



Insurance and Quantitative Finance
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***“Managing Global Companies via
Decentralized Risk Management”***



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OUTLINE

Part I: Centralized ALM Model for a P/C Insurance Company

- Renaissance Reinsurance vs AXA***
- Centralized vs Decentralized***
- Expected Utility Approach vs Risk-Return Analysis***

Part II: Decentralized Risk Management for a Global Firm via Multi-Stage Stochastic Programs

- Building on concepts of global financial companies***
- Linking strategic and operational decisions***



Earthquake Risk Estimation





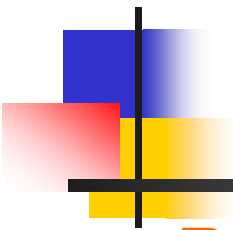
Part I

Renaissance Reinsurance vs AXA

Renaissance Reinsurance:

- Headquartered in Bermuda***
- Global provider of reinsurance and insurance***
- Leader in using sophisticated computer models to construct a superior portfolio.***
- All major decisions made within a single planning environment.***
- 500,000 scenarios - LP models***

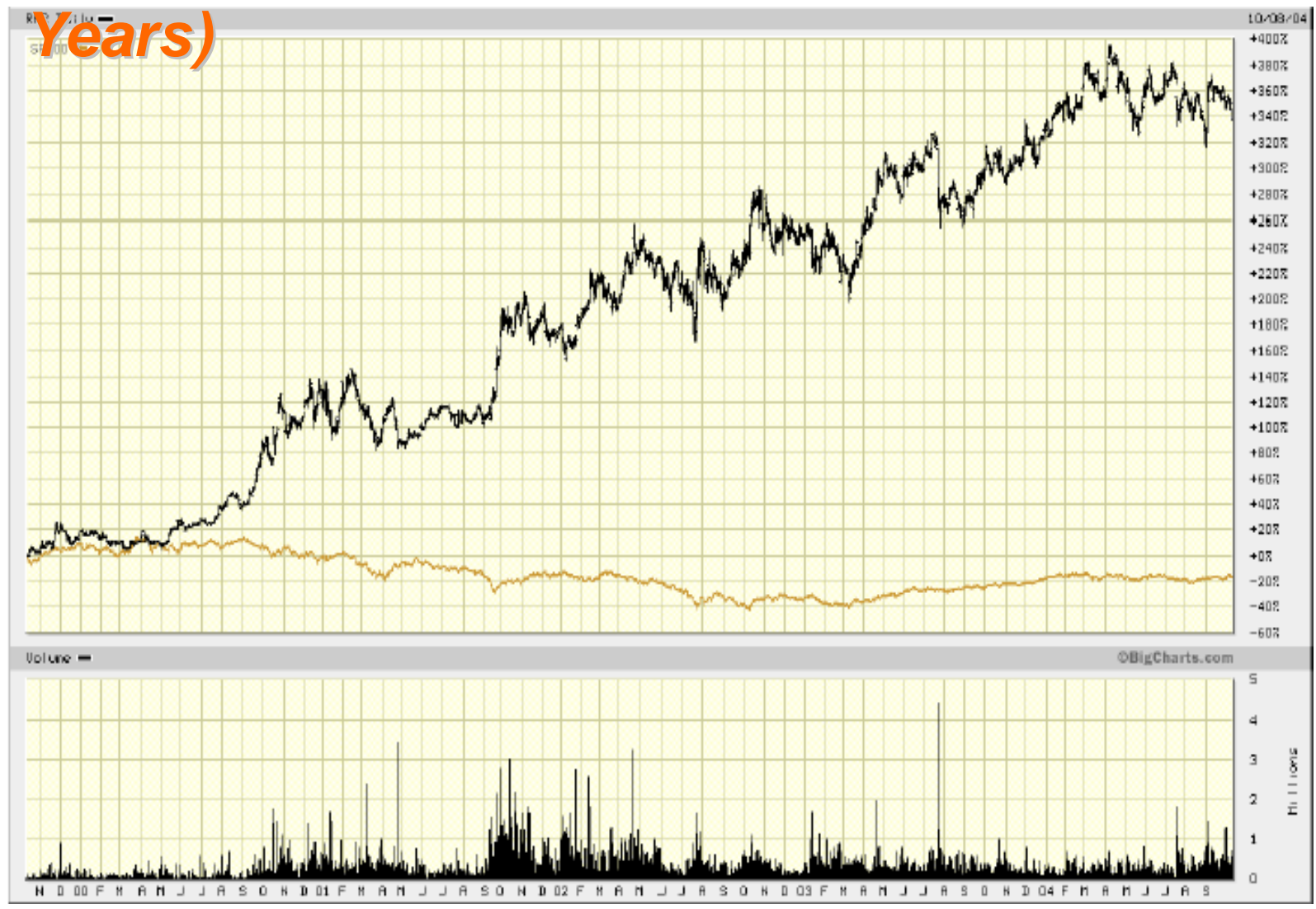




Part I

Renaissance Reinsurance vs AXA

Renaissance Reinsurance vs SP500 (Last 5 Years)

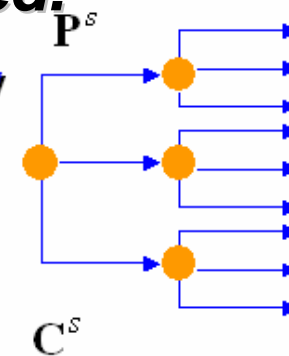
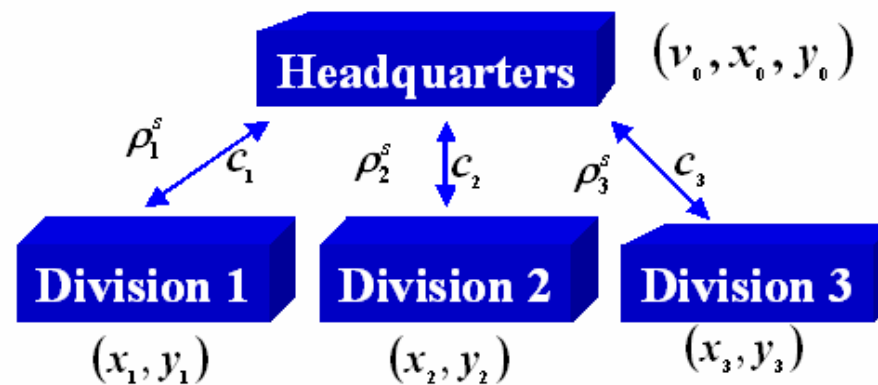


Part I

Renaissance Reinsurance vs AXA

AXA: Global insurer with multiple divisions and becoming more and more diversified.

Global Financial Company AXA



P^s enterprise-level profit (scenario $s \in \mathcal{S}$)

Assume {

- v enterprise-level decisions
- x asset-related decisions
- y liability-related decisions

