INTRODUCTION TO OPTIMIZATION: COMPARING PORTFOLIO ALLOCATION WITH DETERMINISTIC X STOCHASTIC ASSUMPTIONS

IMAGINE RISKS AND ANALYTICS
Rafael Hartke, M.Sc., MBA, ERP




IMAGINE
RISKS AND ANALYTICS

LUMIVERO

Imagine Risks and Analytics

- Risk Management
- Monte Carlo Simulation
- Optimization Models
- Predictive Analysis
- Statistical Tools
- Machine Learning
- Customized Solutions

IMAGINE RISKS AND ANALYTICS

Imagine Risks and Analytics is a consulting firm specialized in Risk Management and Predictive Analysis.

We work with the best tools and methodologies in order to offer clients customized and exclusive solutions.

We believe in mathematics as a way to explain the world, in the power of teamwork, and in ethics as a value.

Imagine Risks and Analytics

- Risk Management
- Monte Carlo Simulation
- Optimization Models
- Predictive Analysis
- Statistical Tools
- Machine Learning
- Customized Solutions

Rafael Hartke, M.Sc., MBA, ERP

rhartke@imaginerisks.com

linkedin.com/in/rafaelhartke

- Imagine Risks & Analytics – Founder and Consultant (São Paulo/Global)
- Palisade Corporation – Senior Risk Consultant (NYC/Global)
- Petrobras – Risk Management (Rio de Janeiro)
- M.Sc. in Mechanical Engineering / MBA in Finance, Investment and Risk
- Certified Energy Risk Professional (ERP)

Large experience in Oil&Gas, energy and infrastructure projects, valuation, cash flow modeling, forecasting, risk analysis and project analytics

LUMIVERO

This Webinar

- Portfolio Analysis
- Optimization
- Deterministic Optimization
- Uncertainties and Risks
- Stochastic Optimization
- Robust Strategies

How to find a Portfolio Allocation that is both **optimized and robust** in face of an **uncertain future**?

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

This Webinar

- Portfolio Analysis
- Optimization
- Deterministic Optimization
- Uncertainties and Risks
- Stochastic Optimization
- Robust Strategies

How to find a Portfolio Allocation that is both optimized and robust in face of an uncertain future?

Optimization is a very important tool in **business decisions**, but there's a huge difference in outcomes if the business environment deviates from the **assumptions used to optimize the strategy**.

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

This Webinar

- Portfolio Analysis
- Optimization
- Deterministic Optimization
- Uncertainties and Risks
- Stochastic Optimization
- Robust Strategies

How to find a Portfolio Allocation that is both optimized and robust in face of an uncertain future?

In this webinar we will show the difference between deterministic and **stochastic optimization**, and how we can develop much more **robust strategies** by **accounting for uncertainties** in the models.

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

This Webinar

- Portfolio Analysis
- Optimization
- Deterministic Optimization
- Uncertainties and Risks
- Stochastic Optimization
- Robust Strategies

How to find a Portfolio Allocation that is both optimized and robust in face of an uncertain future?

Stochastic optimization helps integrate both **risk analysis and optimization into a single process**, generating a **decision strategy** that is both **optimized and robust** in face of an uncertain future.

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

This Webinar

- Portfolio Analysis
- Optimization
- Deterministic Optimization
- Uncertainties and Risks
- Stochastic Optimization
- Robust Strategies

How to find a Portfolio Allocation that is both optimized and robust in face of an uncertain future?

We will demonstrate how to perform **Portfolio Allocation under a context of uncertainty** using stochastic optimization, and compare the resulting decision strategy with the traditional deterministic optimization.

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

This Webinar

- Portfolio Analysis
- Optimization
- Deterministic Optimization
- Uncertainties and Risks
- Stochastic Optimization
- Robust Strategies

Ignoring risk does not make it go away…

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

This Webinar

- Portfolio Analysis
- Optimization
- Deterministic Optimization
- Uncertainties and Risks
- Stochastic Optimization
- Robust Strategies

Before we continue, just a quick definition of stochastic optimization…

Stochastic optimization may refer to the use of randomness in:

i. the optimization algorithm (that runs within the software, such as genetic algorithm)

ii. **the objective function (the business problem to maximize/minimize)**

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

DecisionTools Suite

- @RISK
- PrecisionTree
- Evolver
- RISKOptimizer
- StatTools
- NeuralTools
- TopRank

DecisionTools Suite

@RISK

Evolver/RISKOptimizer

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

DecisionTools Suite

- @RISK
- PrecisionTree
- Evolver
- RISKOptimizer
- StatTools
- NeuralTools
- TopRank

Typical DTS applications:

