RM 岊は公式表
\n
$$
NPV = \sum_{t=0}^{N} \frac{CF_t}{(l + d \text{ iscount rate})^t}
$$
\noundations of Risk Management

Foundations of Risk Management

- \bullet and the contract of \bullet
- WACC = $W_e \times Cost$ of equity+ $W_d \times Cost$ of debt

ta \times equity risk premium (CAPM) $\frac{\left(R_i, R_{_\mathrm{M}}\right)}{\sigma^2_{_\mathrm{M}}}$ Cost of equity = risk-free rate +beta \times equity risk premium (CAPM)

t

debt

+ beta × equity risk premium (CAPM)
 $\frac{\text{Cov}(\text{R}_i, \text{R}_\text{x})}{\sigma_{\text{tot}}^2}$

tax $\frac{\sigma_{\text{tot}}^2}{\sigma_{\text{tot}}^2}$ Cost of debt = cost of
beta_i = $\frac{\text{Cov}(R_i, R_M)}{\sigma_M^2}$ M考试公式表

NPV = $\sum_{k=0}^{\infty} \frac{CF_1}{(1+d \text{ iso}})$

undations of Risk Management

WACC = W_. × Cost of equity+W_d × Cost of debt

Cost of equity = risk-free rate + beta × equity risk premium (CAPM)

Cost of debt = cost of
 borrowing \times (1-marginal tax $\overline{}$

rate)

- Measures of systematic risk:
- Arbitrage Pricing Theory $E(R_i) = R_F + \beta_{i1}RP_1 + \beta_{i2}RP_2 + ... + \beta_{iK}RP_K$

(APT):

- $\text{h.c.}\text{cost of debt}$
 beta_i = Cov(R₁,R_M)
 beta_i = Cov(R₁,R_M)
 beta_i = Cov(R₁,R_M)
 isk:
 isk:
 beta_i = R_F + β_n RP_i + β_{12} RP₂ + ... + β_{1K} RP_K
 paramages is a by ha = E(R_P)-{R + $\beta_{ik}RP_k$
 $\frac{(R_p)-R_F}{\beta_P}$ m (CAPM)

... + $\beta_{ik}RP_k$
 $E(R_p) - R_f$
 $E(R_p) - R_{n h}$ ${min}$ (CAPM)
+ ... + β_{ik} RP_K
= $\frac{E(R_p) - R_F}{\beta_p}$
= $\frac{E(R_p) - R_F}{\beta_p}$ $am (CAPM)$

... + $\beta_{ik}RP_k$
 $\left[\frac{E(R_p)-R_p}{\beta_p}\right]$
 $\frac{E(R_p)-R_{a,b}}{B}$
 $m = s$ tan dard deviation equity risk premium (CAPM)
 $\beta_{11}RP_1 + \beta_{12}RP_2 + ... + \beta_{1K}RP_K$

)- $\{R_r + \beta_k[E(R_M) - R_r]\}$

Treynorm easure $= \left[\frac{E(R_r) - R_r}{\beta_r}\right]$ natic risk:

Theory $E(R_i) = R_F + \beta_{i1}RP_i + \beta_{i2}RP_2 + ... + \beta_{iK}RP_K$

of Jensen's alpha = $E(R_F) - \{R_F + \beta_F[E(R_M) - R_F]\}$

Treynorm easure = $\left[\frac{E(R_F) - R_F}{\beta_P}\right]$
 $\frac{(R_F) - R_F}{\sigma_P}$

Sortino Ratio = $\frac{E(R_P) - R_m}{\sigma_S}$

Theory of $E(R_F) - E(R_B)$ of equity+W_a × Cost of debt

= risk-free rate + beta × equity risk premium (CAPM)

= cost of
 $\text{beta}_{\text{net}} = \frac{\text{Cov}(R_1, R_{\text{wt}})}{\text{beta}}$

