes for credit evaluation system

1) Sensitivity of rating to real changes and hence the effect of these changes to the credit quality.
2) Lead time with respect to the recognized changes in quality. It means how the change in data quality affects the performance of the model and how fast we are able to detect it or incorporate that in out model.
3) Stability of the rating model where no fundamental change has occurred.
4) Graduated tiering of the risk assessment that facilitates rationality in the pricing of credit and the setting of loan terms.
5) Consistency of ratings across industries, company sizes and locations.

Other credit risk measuring criteria

Risk to default.

This can be measured by MMR_t and CMR_t

Where

- MMR_t = Marginal Mortality Rate for the t^{th} time period = (X_t/Y_t)
- CMR_T = Cumulative Mortality Rate for the whole time period T = $1 - \prod_{t=1}^{T} SR_t$
- X_t = Total value of defaulting debt in t^{th} time period
- Y_t = Total value of the debt at the start of the t^{th} time period
- SR_t = Survival rate at for the t^{th} time period = $\{1 - MMR_t\}$

Introduction to Portfolio approaches

For measuring diversity many of the credit rating agencies use **diversity index**. Few important things which are assumed for the diversity index are as follows:

- Firms in the same industry tend to be correlated.
- Firms in different industries are less correlated or correlation is very negligible.

Now banks invest in different sectors of the economy and into different industries. Hence managing the portfolio of the bank is very important and the risk arising due to this is known as the banking risk, which is defined as the adverse impacts on profitability of several distinct sources of uncertainty. Some examples of different types of prominent risks which are found are Credit risk, Market risk, Interest risk, Liquidity risk, Operational risk, Foreign exchange risk, Country risk, Settlement risk, Performance risk, etc.

Introduction to Portfolio approaches

Consider a bank that borrows Rs.100 million at 3.00% for a year and lends the same money at 3.20% to a highly-rated borrower for 5 years. For simplicity, assume interest rates are annually compounded and all interest accumulates to the maturity of the respective obligations. The net transaction appears profitable—the bank is earning a 20 basis point spread—but it entails considerable risk. At the end of a year, the bank will have to find new financing for the loan, which will have 4 more years before it matures. If interest rates have risen, the bank may have to pay a higher rate of interest on the new financing than the fixed 3.20 it is earning on its loan.

Suppose, at the end of a year, an applicable 4-year interest rate is 6.00%. The bank is in serious trouble. It is going to be earning 3.20% on its loan and paying 6.00% on its financing. Accrual accounting does not recognize the problem. The book value of the loan (the bank's asset) is $100*(1+0.032)^1 = 103.2$, while the book value of the financing (the bank's liability) is $100*(1+0.030)^1 = 103.0$

Introduction to Portfolio approaches

Note the following:

1) Accrual Accounting: The book value of the bank's liability is $100*(1+0.030)^1 = 103.0$, while the asset is $100*(1+0.032)^1 = 103.2$. Hence the bank earned Rs. 0.2 million.
2. Market Value Accounting: The market value of the bank's liability is $100*(1.030)^1 = 103.0$, while the asset as $100*(1.032)^5/(1.060)^4 = 92.72$. Hence the bank lost Rs. 10.28 million.