- Reserve estimation and production risk analysis
- CAPEX/cost estimation and contingency
- Schedule risk analysis and contingency
- Resource allocation
- Economic/NPV risk analysis (schedule, cost, production, prices...)
- Planning with decision tress
- Value of information, flexibility, option, etc...
- Real options valuation
- Portfolio optimization under uncertainty
- Prices/curves forecasting

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

DecisionTools Suite

- @RISK
- PrecisionTree
- Evolver
- RISKOptimizer
- StatTools
- NeuralTools
- TopRank

@RISK features:

- Monte Carlo simulation
- Extensive modeling capabilities
- Broad library of probability distributions
- Data fitting tools (distributions and time series)
- Correlation modeling
- Sensitivity analysis
- Customizable and exportable graphs and reports
- 100% Excel integration

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

DecisionTools Suite

- @RISK
- PrecisionTree
- Evolver
- RISKOptimizer
- StatTools
- NeuralTools
- TopRank

Evolver features:

- Deterministic optimization tool
- 100% Excel integration
- Easy to use, interface similar to Excel's solver
- Supports real, integer and step variables
- Supports multiple adjustable cells and constraints
- Efficient search methods and optimization engines
- Reports on the best/optimized solution and also on all solutions tested

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

DecisionTools Suite

- @RISK
- PrecisionTree
- Evolver
- RISKOptimizer
- StatTools
- NeuralTools
- TopRank

RISKOptimizer features:

- Stochastic optimization tool
- 100% Excel integration
- Combines the Monte Carlo simulation of @RISK with the optimization of Evolver

Optimization

- Portfolio Analysis
- Optimization
- Deterministic Optimization
- Uncertainties and Risks
- Stochastic Optimization
- Robust Strategies

We will use @RISK, Evolver and RISKOptimizer to understand and model:

i. Portfolio Analysis Without Optimization

    Portfolio analysis done manually

ii. Optimization Objectives and Constraints

iii. Deterministic Optimization

    Portfolio optimization under a single scenario

iv. Risks and Uncertainty Versus Optimization

    Monte Carlo simulation, optimization objectives and constraints

v. Stochastic Optimization

    Portfolio optimization under multiple scenarios

vi. Robust Strategies, Strategy Cloud and Efficient Frontier

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

Optimization?

- Strategy
- Objectives
- Constraints

Risk Analysis?

- Results and Benefits

Optimization and portfolio analysis:

- In business, **portfolio optimization is the process of searching for the strategy that maximizes/minimizes a desired business result**
- The **strategy** can be the allocation, use or investment/disinvestment of assets, projects, resources, budget, time, or any **decision variable** of the business!
- Requires a business **objective to optimize** (NPV, production, market share, costs, probability of success, etc.)
- May also include **business constraints** (budget, available time, available resources, etc.)

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

Optimization?

- Strategy
- Objectives
- Constraints

Risk Analysis?

- Results and Benefits

Optimization and risk:

Deterministic optimization works with static assumptions and finds the optimal strategy for that single scenario

The deterministic optimal strategy can be optimal for that single scenario, but it extremely bad and violate the business constraints under other alternative scenarios

Stochastic optimization accounts for uncertainty within the assumptions (risks, modeled as probability distributions), and finds an optimal strategy that is both optimized and robust

The stochastic optimal strategy will be quasi-optimal and respect the business constraints under all possible scenarios

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

Optimization?

- Strategy
- Objectives
- Constraints

Risk Analysis?

- Results and Benefits

Risk analysis models:

- Risk analysis is an evolution of traditional analyses, moving analysis beyond the deterministic world
- **Explicitly acknowledge uncertainties**
- Project risks are modeled based on probabilities and impacts, using **probability distributions**

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

Optimization?

- Strategy
- Objectives
- Constraints

Risk Analysis?

- Results and Benefits

Risk analysis models:

- Provide ranges and probabilities for the project's traditional metrics, along with new, **risk based metrics to support decisions**
- Allow the **identification of key risk drivers** and the valuation of mitigating strategies
- Allow assessing the impact of rare, extreme events

