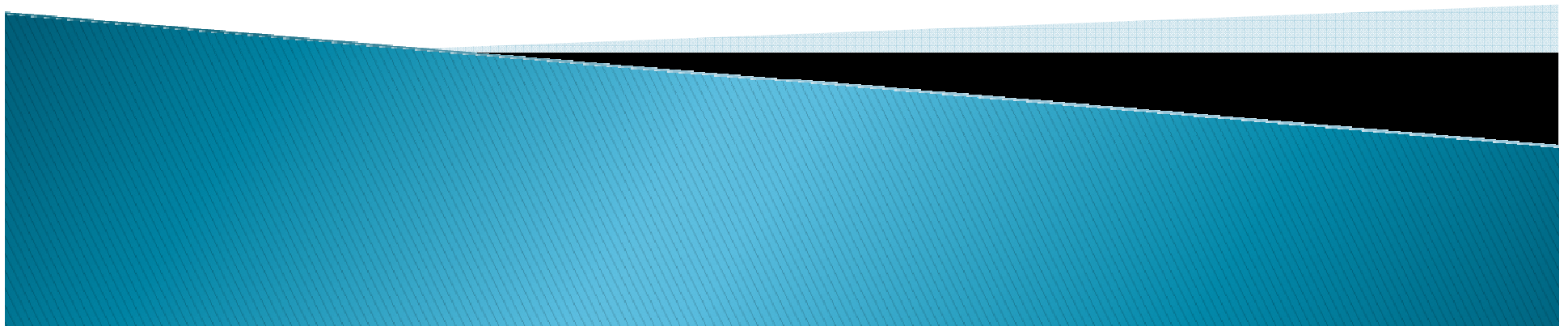


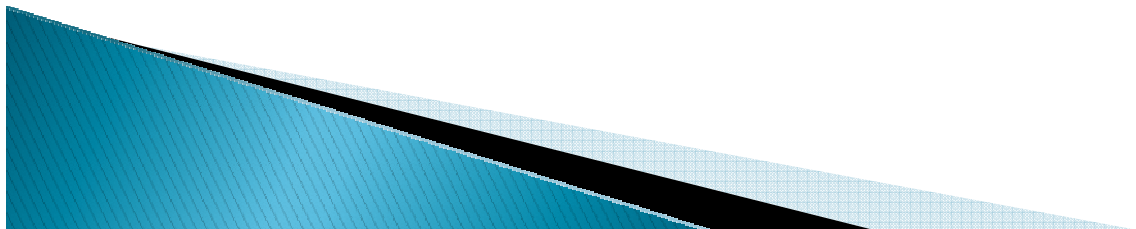
CVaR as linear programming model

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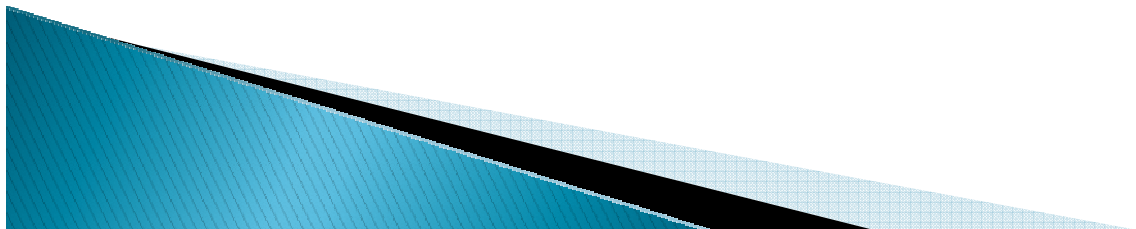
Conditional value at risk (CVaR)

1. Conditional value at risk (CVaR)
2. CVaR as linear programming model



Conditional value at risk (CVaR)

- ▶ Value at risk (VaR) a standard tool of risk management in the financial sector
- ▶ An alternative measure of risk—conditional VaR
- ▶ shortcomings of VaR:
 - I. VaR measures only percentiles of profit and loss, and thus disregards the loss beyond the VaR,
 - II. VaR is not a coherent risk measure because it is not sub-additive