: (1-marginal tax $\frac{\sigma_M^2}{\sigma_M^2}$

stematic risk:

ing Theory E(R₁) = R_F + risk-free rate + beta × equity risk premium (CAPM)

cost of
 $beta_n = \frac{Cov(R_1, R_N)}{\sigma_n^2}$

(1-marginal tax $\frac{1}{\sigma_n^2}$

ermatic risk:

g Theory $E(R_i) = R_F + \beta_{ii}RP_i + \beta_{12}RP_2 + ... + \beta_{ik}RP_k$

of <sup>Jonson's a b h a $E(R_r) + [R_r + \beta_{12}RP_2$ WACC = W_, × Cost of equity - W_, × Cost of debt

Cost of equity = risk-free rate + beta × equity risk premium (CAPM)

Cost of debt = cost of
 $\log_{10} = \frac{Cov(R_1, R_3)}{\sigma_{31}^2}$

borrowing × (1-marginal tax σ_{31}^2

mat of
 $\text{beginal}} \text{Cov}(R_1, R_2)$
 $\text{arginal} \quad \text{tax} \quad \frac{\sigma_N^2}{\sigma_N^2}$
 ic risk:
 $\text{neory E}(R_1) = R_F + \beta_{ii} R P_i + \beta_{i2} R P_2 + \dots + \beta_{iK} R P_K$
 $\text{of } \frac{\text{I}}{\text{en seen's abha}} = F(R_1) \cdot (R_1 + \beta_1) F(E(K_2) - R_1)$
 $\text{Treynorm} \text{ easure} = \left[\frac{E(R_2) - R_2}{\beta_P} \right]$
 \frac f

beta_i = $\frac{\text{Cov}(R_i, R_M)}{\sigma_M^2}$

risk:

cory $E(R_i) = R_F + \beta_{ii}RP_1 + \beta_{i2}RP_2 + ... + \beta_{iK}RP_K$

Jensen's abba = $E(R_r) \cdot (R_r + \beta_r [E(R_M) \cdot R_r])$

Treynorn easure = $\frac{E(R_r) - R_r}{\beta_r}$

Treynorn easure = $\frac{E(R_r) - R_{iK}}{\beta_r}$
 $\frac{E(R_r) - E(R_n$ f

beta_i = $\frac{\text{Cov}(R_1, R_M)}{\text{dual tax}}$

risk:

ory $E(R_1) = R_r + \beta_{11}RP_1 + \beta_{12}RP_2 + ... + \beta_{1K}RP_K$

Jensen's a bha = $E(R_r) \cdot (R_1 + \beta_1 [E(R_\infty) - R_1])$

Treynorm easure = $\frac{E(R_r) - R_r}{\beta_r}$

Treynorm easure = $\frac{E(R_r) - R_{11}}{\beta_r}$
 $\frac{$ Cost of debt = cost of
 $\text{Beta}_{n} = \frac{\text{Cov}(R_1, R_M)}{\text{beta}_{n}}$

Cost of debt = cost of
 $\text{beta}_{n} = \frac{\text{Cov}(R_1, R_M)}{\sigma_M^2}$

borrowing × (1-marginal tax σ_M^2

mate)

Measures of systematic risk:

Arbitrage Pricing Theory $E(R_1) =$ $\begin{aligned} &\mathcal{L}_{q} \times \text{Cost of debt} \ &\text{ee rate +beta} \ &\text{eta} \leq \text{Cov}(R_i, R_M) \ &\text{bf} \end{aligned}$
 $\begin{aligned} &\text{if} \ &\text{beta}_{\text{net}} = \text{Cov}(R_i, R_M) \ &\text{signal} \ &\text{tax} \quad \sigma^2_{\text{in}} \end{aligned}$
 $\begin{aligned} &\text{if} \ &\text{dist}:\\ &\text{or} \ &\text{E}(R_i) = R_i + \beta_{ii} R P_i + \beta_{i2} R P_2 + ... + \beta_{ik} R P_k \end{aligned}$
 $E(R_p) - R_E$
 $E(R_p) - R_{n_{in}}$
 $E(R_p) - R_{n_{in}}$
 $E(R_p) - R_{n_{in}}$
 $E(R_p) - R_{n_{in}}$ ${}_{1}P_{2} + ... + \beta_{ik}RP_{K}$
 ${}_{1}P_{3} = \left[\frac{E(R_{p}) - R_{k}}{\beta_{p}}\right]$
 $= \frac{E(R_{p}) - R_{n}^{2}}{\text{semi – s standard deviation}}$
 $= \text{original distribution}$ $\beta_{ik}RP_k$
 $\begin{bmatrix} R_p \end{bmatrix} - R_i$
 $\begin{bmatrix} R_p \end{bmatrix} - R_{n \text{ in}}$

tan dard deviation - s tandard deviation equity risk premium (CAPM)

