Financial Risk Management

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Outline

- Definition of Risk

- GenCo Financial Risk Management: Three Illustrative Scenarios

  - A GenCo signs a bilateral contract with an LSE at its bus
  - A GenCo purchases FTR contracts and signs bilateral contracts with LSEs at different buses
  - A GenCo jointly participates in a day-ahead energy market, an FTR market, and bilateral contracts with LSEs at different buses

- Financial risk management as a four-stage process

Definition of Risk

- K/S rough definition of risk (Chapter 2.4): Deviation from an expected outcome.

- More precise definition of financial risk from the perspective of a profit-seeking GenCo:

Financial Risk = The possibility that a *financial* outcome for the GenCo *adversely* deviates from what the GenCo anticipated.

Financial Risk Management for a Profit-Seeking GenCo

Objective:

- Maintain the "best" possible portfolio of contracts at all times

Contracts Available For Inclusion in GenCo's Portfolio: Examples

- Forward bilateral contracts: forward electric energy contracts
- Day-ahead energy market trades: forward electric energy contracts
- Financial transmission rights (FTRs): forward financial contracts

Data Gathering:

- Transmission grid information
- Historical electricity , fuel price, load and outage data

Sources of Uncertainty:

- Uncertainty about demand conditions and rivals' supply offers
- Uncertainty about fuel costs

Settlement of an FTR Obligation

Example: Settlement $\pi(FTR_{AB})$ of an FTR contract for FTR_{AB} MWs from a "source bus" A to a "sink bus" B:

$$\pi(FTR_{AB}) = (LMP_B - LMP_A) * FTR_{AB} \quad \$/\text{h}$$

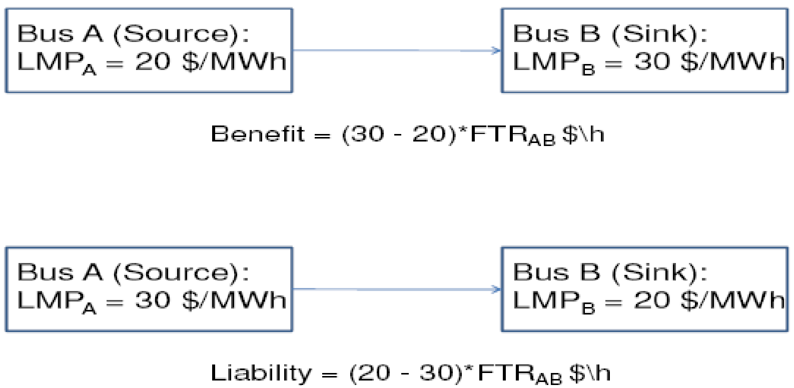
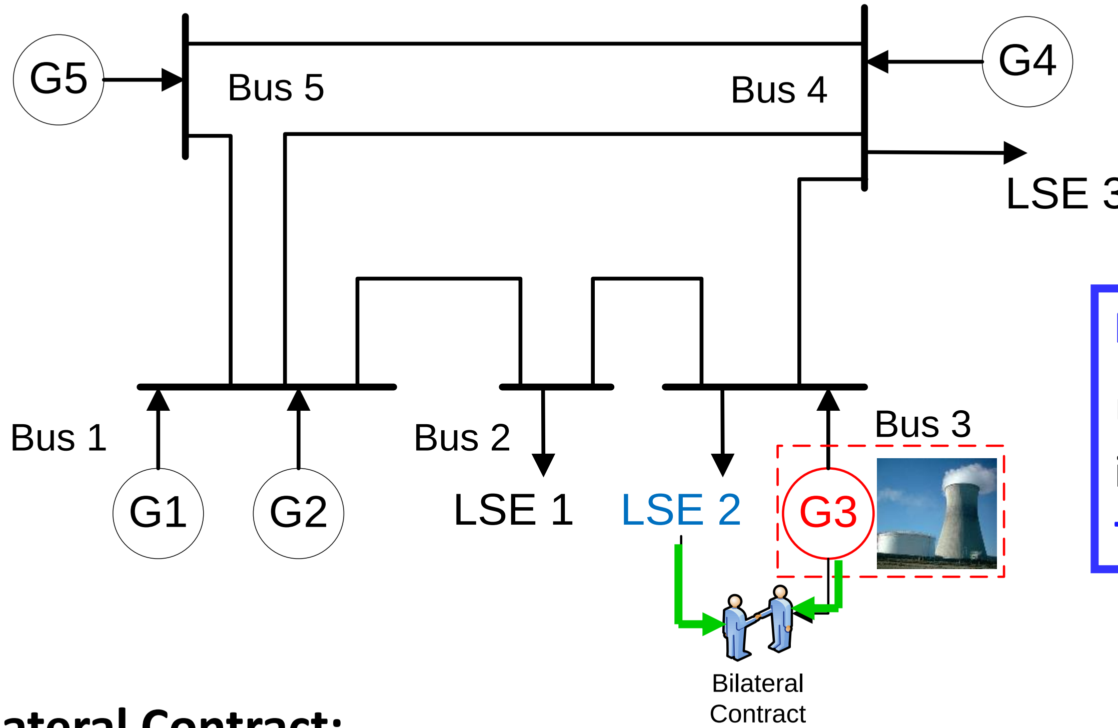