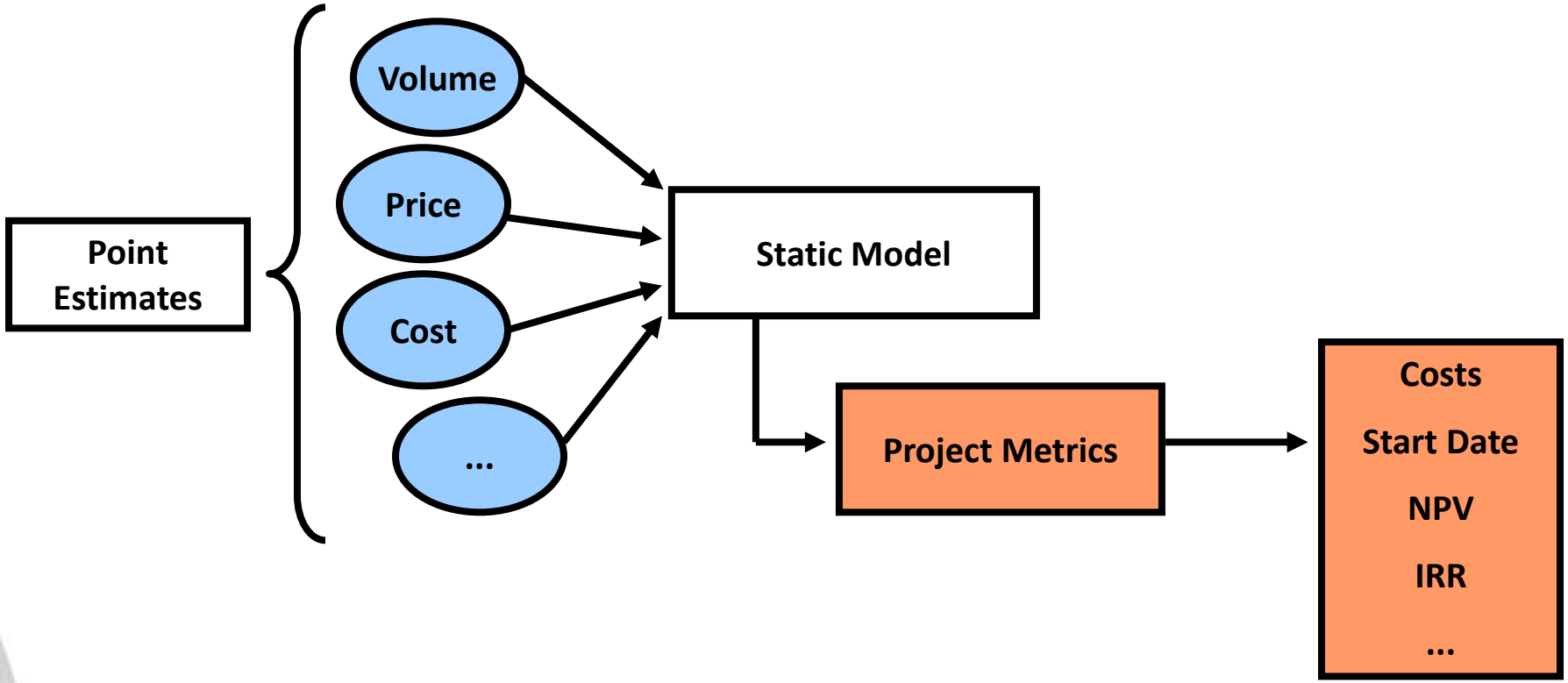
Start qualitative, then go quantitative

IMAGINE
RISKS AND ANALYTICS

LUMIVERO

Traditional Analysis

- Statics Metrics/KPIs
- Poor Sensitivities
- Single Scenario
- Static Inputs
- No Correlations
- Not Realistic