(d)

(d)

(d)

(d)

(d)

(d)

(e)

(R_r+B_r[E(R_x) - R_r]

(R_r+B_r[E(R_x) - R_r]

(R_p) - R_r

(D)

(Region B)

(D)

(R_p) - R_r

(D)

(D)

(D)

(D)

(R_p) - R_{gi}

(D)

(D)

(D)
 \bullet Measures of \bullet of \bullet Performance:
- Financial Disaster:

Barings: rogue trader, Nick Leeson, took speculative derivative positions (Nikkei 225 futures) in an attempt to cover trading losses; Leeson had dual responsibilities of trading and supervising settlement operations, allowing him to hide trading losses; lessons include separation of duties and management oversight

Meltallgesellschaft: short-term futures contracts used to hedge long-term exposure in the petroleum markets; stack-and-roll hedging strategy; marking to market on futures caused

huge cash flow problems.

Long-Term Capital Management: hedge fund that used relative value strategies with enormous

d
 agement: hedge fund that used relative value strategies

hen Russia defaulted on its debt in 1998, the increase in

nuge losses and enormous cash flow problems from

ket

dack of diversification, model risk, leverage, s caused

roblems.

tal Management: hedge fund that used relative value strategies

rage: when Russia defaulted on its debt in 1998, the increase in

stage: when Russia defaulted on its debt in 1998, the increase in

stag 1
 igement: hedge fund that used relative value strategies

en Russia defaulted on its debt in 1998, the increase in

uge losses and enormous cash flow problems from

ket

ket

ack of diversification, model risk, levera that used relative value strategies

on its debt in 1998, the increase in

rmous cash flow problems from

model risk, leverage, and funding

model risk, leverage, and funding
 $\text{Cov}(\mathbf{R}_i, \mathbf{R}_j) = \frac{\text{Cov}(\mathbf{R}_i, \mathbf{R$ crease in

finding
 $\frac{\text{Cov}\left(R_i, R_j\right)}{\sigma\left(R_i\right)\sigma\left(R_j\right)}$

ariance: 1998, the increase in
flow problems from
everage, and funding
 $\begin{bmatrix} (X-\mu)^2 \\ \text{Corr}(R_i, R_j) = \frac{\text{Cov}(R_i, R_j)}{\sigma(R_i)\sigma(R_j)} \end{bmatrix}$
Covariance: ease in

From
 unding $\frac{\mathsf{bv}\big(\mathrm{R}_i,\mathrm{R}_j\big)}{\mathrm{R}_i\big)\sigma\big(\mathrm{R}_j\big)}$ \tt iance: the increase in
problems from
e, and funding
 $(R_i, R_j) = \frac{\text{Cov}(R_i, R_j)}{\sigma(R_i) \sigma(R_j)}$
Covariance: caused huge losses and enormous cash flow problems from

ing to market

sinclude lack of diversification, model risk, leverage, and funding

uidity risks.
 $P(10) = \frac{P(0|1)}{P(0)} \times P(1)$

uula:
 $E(X) = \sum P(x, y, x)$ value: Varia amounts of leverage; when Russia defaulted on its debt in 1998, the increase in yield spreads caused huge losses and enormous cash flow problems from realizing marking to market age; when Russia defaulted on its debt in 1998, the increase in

used huge losses and enormous cash flow problems from

to market

clude lack of diversification, model risk, leverage, and funding

lity risks.
 $P(1|0) = \frac{$

losses; lessons include lack of diversification, model risk, leverage, and funding and trading liquidity risks.