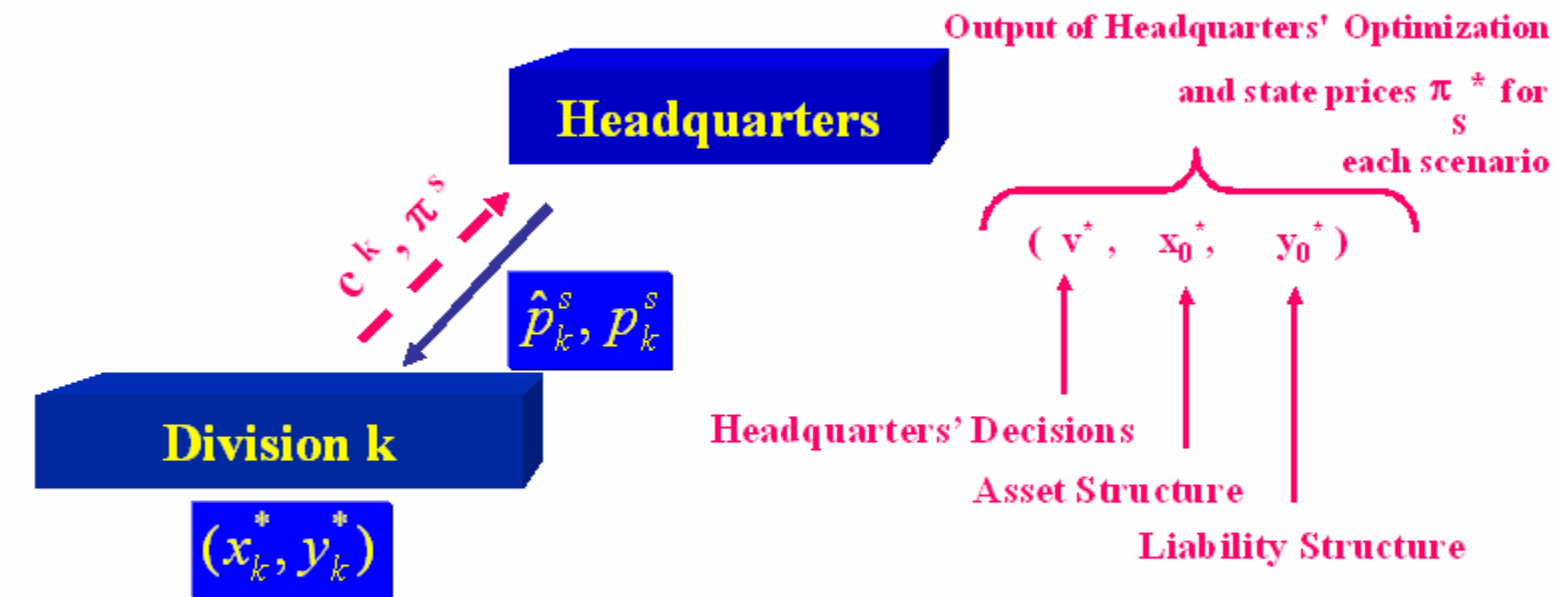


Part I

Centralized vs Decentralized

Decentralized ERM with optimization

State – Price Coordination



Headquarters solve its optimization problem in order to find the best decisions with respect to: capital structure v^* , enterprise assets x_0^* and enterprise-level liabilities y_0^* .

IF $E(\hat{p}) > 0 \Rightarrow$ activity is profitable for the enterprise on the margin





Part I

Centralized vs Decentralized

Fundamental Equations (per time t , per scenario s)

$$\sum_{j \in J} x_{j,t}^s = \text{assets}_t^s \pi_t^s$$

State Prices

$$\sum_{i \in I_r} y_{i,t}^s = \text{product}_{r,t}^s \pi_{r,t}^s$$





Part I

Centralized vs Decentralized

Compute Marginal Risk-Adjusted Profit

- ◆ *Via allocated capital criteria, or*
- ◆ *Employ prices of risk:*
 - *for each new property (losses = $l_{s,t}$)*

$$\textit{profit} = \textit{net revenue} - \sum_{s \in S} l_{s,t} * \pi_{r,t}^s$$



Part I

Expected Utility vs Risk-Return Analysis

Mulvey and Erkan (2003) proves that the maximization of the expected firm's value will be equivalent to the expected utility maximization in terms of the optimal strategy only if the risk premiums are scenario dependent which leads to the concept of state prices (Lagrange multipliers).