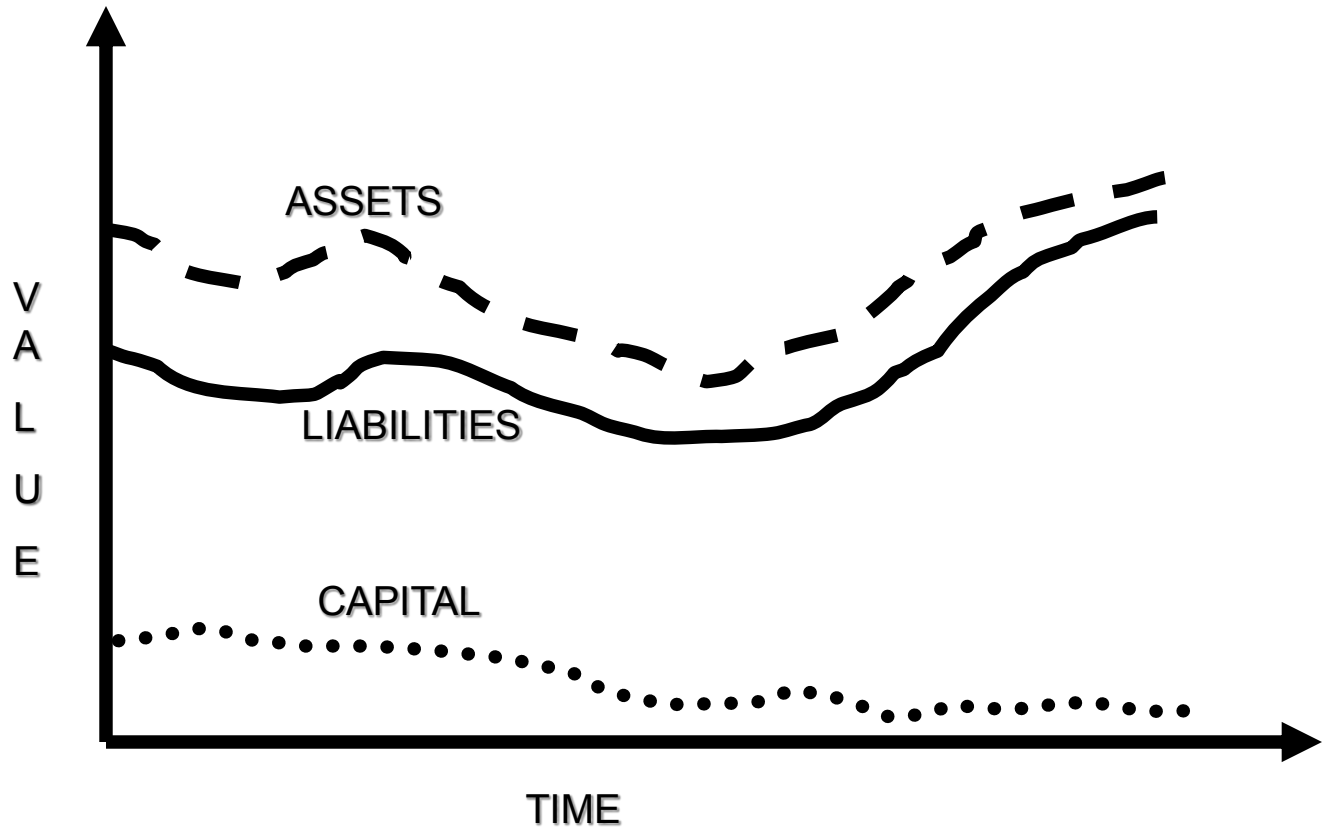
Introduction to Portfolio approaches

The problem in this example was caused by a mismatch between assets and liabilities. Previously such mismatches tended not to be a significant problem. Interest rates in developed countries experienced only modest fluctuations, so losses due to asset-liability mismatches were small or trivial. Many firms intentionally mismatched their balance sheets. Because **yield curves** were generally upward sloping, banks could earn a spread by borrowing short and lending long.

Asset Liability Management

Increasingly, managers of financial firms focused on asset-liability risk. The problem is not that the value of assets might fall or that the value of liabilities might rise. It is that capital might be depleted by narrowing of the difference between assets and liabilities—that the **values of assets and liabilities might fail to move in tandem**. The capital of most financial institutions is small relative to the firm's assets or liabilities, so small percentage changes in assets or liabilities can translate into large percentage changes in capital..