Quantitative

$$
P(I|O) = \frac{P(O|I)}{P(O)} \times P(I)
$$

Analysis

Baye's Formula:

 $(X) = E|(X-\mu)^2|$ (R_i, R_i) $(R_i)\sigma(R_i)$ ng $\frac{1}{\mathfrak{r}(\mathbf{R}_j)}$ j_i, R_j) = $\frac{\text{Cov}(R_i, R_j)}{\sigma(R_i)\sigma(R_j)}$

• Covariance: $\frac{\left(R_i, R_j \right)}{\left(R_j \right)}$
ance: • Expected $E(X) = \sum P(x_i)x_i$ value: $Variance(X) = E[(X-\mu)^2]$ $Cov(R_i, R_i)$

Variance:

$$
Cov(R_i, R_j) = E\{[R_i - E(R_i)] \times R_j - E(Rj)\}
$$
 Covariance:

Correlation:

- Skewness refers to the symmetrization of distribution. Skewness of normal distribution is 0. A positively skewed distribution is right tail. A negatively skewed distribution is left tail.
- Kurtosismeasures the distribution is more or less "peaked" than normal

$$
z = \frac{x - \mu}{\sigma}
$$

distribution. Excess kurtosis = Kurtosis - 3. Leptokurtic: more peaked.

Platykurtic: less peaked, flatter.

- Normal distribution: N~(0, 1). Z score:
- Standard $\sigma_{\overline{x}} = \frac{\sigma}{\sqrt{n}}$ error: $\overline{x} \pm z_{\alpha/2} \frac{\sigma}{\sqrt{n}}$ Confidence interval:
- xcess kurtosis = Kurtosis 3. Leptokurtic: more peaked.

ss peaked, flatter.

uution: N~(0, 1). Z score:

error: $\overline{x} \pm z_{w2} \frac{\sigma}{\sqrt{n}}$ Confidence interval:

confidence intervals; 1.96 for 95% confidence intervals; 2.58 1.65 for 90% confidence intervals; 1.96 for 95% confidence intervals; 2.58 for 99%.
- 5% confidence intervals; 2.58
 $a \neq 0$. One-tailed: H₀: $\mu \leq 0$, H_A:

when it is actually true.

nesis when it is actually false.

R² = $\frac{ESS}{TSS}$ = 1- $\frac{SSR}{TSS}$ regression. confidence intervals; 2.58

2.58

2.59

2.59

2.59

2.59

2.59

3.59

3 **•** Hypothesis testing: Two-tailed: $H_0: \mu = 0$, $H_A: \mu \neq 0$. One-tailed: $H_0: \mu \leq 0$, $H_A:$ $\mu > 0$.
- Type I error: Rejection of the null hypothesis when it is actually true. Significance level.
- Type II error: Failure to detect the null hypothesis when it is actually false. Power of test.
- Simple linear regression: $Y_i = B_0 + B_1 \times X_i + \epsilon_i$
- R² measures the "goodness of fit" of the $R^2 = \frac{2.55}{TSS} = 1 \frac{3.5K}{TSS}$ regression.
- Regression assumption violations:
	- \checkmark Heteroskedasticity occurs when the variance of the residuals is not the same across all observations in the sample.
- $R^2 = \frac{ESS}{TSS} = 1 \frac{SSR}{TSS}$ regression.

ce of the residuals is not the

...

en two or more of the

ons of the independent

ly correlated with each other.

which the residual terms are

adjusted $R^2 = 1 (1 R^2) \times \frac{n-1}{n-k$ ssion.

not the

the other.

ms are
 $\frac{n-1}{n-k-1}$ $rac{\text{SSR}}{\text{TSS}}$ regression.

esiduals is not the

more of the

independent

ed with each other.

residual terms are

= 1-(1-R²)× $\frac{n-1}{n-k-1}$ sion.

other.