Part II

Decentralized Risk Management for Managing Strategic and Operations Risks

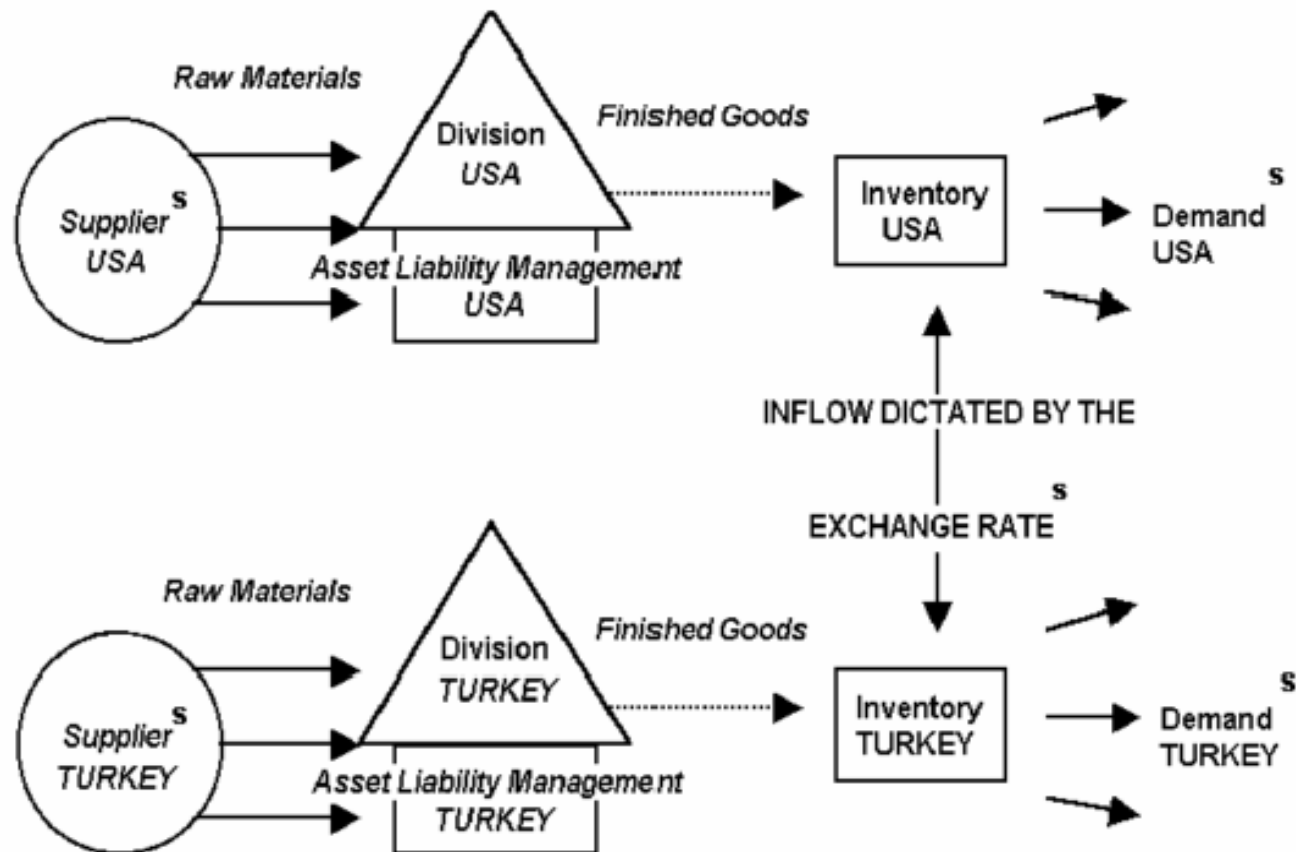
Decentralized Risk Management for a Global Firm via Multi-Stage Stochastic Programs:

- *Linking the Strategic and Operational Risks*
- *Uncertainties*
- *Asset Liability Management*
- *Operational Decisions*