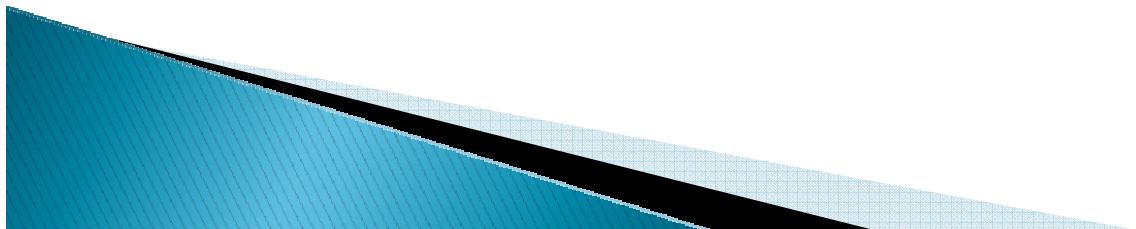


CVaR as linear programming model

Model of portfolio selection based on CVaR:

$$CVaR_{\alpha}(X) = \min \left\{ VaR_{\alpha} + \frac{1}{\alpha} E \left[(E_p - X - VaR_{\alpha})^+ \right] \right\}$$

where VaR_{α} – Value at risk, E_p – target return, formula $(E_p - X - VaR)^+$ is a positive part of difference $E_p - X - VaR$

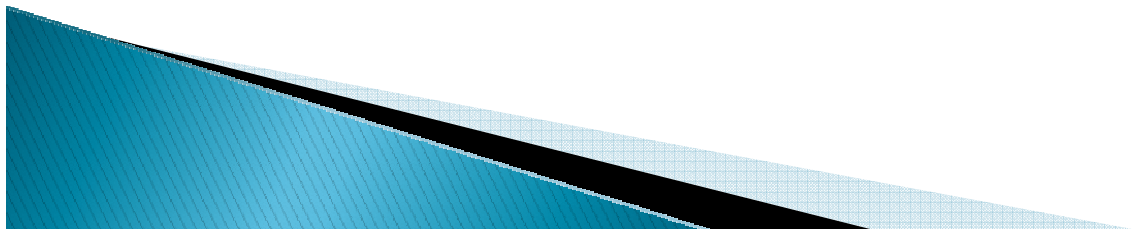


CVaR as linear programming model

Variable X – expectant return of portfolio $w^T r_k$

Objective function:

$$\min \left\{ VaR_\alpha + \frac{1}{\alpha t} \sum_{k=1}^t [E_p - w^T r_k - VaR_\alpha]^+ \right\}$$

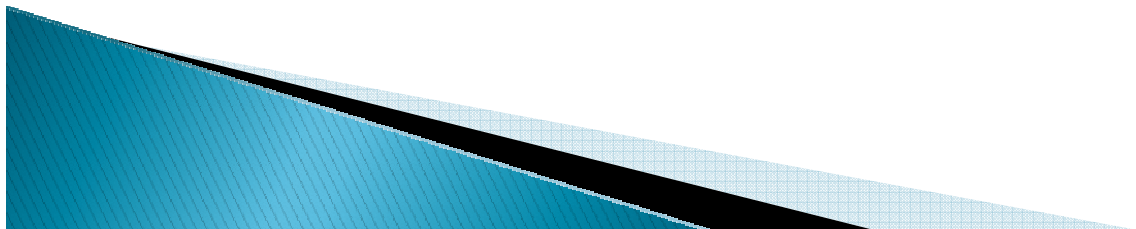


CVaR as linear programming model

To avoid the nonlinear formulation it is necessary to replace the element

$$\left[E_p - w^T r_k - VaR_\alpha \right]^+$$

with the variable $z = (z_1, z_2, \dots, z_t)$, where $z_k \geq 0$ for $k=1, 2, \dots, t$.



CVaR as linear programming model

$$\min \left\{ VaR_{\alpha} + \frac{1}{\alpha t} \sum_{k=1}^t z_k \right\}$$

$$z_k - E_p + w^T r_k + VaR_{\alpha} \geq 0, \quad k = \{1, 2, \dots, t\},$$

$$w^T E(r_n) \geq E_p$$

$$w^T e = 1$$

$$z \geq 0,$$

$E(r_n)$ – vector of expected returns of assets