s are
 $\frac{n-1}{-k-1}$ \checkmark Multicollinearity refers to the condition when two or more of the independent variables, or line a combinations of the independent variables, in a multiple regression are highly correlated with each other.
	- adjusted R² = 1- $(1 R^2) \times \frac{n-1}{n-k-1}$ \checkmark Serial correlation refers to the situation in which the residual terms are correlated with one another.
- Multiple Linear Regression: $Y_i = B_0 + B_{1i} \times X_i + B_2 \times X_{2i} + \epsilon_i;$
- EWMA $\sigma_n^2 = (1 \lambda) r_{n-1}^2 + \lambda \sigma_{n-1}^2$ model: $\sigma_n^2 = \omega + \alpha$ **r Regression**: $Y_i = B_0 + B_{1i} \times X_i + B_2 \times X_{2i} + \epsilon_i;$
 $\sigma_n^2 = (1 - \lambda) r_{n-1}^2 + \lambda \sigma_{n-1}^2 \quad \text{model:} \quad \sigma_n^2 = \omega + \alpha r_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma$
 \vdots ar Regression: $Y_i = B_0 + B_{11} \times X_i + B_2 \times X_{2i} + \epsilon_i$;
 $\sigma_n^2 = (1 - \lambda) r_{n-1}^2 + \lambda \sigma_{n-1}^2 \quad \text{model:} \quad \sigma_n^2 = \omega + \alpha r_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma v_L$

21:

nounding: FV, = PV_o $\times e^{r \times n}$ Discrete compounding: FV_o = PV_o $\left(1 + \frac{$ $B_2 \times X_{2i} + \epsilon_i;$
 $\alpha^2 = \omega + \alpha r_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma v_L$ $+ B_2 \times X_{2i} + \epsilon_i;$
 $\sigma_n^2 = \omega + \alpha r_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma v_L$ γ v_L

GARCH Model:

 \bullet and the contract of \bullet

Multiple Linear Regression: $Y_i = B_0 + B_{1i} \times X_i + B_2 \times X_{2i} + \epsilon_i$;
 EWMA $\sigma_n^2 = (1 - \lambda) r_{n-1}^2 + \lambda \sigma_{n-1}^2 \quad \text{model:} \quad \sigma_n^2 = \omega + \alpha r_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma v_L$
 GARCH Model:
 CONOTINUOUS: FV_n = PV₀ $\times e^{i\alpha}$ Discre $B_{11} \times X_1 + B_2 \times X_{21} + \epsilon_1;$

del: $\sigma_n^2 = \omega + \alpha r_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma v_L$

Discrete compounding: FV_n = PV₀ $\left(1 + \frac{r}{m}\right)^{m \times n}$

c vield)¹⁺¹ $\beta \sigma_{n-1}^2$ $\omega = \gamma v_L$
= $PV_o \left(1 + \frac{r}{m} \right)^{m \times n}$ + $b_2 \wedge b_2$ + c_1 ,
 $\sigma_n^2 = \omega + \alpha r_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma v_L$
 \therefore compounding: $FV_n = PV_0 \left(1 + \frac{r}{m}\right)^{m \times n}$
 \therefore compounding: $FV_n = PV_0 \left(1 + \frac{r}{m}\right)^{m \times n}$ $t_i = B_0 + B_{1i} \times X_i + B_2 \times X_{2i} + \epsilon_i;$

 $\sigma_n^2 = \omega + \alpha r_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma v_L$

 $t_0 \times e^{r \cdot n}$ Discrete compounding: $FV_n = PV_0 \left(1 + \frac{r}{m}\right)^{n \cdot n}$

 $t_1 + \text{periodic yield}\right)^{t+1}$ **rate:**
 $(t_1 + \text{periodic yield})^{t-1}$ **rate:**
 $\text{etc.} > \$ ar Regression: $Y_1 = B_0 + B_{11} \times X_1 + B_2 \times X_{21} + \epsilon_1$;
 $\sigma_n^2 = (1 - \lambda) r_{n-1}^2 + \lambda \sigma_{n-1}^2 \quad \text{model:} \quad \sigma_n^2 = \omega + \alpha r_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma v_1$.