Figure: FTR Obligation and Liability Calculation

Illustrative Scenarios

Scenario One: GenCo G3 can enter into a forward bilateral contract with LSE 2.



Risk Issues:

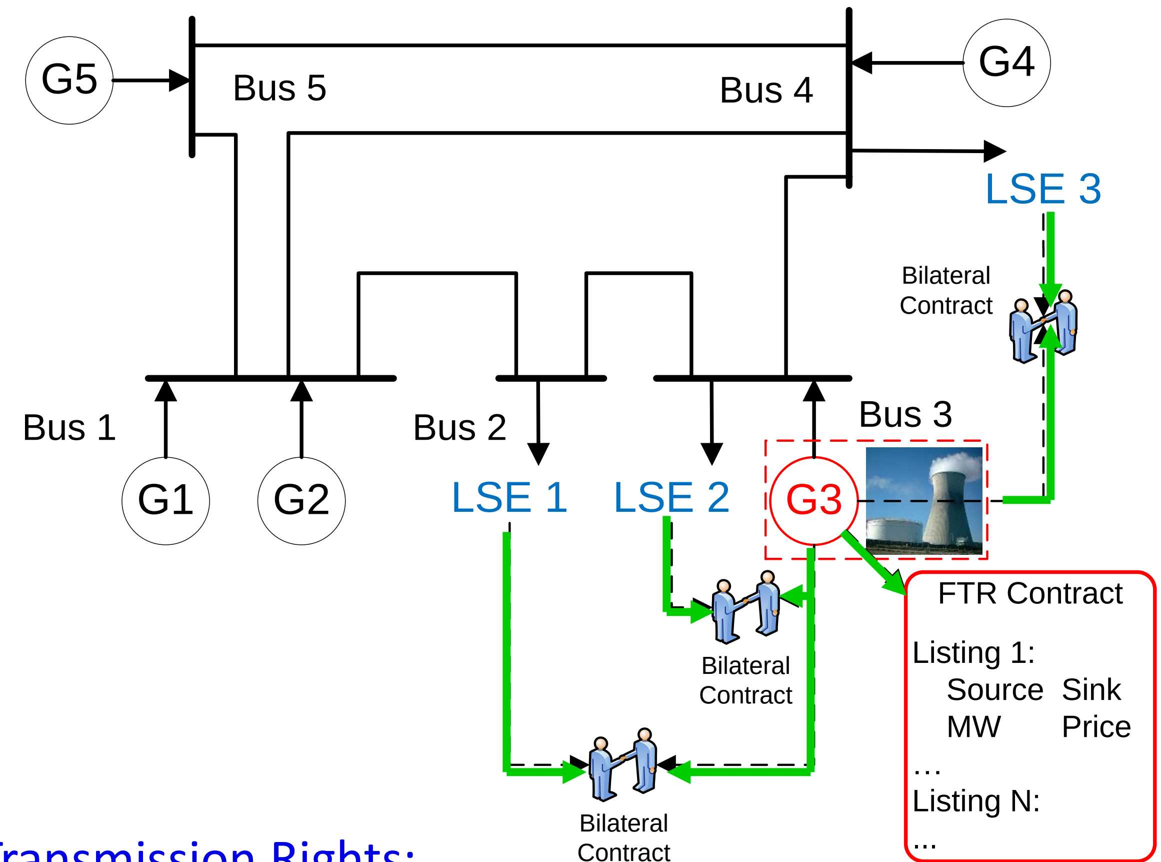
Uncertainty results in **price risk at Bus 3 for G3**

Financial Bilateral Contract:

If GenCo 3 contracts with LSE 2 for q MWs at strike price p for hour h, these responsibilities and liabilities are incurred :

- At hour h, if $LMP^h_3 \geq p$ then GenCo 3 pays LSE 2 the amount $[LMP^h_3 - p] q$.
- However, if $LMP^h_3 < p$ then LSE 2 pays GenCo 3 the amount $[p - LMP^h_3] q$
- LMP^h_3 is the locational marginal price at bus 3 in hour h.

