12. Risk Management. Hedging and Speculation. Gap Management

Risk Management System

Goals	Risk factors	Exposure	Measures	Management
1. absolutne value earnings cash flows	1. market risk - volatility a. price b. interest rate c. exchange rate	1. valuation methods a. traditional b. non-arbitrage c. binomial d. simulation	1. traditional methods variance standard deviation	1. management strategies conservative active (optimization) (captal allocation)
2. relative simple rate of return logarithmic rate of return	2. credit risk creditworthiness changes a. cash flows adjustments credit scoring default probabilities recovery rates b. interest rate adjustments risk premium migration analysis		2. concentration and diversification measures	2. limits
	3. operational risk		3. sensitivity measures currency gap interest rate (duration) gap options $\delta, \gamma, \tau, \rho, \kappa$	3. capital adequacy regulatory capital economic capital
			4. modern methods VaR EaR CFaR	4. performance measurement ΔV/VaR P&L/EaR ΔCFAT/CFaR
			5. Stress test	

Goals

(1) $$PV = \sum_{t=1}^{n} \frac{CF_t}{(1+RRR)^t} + \frac{CV_n}{(1+RRR)^n}$$

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

(2) $$= \frac{P_t}{P_{t-1}} - 1$$

$$= \frac{\Delta P_t}{P_{t-1}}$$

(3) $$1 + R_t = \frac{P_t}{P_{t-1}}$$

$$r_t = \ln(1+R_t) = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

(4) $$= \ln(P_t) - \ln(P_{t-1})$$

$$= p_t - p_{t-1}$$

Risk factors

- *price risk*
- *interest rate risk*
- *foreign exchange rate risk*)
- *market risk*
- *credit risk*
- *liquidity risk*
- *capital risk*
- *country/sovereign risk*
- *off-balance-sheet risk*
- *business risk*
- *operational risk*
- *technology risk*
- *marketability risk*
- *environment*
- *war, revolution*

Exposure

- sensitivity analysis,
- scenario analysis,
- probabilistic (decision trees),
- analytical,
- simulation.

Analytical Methods

Taylor's expansion:

(5) $$f(x) = \frac{f(x_0)}{0!} + \frac{f^{'}(x_0)}{1!}(x - x_0) + \frac{f^{''}(x_0)}{2!}(x - x_0)^2 + ... + \frac{f^{n}(x_0)}{n!}(x - x_0)^n + R_n$$

(6) $$\Delta W \cong + \delta \, \Delta x$$

(7) $$\Delta W \cong + \delta \, \Delta x + \frac{1}{2} \gamma \, \Delta x^2$$

$\Delta W = f(x) - f(x_0)$ – change in value, $\Delta x = x - x_0$ change in risk

Risk Measures

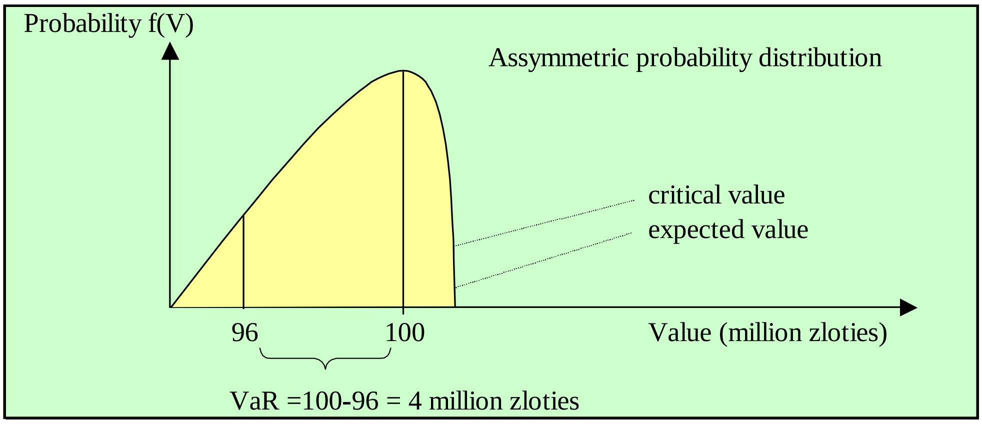
Risk arises from the variability of future returns, values, cash flows, earnings and other stated goals. This variability is caused by changes in prices (price risk), exchange rates (currency risk), interest rates (interest rate risk), creditworthiness (credit risk) and other factors.