1:

1:

bounding: $FV_n = PV_0 \times e^{r \alpha}$ Discrete compounding: $FV_n = PV_0 \left(1 + \frac{r}{m}\right$ $\mathbf{B}_1 = \mathbf{B}_0 + \mathbf{B}_{11} \times \mathbf{X}_1 + \mathbf{B}_2 \times \mathbf{X}_{21} + \mathbf{\epsilon}_1;$

1 model: $\sigma_n^2 = \omega + \alpha \mathbf{r}_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma \mathbf{v}_1.$
 $\times \mathbf{e}^{\text{van}}$ Discrete compounding: $\text{FV}_n = \text{PV}_0 \left(1 + \frac{\mathbf{r}}{\text{m}} \right)^{\text{man}}$
 $\text{H} + \$ **Regression:** $Y_1 = B_0 + B_{11} \times X_1 + B_2 \times X_{21} + \epsilon_1$;
 $\frac{1}{2} = (1 - \lambda) I_{n-1}^2 + \lambda \sigma_{n-1}^2 \quad \text{model:} \quad \sigma_n^2 = \omega + \alpha I_{n-1}^2 + \beta \sigma_{n-1}^2 \quad \omega = \gamma V_L$

sunding: $FV_n = PV_0 \times e^{r_0 n}$ Discrete compounding: $FV_n = PV_0 \left(1 + \frac{1}{m}\right)^{m_0 n}$
 Multiple Linear Regression: Y₁ = B₀+B₁×X₁+B₂×X₂₁+C_i;

EWMA $\sigma_n^2 = (1-\lambda) r_{n1}^2 + \lambda \sigma_{n2}^2$ model: $\sigma_n^2 = \omega + \alpha t_{n-1}^2 + \beta \sigma_{n-1}^2$ $\omega = \gamma v_1$.

GARCH Model:

Continuous compounding: FV_n = PV₀ × e^{con} D Financial Markets and Products

- $(1 + \text{forward rate})^t = \frac{(1 + \text{periodic yield})^{t+1}}{\sqrt{t}}$ rate: $(1 + \text{periodic yield})$ t_{t} (1+ periodic yield)^{$t+1$} $+$ periodic yield)^{\prime} • Forward $(1 + \text{forward rate})^t = \frac{(1 + \text{product period})^t}{(1 + \text{forward cost of the total})^t}$ rate:
- \bullet Coupon rate $>$ YTM, bond price $>$ par value, premium bond.

Coupon rate < YTM, bond price < par value, discount bond

Coupon rate $=$ YTM, bond price $=$ par value, par bond

- rd rate)' = $\frac{(1 + \text{periodic yield})^{t+1}}{(1 + \text{periodic yield})^t}$ **rate:**

, bond price > par value, premium bond.

, bond price < par value, discount bond

, bond price = par value, par bond

, bond price = par value, par bond
 $\frac{y}{x+y} BV_{+$ 1 \times 200 \times $\frac{1}{2}$ $2 \times BV_0 \times \Delta y$
- $(-\lambda) r_{n+1}^2 + \lambda \sigma_{n+1}^2$ model: $\sigma_n^2 = \omega + \alpha r_{n+1}^2 + \beta \sigma_{n-1}^2$ $\omega = \gamma v_L$

ing: $FV_n = PV_0 \times e^{cn}$ Discrete compounding: $FV_n = PV_0 \left(1 + \frac{r}{m}\right)^{mn}$
 d Products

ward rate)' $= \frac{(1 + \text{periodic yield})^{n+1}}{(1 + \text{periodic yield})^1}$ **rate:**
 M = $((1-\lambda)\mathbf{r}_{b-1}^2 + \lambda \sigma_{b-1}^2$ model: $\sigma_n^2 = \omega + \alpha \mathbf{r}_{n-1}^2 + \beta \sigma_{n-1}^2$ $\omega = \gamma v_L$

unding: $FV_n = PV_0 \times e^{cn}$ Discrete compounding: $FV_n = PV_n \left(1 + \frac{r}{m}\right)^{n-\alpha}$

and Products

forward rate)' = $\frac{(1 + \text{periodic yield})^{n-1}}{(1 + \text{periodic$ $(\lambda) t_{n-1}^2 + \lambda \sigma_{n-1}^2$ model: $\sigma_n^2 = \omega + \alpha t_{n-1}^2 + \beta \sigma_{n-1}^2$ $\omega = \gamma V_L$
 $\sum_i F V_n = PV_0 \times e^{cn}$ Discrete compounding: $F V_n = PV_0 \left(1 + \frac{1}{m} \right)^{m-n}$
 Products