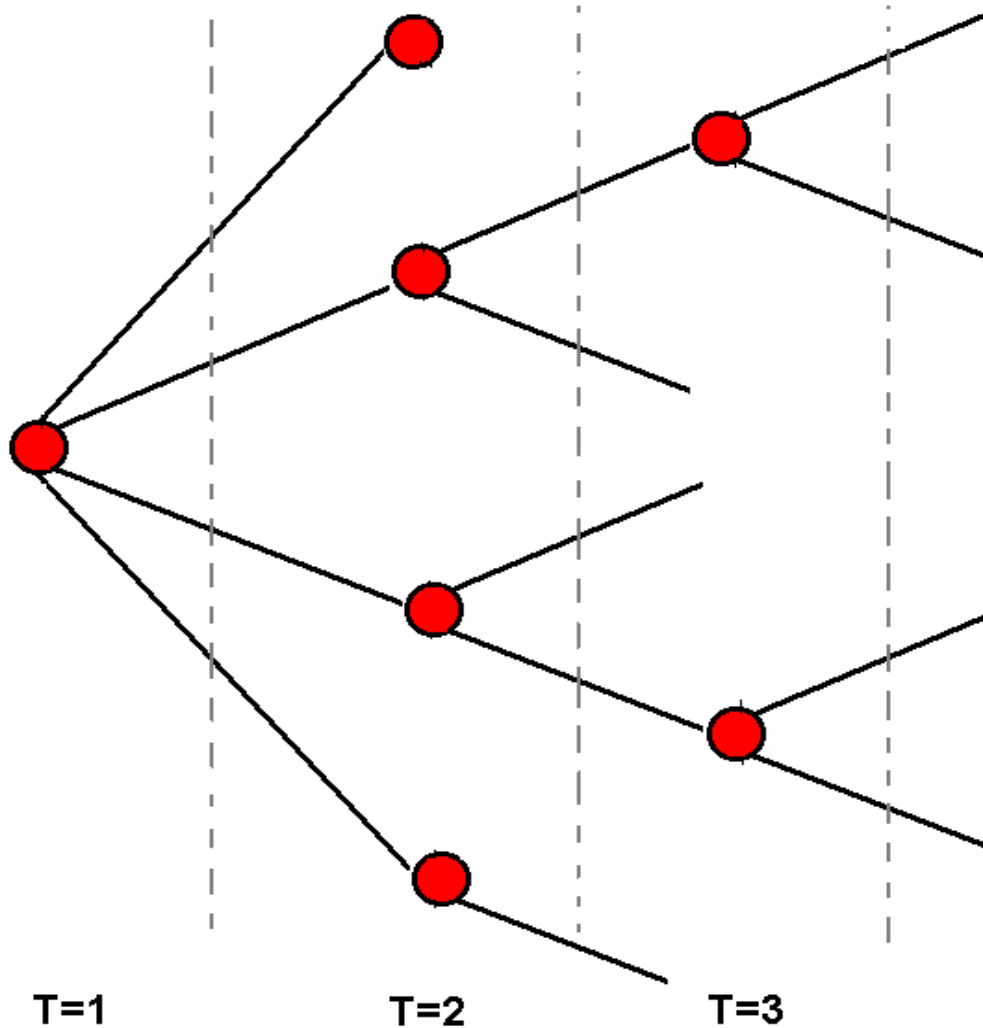
Decentralized Risk Management – Operational Decisions

Decentralized Risk Management for a Global Production-Supply Chain Firm via Multi-Stage Stochastic Programs



Decentralized Risk Management – Operational issues

Nested Benders' Decomposition



Nested Benders' Decomposition:
-Solve the first stage problem first and treat the remaining stages as another multi-stage problem.