There are many risk measures:

- traditional (variance, standard deviation, coefficient of variation),
- modern (Value at Risk, Cash flows at Risk, Earnings at Risk),
- specific (duration gap, currency gap).

VaR, CfaR, EaR

Value-at-Risk is a measure of the maximum potential change in value of a portfolio of financial instruments with a given probability over a pre-set horizon.



Historical Simulation Method. Historical simulation method is used to find an empirical distribution of the rates of return assuming that past history carries out into the future.

Correlation Method. The correlation method, otherwise known as the variance/covariance method, is essentially a parametric approach in which an estimate of VAR is derived from the underlying variances and covariances of the constituents of a portfolio. The variance/covariance approach is based on the assumption that the underlying market factors have a multivariate normal distribution. If a probability of 5 percent is used in determining the value at risk, then the value at risk is equal to 1.65 times the standard deviation of changes in portfolio value:

$$VaR \cong 1{,}65\sigma_P V_{t-1}$$

Monte Carlo Simulation. The Monte Carlo simulation methodology has a number of similarities to historical simulation.
The similar risk measures are CFaR and EaR.

Cash-Flow-at-Risk (CFaR). The maximum shortfall of net cash generated, relative to a specified target, that could be experienced due to the impact of market risk on a specified set of exposures, for a specified reporting period and confidence level.

Earnings at Risk (EaR) The maximum shortfall of earnings, relative to a specified target, that could be experienced due to the impact of market risk on a specified set of exposures, for a specified reporting period and confidence level.

Duration Gap

Duration is the average life of an asset, or more exactly, the weighted average time to maturity using the relative present values of the cash flows as weights. Duration is measured in years. The modified duration is a measure of the interest sensitivity of an asset's price.

Important features of the modified duration (True or False)

1. Duration increases with the maturity.
2. Duration increases as yield decreases.
3. Duration increases as the coupon rate decreases.

Table 1. Modified duration and convexity of bonds

Bonds	Modified duration	Convexity
Coupon bonds (annual interests)	$D = \frac{B\left(c[1+i]\left[(1+i)^T - 1\right] + iT[i-c]\right)}{Pi^2(1+i)^{T+1}}$	$C = \frac{2B\left(c[1+i]^2\left[(1+i)^T - 1\right] - ciT[1+i] + i^2T[T+1]\frac{[i-c]}{2}\right)}{Pi^3(1+i)^{T+2}}$
Zero coupon bonds	$D = \frac{T}{(1+i)}$	$C = \frac{T(T+1)}{(1+i)^2}$
Consol bonds	$D = \frac{1}{i}$	$C = \frac{2}{i^2}$

where: P - price, i – annualized yield, c – coupon rate, B – face value, T - maturity.