Int rate)' $= \frac{(1 + \text{periodic yield})^{n-1}}{(1 + \text{periodic yield})^n}$ **rate:**
 bond $_{-1} + \beta \sigma_{n-1}^2$ $\omega = \gamma v_L$
FV_n = PV₀ (1+ $\frac{r}{m}$)^{mxn}
bond.
bond
= -duration x₄y+ $\frac{1}{2}$ x convexity x₄y²
bond. Decreasing rate, percentage bond price change = -duration $x_0^2 = 0 + \alpha r_{n-1}^2 + \beta \sigma_{n-1}^2$ ($1 + \frac{r}{m}$)
 $\alpha \times e^{cn}$ Discrete compounding: $FV_n = PV_0 \left(1 + \frac{r}{m}\right)^{m \times n}$
 $\alpha \times e^{cn}$ Discrete compounding: $FV_n = PV_0 \left(1 + \frac{r}{m}\right)^{m \times n}$
 α lue, discount bond

nd price change = -duration $x_4y + \frac{1}{2}x_5y_4y_5$

buy back the bond. Decreasing rate,

back the bond.
 $\frac{1}{x} = \frac{2x}{\pi} \cos 2x - \frac{1}{2} \cos 2x$
 $\beta_y \times \left(\frac{\text{portfolio value}}{\text{future price}} \times \text{contract multiplier} \right)$ ratio: Callable bond: issuer has the right to buy back the bond. Decreasing rate, negative convexity.

Putable bond: buyer has the right to sell back the bond.

- forward rate)' $= \frac{(1 + \text{periodic yield})^{1/2}}{(1 + \text{periodic yield})}$ **rate:**
 PTM, bond price > par value, premium bond.
 PTM, bond price < par value, discount bond
 PTM, bond price < par value, discount bond
 $= \frac{BV_{\infty} BV_{\infty}}{2 \times BV_0 \times$ Frice $>$ par value, discount bond.
 \angle perentage bond price change = -duration $\times_2 y + \frac{1}{2} \times \text{convexity} \times_2 y^2$

the right to buy back the bond. Decreasing rate,
 \therefore

Fight to sell back the bond.
 $\therefore \frac{1}{\sqrt{\sigma_{\text{Lop$ ce > par value, premium bond.

ce < par value, discount bond

ce = par value, par bond

vercentage bond price change = -duration x₂y+ $\frac{1}{2}$ x convexity x₂y²

e right to buy back the bond. Decreasing rate,

ight to ● Expected loss $_{\text{UL} = \text{AE} \times \sqrt{\text{EDF} \times \sigma_{\text{LOP}}^2 + \text{LGD}^2 \times \sigma_{\text{EDF}}^2}$ = exposure×loss given default× probability of default
- \bullet Unexpected loss :

• **University of the image**
\n• **Minimum variance**
$$
\text{hedge}_{\# \text{ of contracts}} = \beta_P \times \left(\frac{\text{portfolio value}}{\text{futures price} \times \text{contract multipleer}}\right)
$$
 ratio:

S_s and the state of the s

- Hedging with stock index futures:
- Forward Rate Agreement:

Cash flow(if paying R_k)=L*(R- R_k)*(T₂-T₁); cash flow(if receiving R_{K})=L*(R_K-R)*(T₂-T₁);

Cost-of-Carry Model:

Cost-of-Carry Model:

F₀ = S₀e^r F₀ = S₀ + U – I)e^r F₀ = S₀ + U – I)e^r

Backwardation: Future price < spot price; Contango: Future price > spot price

Cheapest-to-delivery(CTD): arry Model:
 $F_0 = S_0 + U - I)e^{iT}$ $F_0 = S_0 + U - I)e^{iT}$

ttion: Future price < spot price; Contango: Future price > spot price

to-delivery(CTD): ● Backwardation: Future price < spot price; Contango: Future price > spot price

Cheapest-to-delivery(CTD):