Asset Liability Management

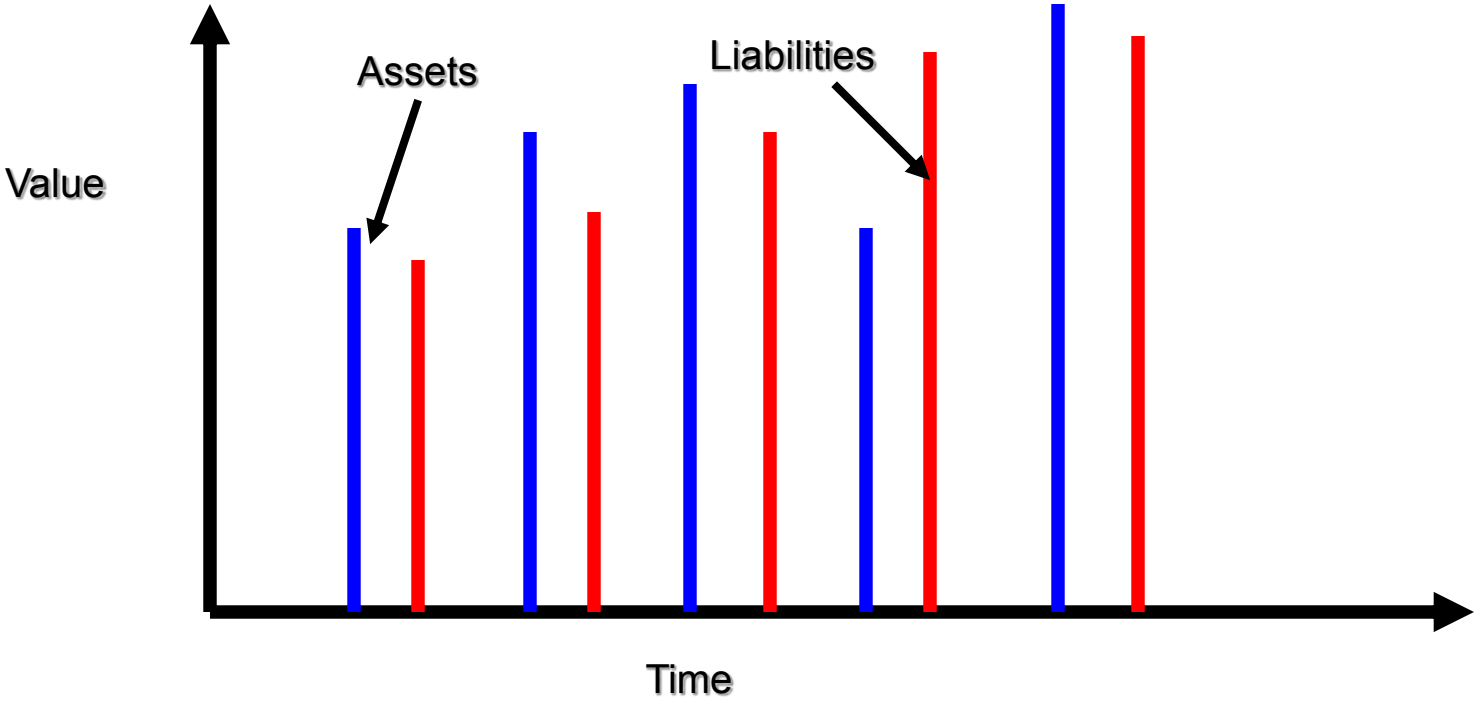


Asset Liability Management

Since the asset value is the discounted value of all future cash flows at market rates, there is an inverse relationship between interest rate and asset value and the market value, i.e., the graph of asset value is a downward sloping curve with respect to interest rate.