Scenario Two: GenCo G3 can acquire forward bilateral contracts with LSEs *and* purchase FTR contracts from the Independent System Operator (ISO).



Risk Issues:

Uncertainty results in possible price risk at all buses for G3

Financial Transmission Rights:

If GenCo G3 purchases q MWs of FTRs with source at bus 1 and sink at bus 4 at price r:

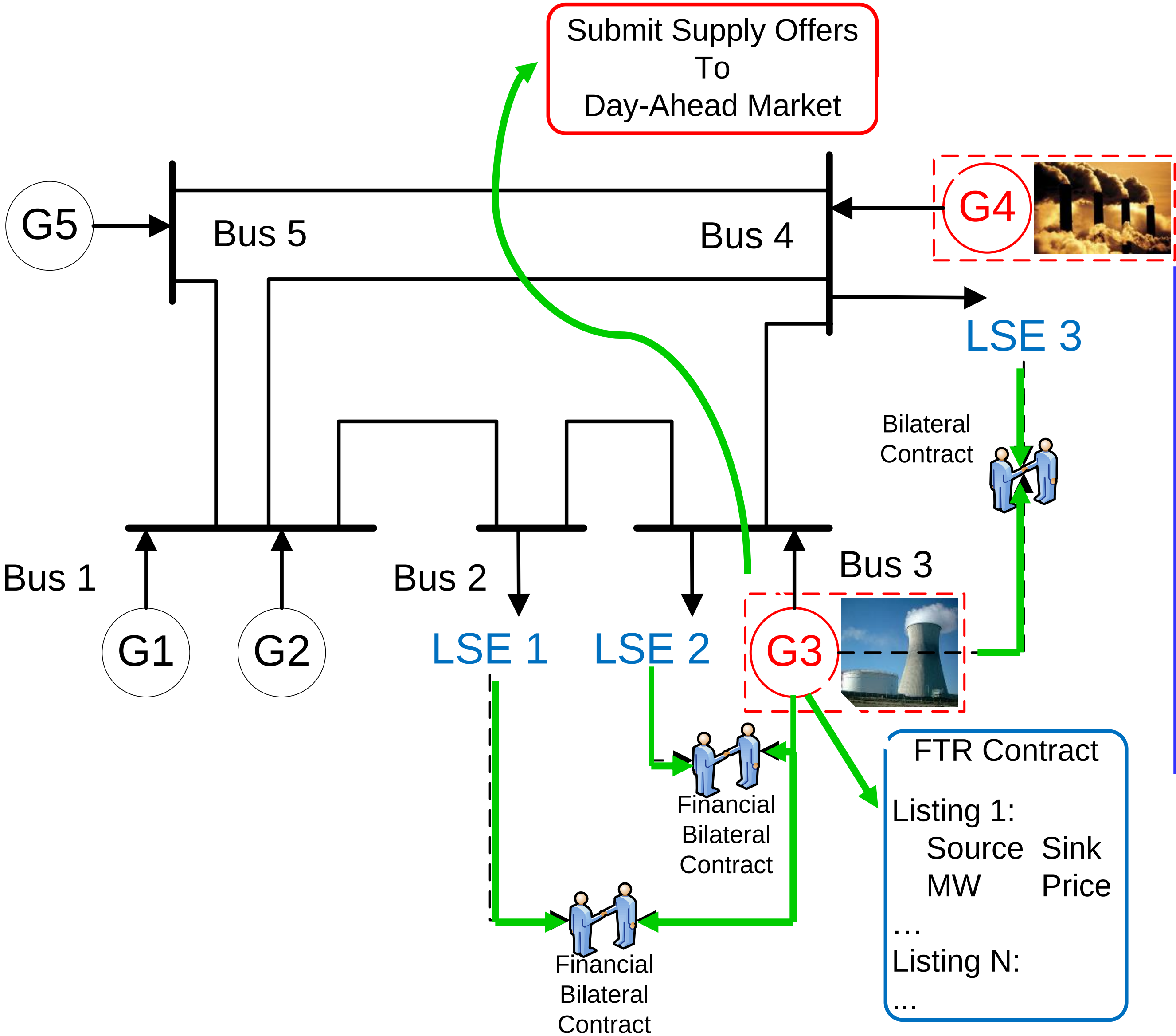
The corresponding FTR will be transferred to GenCo G3 for purchase amount r•q.