Cash received by the short=quoted futures price \times conversion factor + accrued

interest

Cash to purchase bond $=$ quoted bond price $+$ accrued interest

 of days in coupon period # of days from last coupon to the settlement date) $\#$ of days in coupon period \qquad

- # of contracts = $\frac{\text{portfolio value} \times \text{duration}_{\text{p}}}{\text{precision} + \text{ratio}}$ ratio: ^F portfolio value duration of contracts = - The^{rT}
idee; Contango: Future price > spot price
curres price × conversion factor + accrued
d
price + accrued interest
duration_r **ratio:**
futures value × duration_r **ratio:**
protected put=long stock + long put \times duration_F Cost-of-Carry Model:
 $\frac{1}{r_0} = S_0 e^{rt} - F_0 = S_0 + U - I)e^{rt}$
 $\frac{1}{r_0} = S_0 + U - Ie^{rt}$
 $\frac{1}{r_0} = S$ **st-of-Carry Model:**
 $= S_0 e^T - F_0 = 6_0 + U - D e^T$
 **Ekwardation: Future price < spot price; Contango: Future price > spot price

eapest-to-delivery(CTD):

sh received by the short=quoted futures price×conversion factor + a** • Duration-Based hedge $\#$ of contracts = portfolio value \times duration $\frac{1}{p}$ ratio:
- \bullet Put-Call Parity: P+S=C+Xe^{-rt}
- \bullet Covered call = long stock+ short call; protected put=long stock + long put

Valuation and Risk Models

- Value at Risk: Minimum amount one could expect to lose. VaR(X%)= $z_{xx} \times \sigma$
- **Binomial Option Pricing Model** (two-period binomial model)

Step 1: Calculate option payoff at the end of all states.

 $\sigma\sqrt{T}$ size of down move=D= $\frac{1}{T_{\text{cm}}}$ $\pi_{\text{cm}} = \frac{e^{rt} - D}{2}$; $\pi_{\text{down}} = 1 - \pi_{\text{cm}}$ z. ted put=long stock + long put

pect to lose. VaR(X%)= $z_{X\%}\times \sigma$

inomial model)

all states.
 $\lim_{w_p = \frac{e^{rt} - D}{U - D}}$; $\pi_{down} = 1 - \pi_{up}$
 π_{down} probabilities. Cash to purchase bond = quoted bond price + accrued interest

Al-coupon $\left[\frac{\text{Eed days from number of days in component of the self.}}{\text{er days in component of the 1}}\right]$

Duration-Based hedge \pm of doys in coupon principal

Finites value \times duration₂

Put-Call Parity: P+S=C $\frac{value \times duration_p}{value \times duration_r}$ ratio:

value $\times duration_r$

cted put=long stock + long put

xpect to lose. VaR(X%)=z_{X%}× σ

poinomial model)

all states.
 $\pi_{up} = \frac{e^{\pi} - D}{U - D}$: $\pi_{down} = 1 - \pi_{up}$

ratal probabilities. $-D$ \cdots down \cdots up Fig. 2 1 protected put=long stock + long put

space to lose. VaR(X%)=2_{X%}× σ

odel (two-period binomial model)

ayoff at the end of all states.

flown move= $D = \frac{1}{\sqrt{U}}$, $\pi_{sp} = \frac{e^{\sigma} - D}{U - D}$; $\pi_{s_{\text{bin}}} = 1 - \pi_{sp}$ Step 2: Calculate option values using risk-neutral probabilities.

Step 3: Discount to today using risk-free rate.

• Black-Scholes-Merton $c = S_0 \times N(d_1) - Xe^{-rt} N(d_2) p = Xe^{-rt} N(-d_2) - S_0 \times N(-d_1)$

Model:

Greeks:

- \checkmark Delta: estimates the change in value for an option for a one-unit change in stock price.
- \checkmark Theta: time decay; change in value of an option for a one-unit change in time.
- \checkmark Gamma: rate of change in delta as underlying stock price changes.
- \checkmark Vega: change in value of an option for a one-unit change in volatility.
- \checkmark Rho: sensitivity of option's price to changes in the risk-free rate.