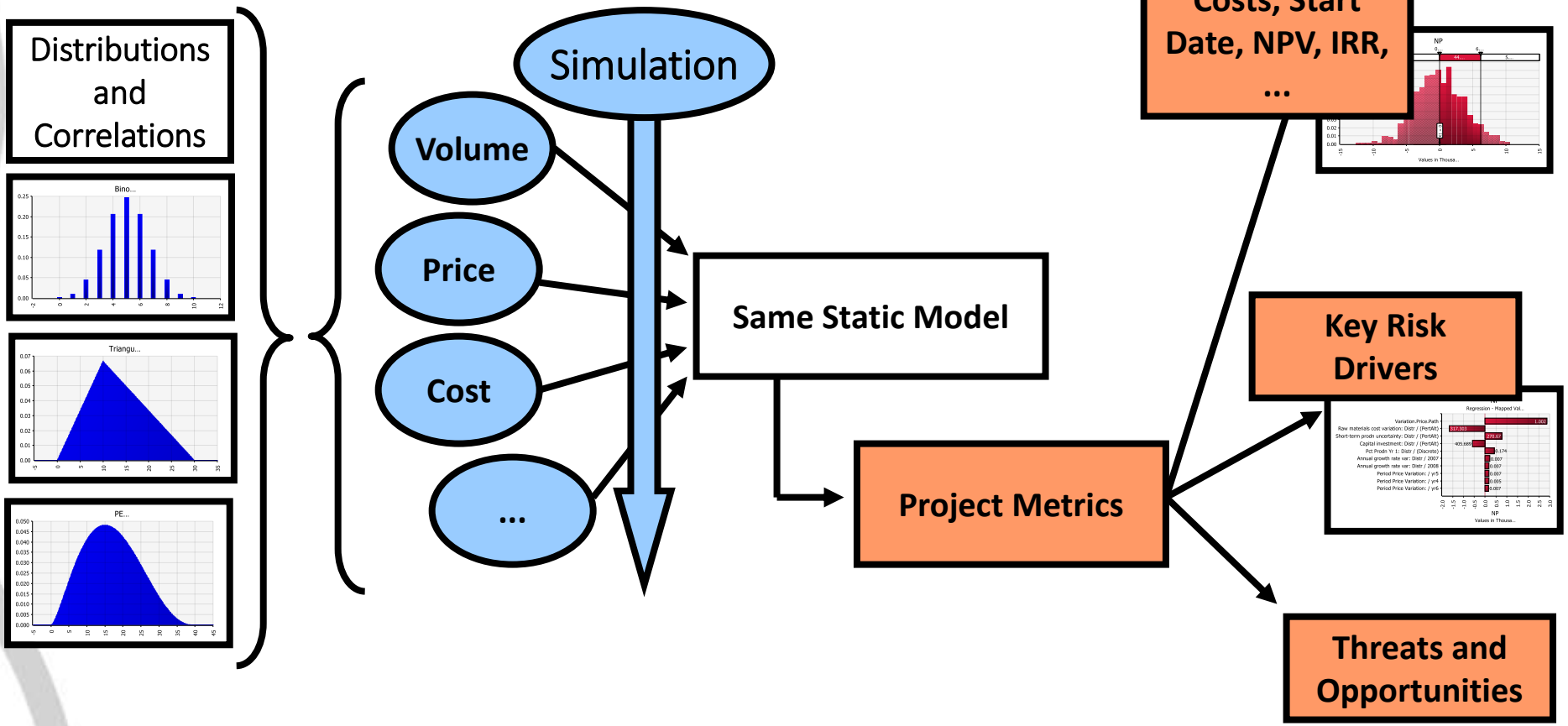


IMAGINE
RISKS AND ANALYTICS

LUMIVERO

Risk Analysis

- Monte Carlo Simulation
- Risk Metrics/KPIs
- Risk Drivers
- Threats & Opportunities
- Distributions
- Correlations
- Same Model
- More Realistic
- Fast Learning Curve



Optimization

- Portfolio Analysis
- Optimization
- Deterministic Optimization
- Uncertainties and Risks
- Stochastic Optimization
- Robust Strategies

We will use @RISK, Evolver and RISKOptimizer to understand and model:

i. Portfolio Analysis Without Optimization

    Portfolio analysis done manually

ii. Optimization Objectives and Constraints

iii. Deterministic Optimization

    Portfolio optimization under a single scenario

iv. Risks and Uncertainty Versus Optimization

    Monte Carlo simulation, optimization objectives and constraints

v. Stochastic Optimization

    Portfolio optimization under multiple scenarios

vi. Robust Strategies, Strategy Cloud and Efficient Frontier

More Information...

- Risk Modeling
- Consulting
- Training
- Events
- Contact

IMAGINE RISKS AND ANALYTICS

Rafael Hartke

rhartke@imaginerisks.com

linkedin.com/in/rafaelhartke

Palisade Events:

palisade.com/events

Palisade Contact:

tech-support@palisade.com

contact@palisade.com

Rafael Hartke

rhartke@imaginerisks.com

rhartke@imaginerisks.com.br

+55 11 98014-6989

+55 54 98425-7669

Rafael Hartke <rhartke@imaginerisks.com>

Consultant With 15+ Years Of Experience In Risk Management And Predictive Analysis

- Profound knowledge in the areas of Energy, Oil&Gas and Finance
- Methodologies for valuation and risk analysis in projects, schedule, budgets, investments, and securities
- Building forecasting and risk models for budgets, revenues, cash flows, CFaR/VaR, production/demand/sales curves, and macroeconomic variables (exchange rates, inflation, interest rates, commodities)
- Risk modeling of extreme/rare events (political, regulatory, environmental, logistical risks, and others)
- Predictive analyses: regression/classification, time series, neural networks, machine learning, decision trees, stochastic optimization, Monte Carlo simulation
- Optimization of portfolios, critical resources and projects
- Multiple working platforms: Excel, Project, VBA, R, @RISK, DecisionTools Suite, ModelRisk, Tamara, among others...
- Ability to translate complex concepts of statistics and business into models in a simple and straightforward way
- Strategic thinking, focused on results, ethics, cooperation and team work, attention to detail, great listener and quick learner