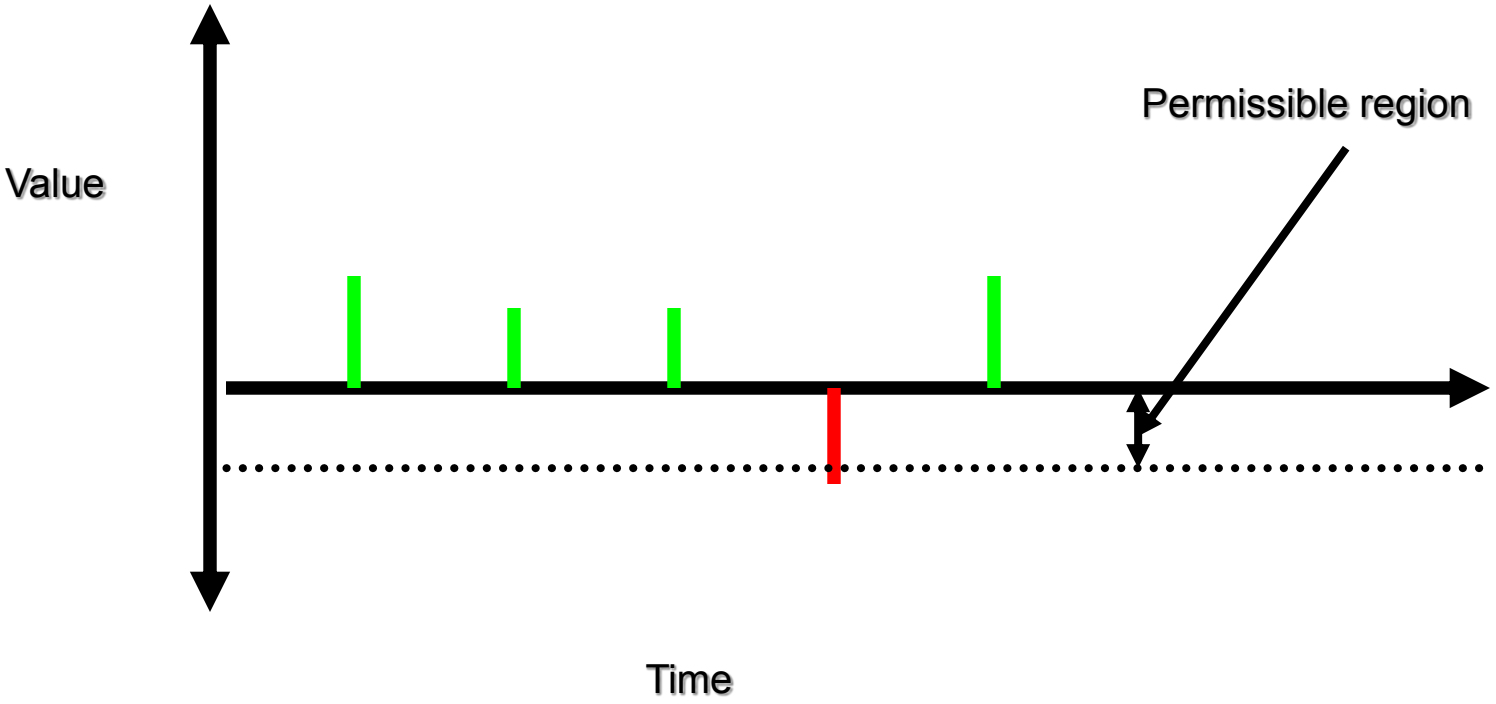
Asset Liability Management

Time profile of assets and liabilities



Asset Liability Management

Time profile of liquidity gaps (which is the difference between assets and liabilities)



Asset Liability Management

We must be aware that the differences between the Assets and the Liabilities, when it is more than a specified value, triggers a credit default. For values of Gap (Liability – Asset) being within a certain value is permissible as we have provisions to take care of that. One provision can be through the use of derivatives.

Asset Liability Management

Liquidity risk, due to mismatch of assets and liabilities result from size and maturity mismatches of assets and liabilities. The standard techniques for characterizing liquidity exposure relies on gap time profiles, i.e., excesses or deficits of funds, starting from the maturity schedules of existing assets and liabilities. This time profile results from operating assets and liabilities, which are loans and deposits.

Asset Liability Management

These gaps, generate liquidity risk, the risk of not being able to raise funds without excess costs. Our main aim to control this liquidity risks, i.e., we are interested in maintaining a cushion of short term assets, so that in case we need cash, we can sell them off without incurring any gains or losses. While dealing with the gaps we must be aware of the concept of static and dynamic gaps. The differences between the existing assets and liabilities is termed as the **static gap**. We try to project the value of the assets and liabilities in future, depending on the present trends, and then try to have some knowledge about the gaps. Then the differences between those projected assets and liabilities is termed as the **dynamic gaps**.

Asset Liability Management

Types of gaps

- Simple gap: $\{A_t - L_t\}$
- Cumulative of simple gaps: $\sum_{t=1}^{T} \{A_t - L_t\}$
- Marginal gap: $[\{A_t - L_t\} - \{A_{t-1} - L_{t-1}\}]$
- Cumulative marginal gaps: $\sum_{t=1}^{T} [\{A_t - L_t\} - \{A_{t-1} - L_{t-1}\}]$

Asset Liability Management

It is important to note that for a fixed rate there would not be any interest rate risk. If the interest rate is floating then the problem of balancing your assets and liabilities becomes difficult, hence making it difficult to manage your gap profile. But the question is how do we analyze the gap arising due to interest rate fluctuation.

Here interest margin is equal to gap*interest.

Hence:

$\Delta IM = IM_t - IM_{t-1} = gap*\Delta i = gap*(i_t - i_{t-1})$

$IM_t = IM_{t-1} + \Delta IM = IM_{t-1} + gap*(i_t - i_{t-1})$

Hence:

$E[\Delta IM] = gap*E[\Delta i]$

$E[IM_t] = IM_{t-1} + gap*E[\Delta i]$

$\sigma[\Delta IM] = |gap|*\sigma[\Delta i]$

$\sigma[IM_t] = |gap|*\sigma[\Delta i]$

Asset Liability Management

To find the successive values of IM, we use the recursive method, i.e., given IM_0, we proceed to find IM_1. After finding IM_1 we estimate IM_2 and so on. But there are caveats. Always try to make the differences between the time periods as small as possible and also try to predict for a short time frame horizon. This will minimize the errors. Per se these values may be important but what we may be interested is to compare these predicted values with the actual values.