The payout (or payment due) for FTR in hour h is $[LMP^h_4 – LMP^h_1]$•q

Need for FTRs to "make whole" forward bilateral contracts between GenCos and LSEs at different buses

- Suppose on Day D that GenCo G3 at Bus 3 signs a forward bilateral contract with LSE 3 at Bus 4 for sale of q MWs at strike price p = 40 $/MWh at hour H of D+1.
- This bilateral contract has a "contract for difference" clause requiring each party to "make whole" the other to assure the effective price is p = 40 $/MWh.
- But at hour H of D+1, LMP_3 = 30$/MWh < p < LMP_4 = 50$/MWh.
- G3 gets q•30$/MWh (too little) & LSE 3 pays q•50$/MWh (too much) relative to p, no way for either to "make whole" the other
- Suppose in addition on Day D that G3 also acquired an FTR for q MWs from Bus 3 to Bus 4 for hour H on Day D+1.
- G3's net earnings from energy sales plus FTR holding at hour H of D+1 are qLMP3 + q[LMP4 – LMP3] = q LMP4 = q.50 $/MWh
- G3 can now "make whole" LSE 3 with a payment of q•10 $/MWh.

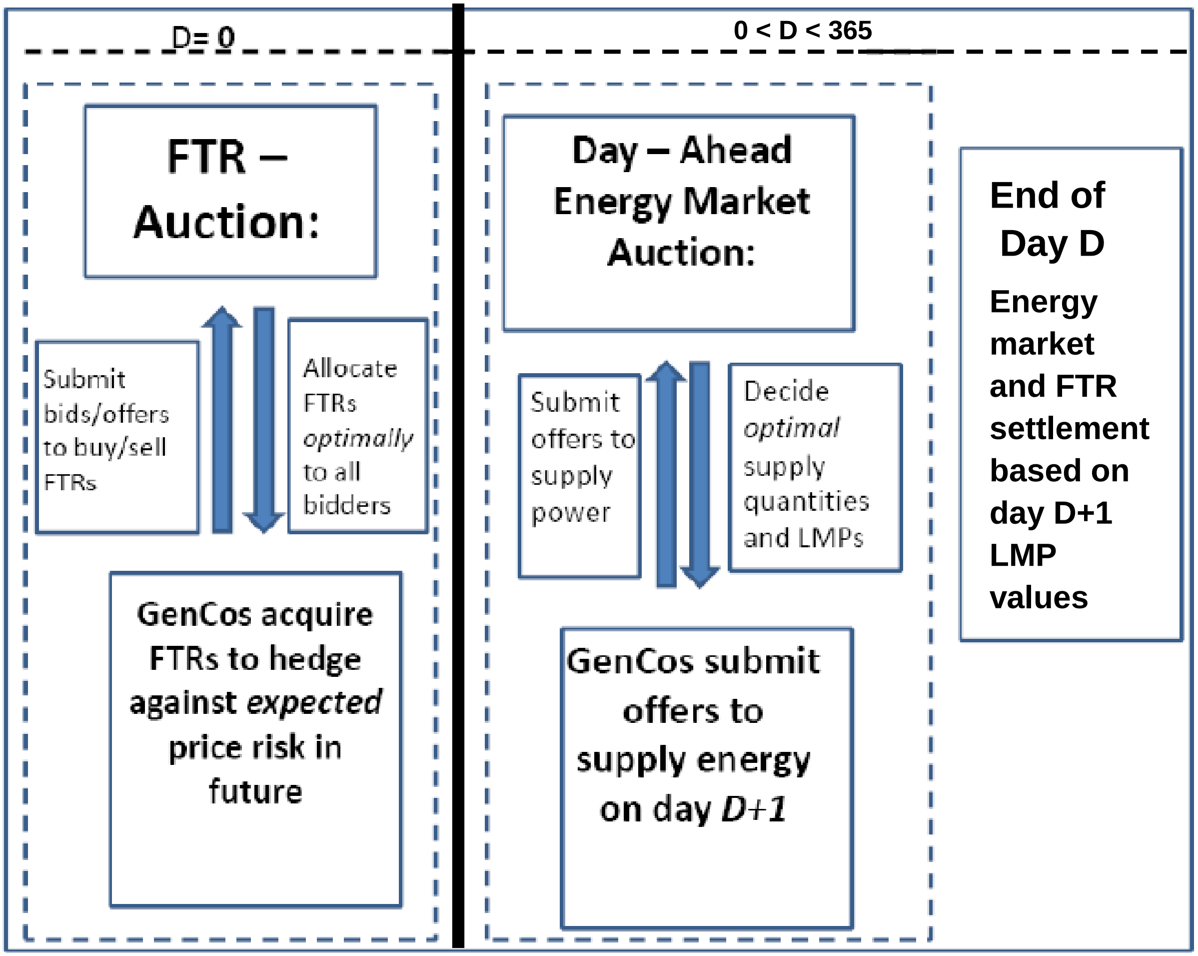
Scenario Three: GenCo G3 simultaneously trades in the day-ahead energy market *and* secures forward bilateral and FTR Contracts.