Duration Model

(8) $$\frac{\Delta W}{W} = -D\,\Delta i$$

Duration and convexity model

(9) $$\frac{\Delta P}{P} = -D\Delta i + \frac{1}{2}C(\Delta i)^2$$

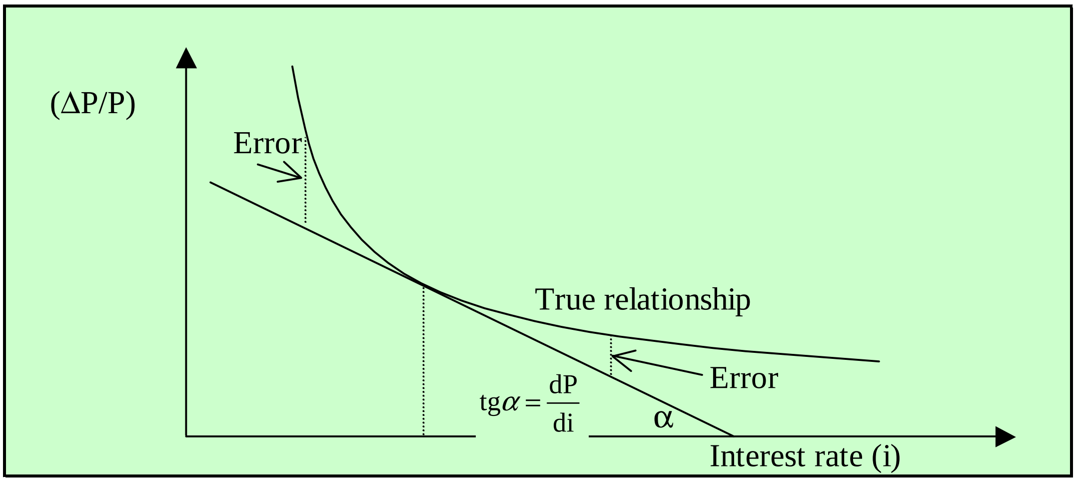
Macaulay Duration Model

(10) $$\frac{\Delta W}{W} = -D_z\left(\frac{\Delta i}{1+i}\right) = -\frac{D_z}{1+i}\cdot\Delta i$$

(11) $$D = \frac{D_z}{1+i}$$

Effective duration and effective convexity

(12) $$D = \frac{V_- - V_+}{2V_0\Delta y}\ ,\ C = \frac{V_- - V_+ - 2V_0}{2V_0(\Delta y)^2}$$



Matching the duration of an asset to the investor's target horizon immunizes it against interest rate risk.

Duration can be calculated for assets or liabilities as a market value weighted average of the individual durations of all items. The duration gap is just a difference between the duration of asset portfolio and the duration of liability portfolio.

(13) $D_A = w_{A1}D_{A1} + w_{A2}D_{A2} + ... + w_{An}D_{An}$

(14) $D_L = w_{L1}D_{L1} + w_{L2}D_{L2} + ... + w_{Ln}D_{Ln}$

(15) $\Delta A = - D_A \cdot A \cdot \Delta y$

(16) $\Delta L = - D_L \cdot L \cdot \Delta y$

(17) $\Delta E = \Delta A - \Delta L = [- D_A \cdot A + D_L \cdot L]\Delta y$

(18) $\Delta E = -[D_A - D_L \cdot k] \cdot A \cdot \Delta y$

$k = \frac{L}{A}$ - is a leverage measure.

(19) $\Delta E = -[D_A - D_P] \cdot A \cdot \Delta y$

Hedging, speculation and arbitrage

Conservative management prefers to hedge cash flows and cost of capital against price risk, interest rate risk and, currency risk and credit risk. Hedging allows for stabilization of value of assets and equity. The simplest and historical way of hedging is **diversification**. It does not increase returns, but it lowers risk. Financial markets and especially derivative markets offer participants the opportunity to reduce or eliminate risk through **hedging** which involves taking out counterbalancing contracts to offset existing risks (price risk, currency risk, interest rate risk, credit risk). Derivative instruments may be used to reduce the risk of the firm's cash flows and the risk of the cost of capital. Risk reduction is the motivation for **hedging**. Hedging can increase firm's value and hence shareholders' wealth. By managing strategic risks, a firm can increase the magnitude of the expected cash flows and hence increase firm value.

Passive strategies include: buy and hold and indexing. The last involves building a portfolio that will match the performance of a specified index. Matched-funding techniques (dedicated portfolios, horizon matching, immunizations) are also considered as conservative strategies. Dedication refers to techniques that are used to construct a portfolio of assets with cash flows that will match the future liabilities.

Active management or **speculation** means a company has open interest rate gap or currency gap and tries to obtain higher returns in risky environment. It is possible to speculate on future direction or volatility of price movement.

Active strategies rely on forecasts, valuation analysis, credit analysis, yield spread analysis, volatility analysis. Active management includes strategies that attempt to outperform a passive benchmark portfolio. These strategies use derivatives (especially options) as an instrument to increase returns.

Arbitrage is defined as transaction of buying a security at a low price in one market and simultaneously selling in another market (or at the same market but in different time) at a higher price to make a profit. In efficient markets such opportunities cannot exist. For most of firms arbitrage opportunities do not exist. Arbitrage may be compared to money being left on the street (rare situation, usually small amounts, somebody may raise this money before you bend, even if you see this situation).