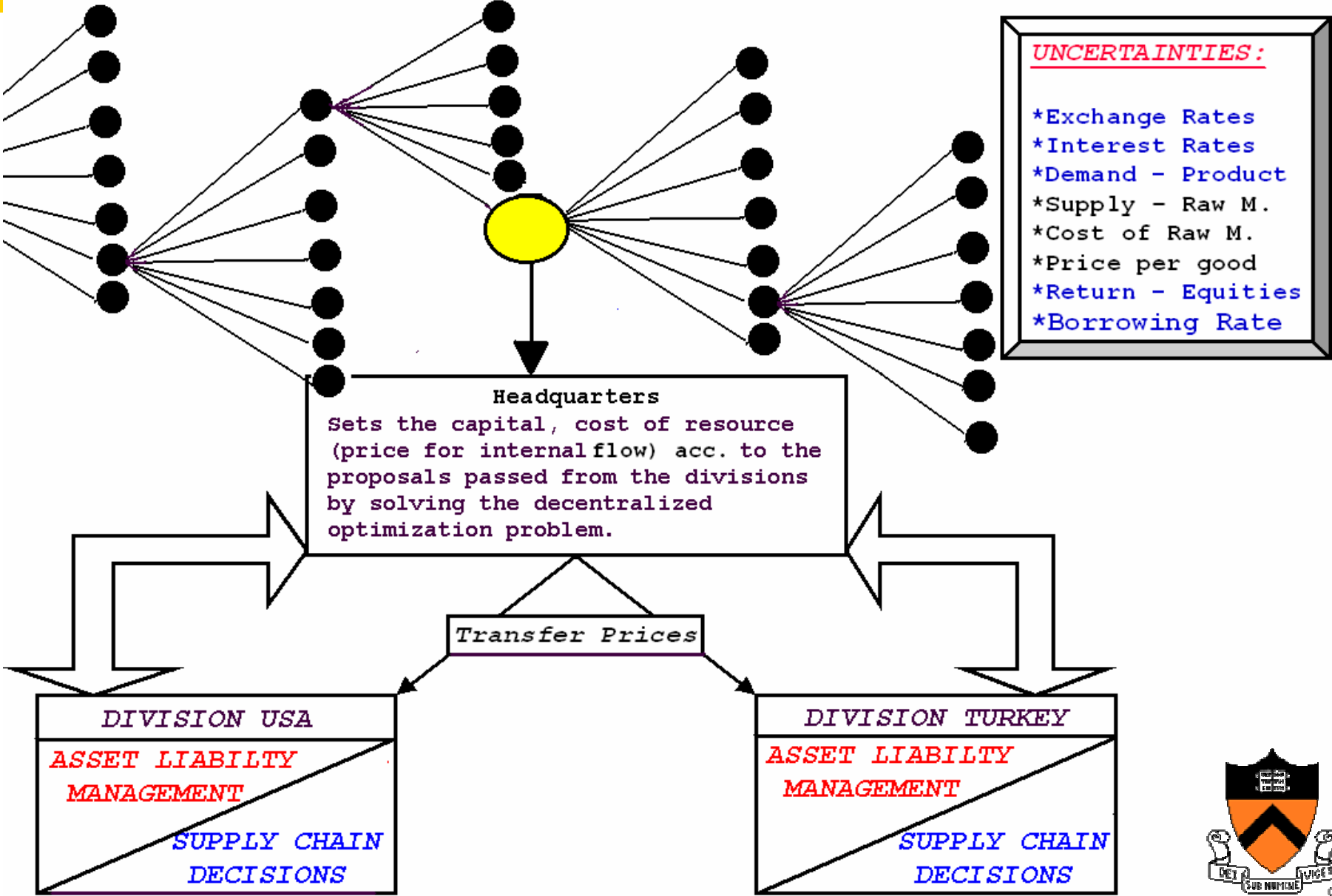
-Generate cuts to stage $t-1$ and proposals to $t+1$.

-As algorithm progresses, current solutions are passed forward to later stages as input, while information is passed back from later stages in the form of feasibility and optimality cuts to the ancestor problems.



Part II

Decentralized Risk Management – Operations



Part II

Decentralized Risk Management - Operations

Building on concepts of global financial companies and Linking strategic and

- A production company with two divisions, in USA(1) and Turkey(2). The headquarters is located in USA. The joint objective function is maximizing expected firm value, ideally the fair value of the conglomerate as described in (Mulvey and Bicer, 2004).

$$\max \sum_s p_s (E_{T,s}^1 + E_{T,s}^2 R_{T,s}^{exchange})$$

- The supply chain decisions and the asset liability management enabling a global production firm to hedge against the uncertainties such as exchange rate, currency movements,...etc. in the countries where the divisions are located.



Part II

Linking strategic and operational decisions

- An Example:
 - Via the decentralization, the only information passed from the headquarters consists of the prices that the divisions are willing to charge for a possible flow of goods.
 - The rest of the optimization is handled at the division level where we pass the same set of scenarios to the divisions.

Method	Subprob.	Objective	Constr.	Var.	min.
NBD	31	\$139,014	93	98	2:40
EDP(Split)		\$138,785	1440	2240	≤ 1

$\tau = 2$; debt ratio = USA 3 TURKEY 1; debt/equity ratio = USA 2 TURKEY 1; asset/capital ratio = USA 3 TURKEY 2 ; dividend payout ratio = USA 0.05 TURKEY 0.06; tax rate = USA 0.2 TURKEY 0.1; risk penalty = USA 0.2 TURKEY 0.4; starting capital = USA \$20000 TURKEY \$40000.