Risk Issues:

Uncertainty for G3 results in possible price risk at all buses, **plus** risk of adverse dispatch in the day-ahead energy market

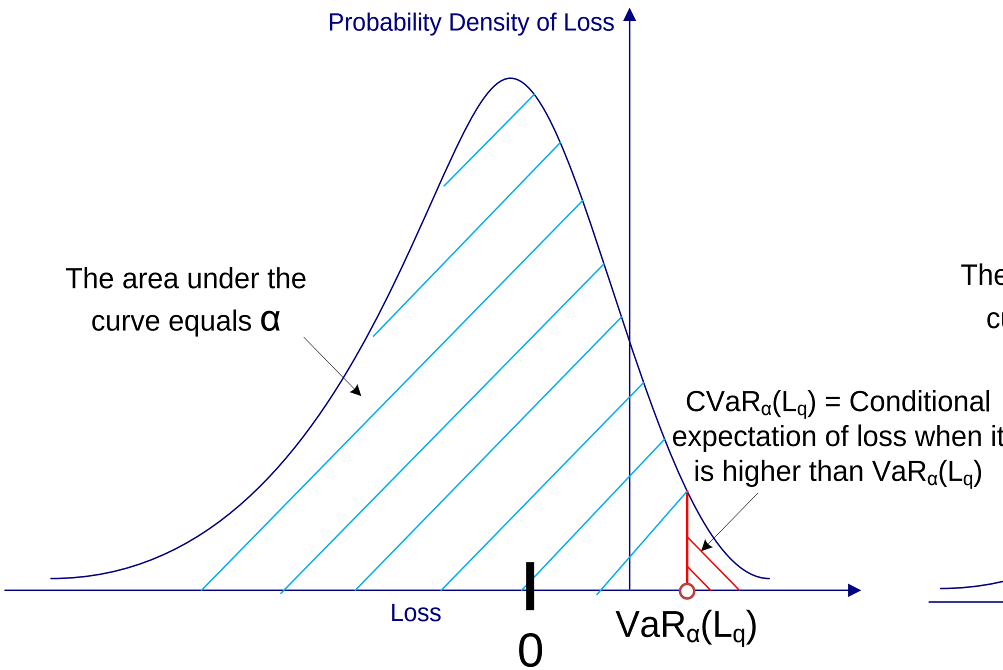
Integrated Operation of Energy and FTR Markets