Asset Liability Management

The historical values of volatility of interests are available from historical time series. Assuming a yearly volatility of 1.5% and using normal distribution we can define a confidence interval for the IM. Now remember the interest margin distribution is dependent on the distribution of the interest rate, multiplied by the gap. Hence with a gap of 2000, we have the yearly volatility of IM as 2000*1.5% = 30%.

Also $E[IM_t] = IM_0 + \{E[\Delta i]/\sigma[\Delta i]\}*\sigma[\Delta IM]$.

If there are more than one interest rate which is affecting the IM, we have $\Delta IM_t = gap_{1t}*\Delta i_{1t} + gap_{2t}*\Delta i_{2t}$

Now if $\Delta i_1 = \beta*\Delta i_2 + \varepsilon_{12}$, $[\varepsilon_{12} \sim N(0,\sigma^2)]$

Then:

$\Delta IM_t = gap_{1t}*(\beta*\Delta i_{2t} + \varepsilon_{12}) + gap_{2t}*\Delta i_{2t}$

Asset Liability Management

Different performance measures for calculating the utilization of assets/capital:

1) Return on Assets (ROA)
2) Return on Equity (ROE)
3) Mark to Market (MTM)
4) Risk Adjusted Return on Capital (RAROC)
5) Return on Risk Adjusted Assets (RORAA)
6) Value at Risk (VaR)

Note: As different types of risks became more and more important, hence it also became important to incorporate the concept of risk adjusting the return or risk adjusting the capital, hence we had RAROC, RARAA and VaR.

Asset Liability Management

1) Return on Assets (ROA) = Income/Assets.
2) Return on Equity (ROE) = Income/Equity.
3) Mark to Market (MTM) = Present market value of Asset/Book Value of Asset.
4) Risk adjusted return on capital (RAROC)

   This measure was introduced by Banker's Trust in the late 1970′s and the early 1980′s. RAROC allocates a capital charge to a transaction or an amount equal to the maximum expected loss (99% confidence level) over one year on an after tax basis.

   Generally stated, we have

   RAROC = [revenues – expenses - expected loss + income from capital]/capital

Asset Liability Management

The basis steps in the process of how to find RAROC:

1) Analyze the activity or product and determine the basic risk categories that it contains, for example, interest rate, foreign exchange rate, etc.
2) Quantify the risk in each category by a market proxy, i.e., a value which you can measure.
3) Using the historical price movements of the market proxy over the past three years compute a market risk factor, given by the following, i.e.,

   RAROC risk factor = 2.33*weekly volatility*$52^{1/2}$*(1–tax rate). In this equation the multiplier 2.33 gives the volatility (expressed as a percent) at the 99 percent confidence level. The term $52^{1/2}$ converts the weekly price movement into an annual movement. The term (1–tax rate) converts the calculated value to an after tax basis. An important thing to remember is that the number 2.33 means that there is a 1% probability that a normally distributed variable will decrease by more than 2.33 standard deviation.
4) Compute the monetary amount of capital required for each risk category by multiplying the risk factor by the size of the position (which is basically the monetary unit).
5) Find the RAROC by dividing the profit (which is planned or expected) by the monetary capital requirement calculated in step 4.

Asset Liability Management

Consider the following example, where a government trader (a person trading only in government treasuries of a particular maturity) requires a nominal capital allocation of Rs. 14 million and a foreign currency trader requires only Rs. 6 million. If both of them make the same profit, say of Rs. 2 million, then very simply stated the government trader would have a profit percentage of 2/14 = 14.3%, while the foreign currency trader would have a profit percentage of 2/6 = 33.3%.

But what must be the actual profit percentages respectively considering interest rate and tax percentage.

Government trader: Suppose he/she assumes a 5% per annum interest rate and with a tax rate of 8% per annum. Then we have $RAROC=2/[2.33*(0.05/52^{1/2})*52^{1/2}*(1-0.08)*14*10^6+14*10^6]=12.9\%$

Foreign currency trader: Suppose he/she assumes a 18% per annum interest rate and with a tax rate of 10% per annum. Then we have $RAROC=2/[2.33*(0.18/52^{1/2})*52^{1/2}*(1-0.10)*6*10^6+6*10^6]=24.2\%$

Note: compare 14.3% vis-à-vis 12.9% for the government trader and compare 33.3% vis-à-vis 24.2% for the foreign currency trader.

Asset Liability Management

Return on Risk Adjusted Assets (RORAA)

It is similar to ROA, but the denominator is adjusted to account for varying riskiness of asset classes