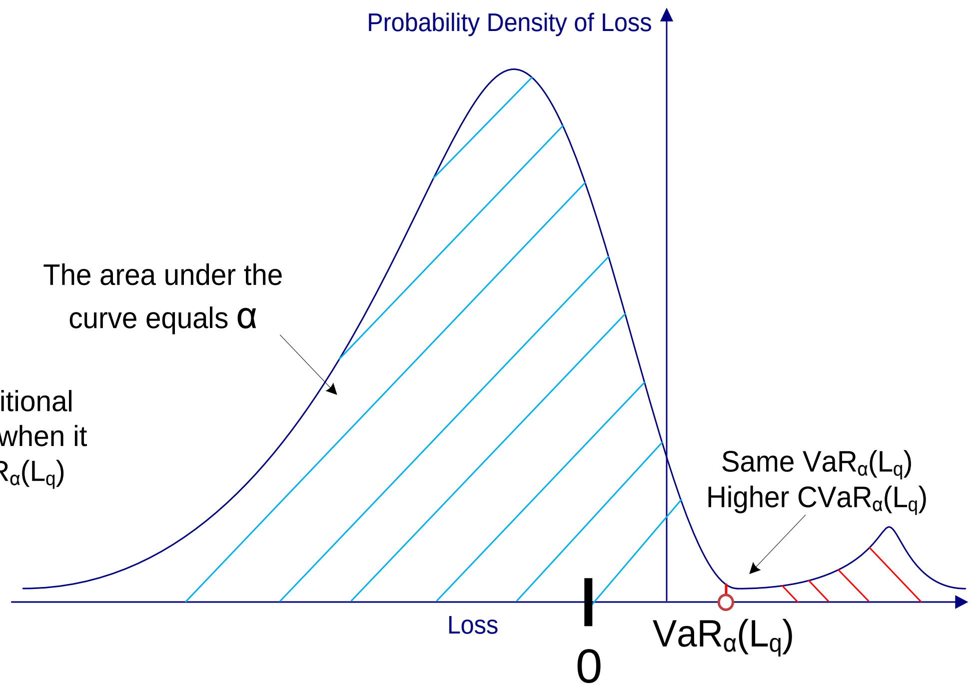


Financial Risk Management as a Four-Stage Process

- *Stage One: Identification and Modeling of Risk Factors*
  - Identify underlying risk factors (***Example:*** Uncertain fuel price P_f)
  - Build a sensible model for these risk factors (e.g., a prob dist fct)
    Example: Prob(P_{f1}) = 2/3, Prob(P_{f2})=1/3
- *Stage Two: Derivation of a Portfolio Loss Function*
  - ***Example:*** Loss(P_{f1}) = \$100/h, Loss(P_{f2}) = \$50/h
- *Stage Three: Derivation of Comprehensive Risk Measures*
  - ***Examples:*** Variance, Value-at-Risk (VaR), Conditional Value-at-Risk (CVaR)
- *Stage Four: Portfolio Optimization*
  - ***Examples:*** Select portfolio to
    - Min [Expected Loss] , where: **Expected Loss = $\sum$ Prob(p_{fj})Loss(P_{fj})**
    - Max [Expected Return Rate – Risk] where: **Risk** = ***variance of return rate***
    - Max [Expected Return Rate – Risk] where: **Risk** = ***VaR or CVar for loss pdf***

VaR Versus CVaR





- Value at risk (VaR): How bad can things get?
  - We are α% certain that our loss will be less than or equal to $VaR_{\alpha}(L_q)$ dollars over the next N days from holding the portfolio q with loss function L_q.
  - α%: Confidence level
  - Negative loss = Gain
- Conditional value at risk (CVaR): If things get bad, how much can we expect to lose ?
  - CVaR: The conditional expected loss during an N-day period given that the loss is greater than or equal to VaR

Var/CVar and the 2009 Financial Crisis

- In theory, the pdf of a portfolio's loss function provides complete info about its risk.
- However, this pdf is too cumbersome for practical use.
- Portfolio managers instead rely on simpler measures of risk, such as variance of the return rate R given by:

$$R \cong [\text{Value}_{D+1} - \text{Value}_D]/\text{Value}_D.$$

- Beginning in 1990s, portfolio managers increasing used Var and CVar in place of variance in recognition that risk is in fact a "one-sided tail event" – i.e., protect against big loss, not big gain!
- But use of simplistic scalar risk measures (variance, VaR, CVar,…) has been singled out as key explanation for the 2009 financial crisis.
- The charge is that portfolio managers failed to properly assess the riskiness of the financial assets they were selling to clients.

References

- ** D. Kirschen and G. Strbac, *Power System Economics*, Sections 2.4 (pp. 33-39) and 6.3.5 (pp. 191-200)

- * N. Yu, A. Somani, and L. Tesfatsion, "Financial Risk Management in Restructured Wholesale Power Markets: Concepts and Tools," *Proceedings*, IEEE Power and Energy Society General Meeting, Mpls, MN, July 2010 (electronic). https://www2.econ.iastate.edu/tesfatsi/FinRiskTutorial.IEEEPESGM2010.pdf