

Petroleum Forecasts under Risk and Uncertainty

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Decision Precision[®]

PetroSkills[®] – OGCI[®]

Why Forecast?

- Anything more important to your success?
- Most-important analytic problem
- Decision-making is easy with “good forecasts”

Petroleum Situation

- **Peak Oil** (fossil liquid hydrocarbons)

- ▶ Has happened _____

- ▶ 1-5 years _____

- ▶ 5-10 years _____

- ▶ 10+ years _____

- ▶ Never _____

Situation Assessments

- **Oil Price** in ____ years
- **Fossil fuel share** of energy mix in ____ yrs
- In ____ years **Global Warming** will _____
- **Emerging economies** will require _____

Topics

- Forecast vs. Projections
- Probability — Language of Uncertainty
- Decision Analysis
- Price Behavior
- Price Modeling
- Financial Crisis

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Forecast vs. Projections

- Projection

- ▶ a what-if scenario

- Forecast

- ▶ The projection that you believe most
- ▶ Probability-weighted average of projections (possible realizations)
- ▶ Pre-1991 Gulf War, Sept ?? 1990, **OGJ**

Forecasting Methods

- **Guess** (intuition; group methods)
- **Extrapolate** (regression; time-series analysis, curve-fitting)
- **Model** our understanding of the system

Decision-making
always involves forecasts.

Credible Forecast

- Suited to the purpose
- Unbiased
 - ▶ Average error = 0
- Not too narrow
 - ▶ Overconfidence bias
- Transparent and trusted methods

Dr. George Cressman

“Apparently many people want the latest forecast simply because it reassures them. It shows that the U.S. government is watching the weather and that bad weather will arrive and depart more or less on schedule.”

Topics

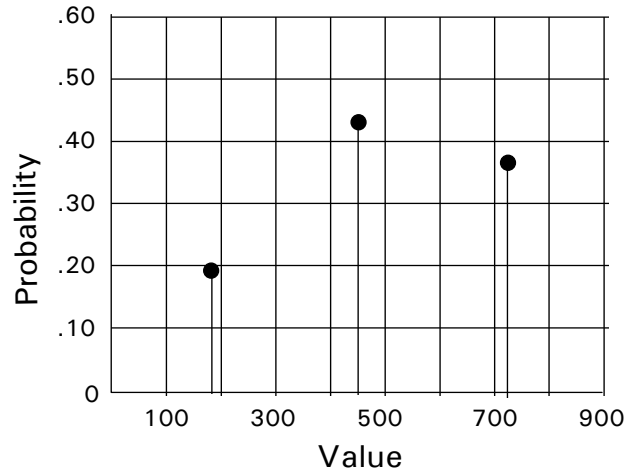
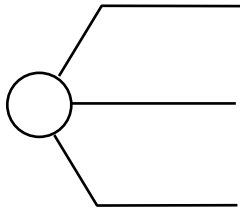
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Probabilities

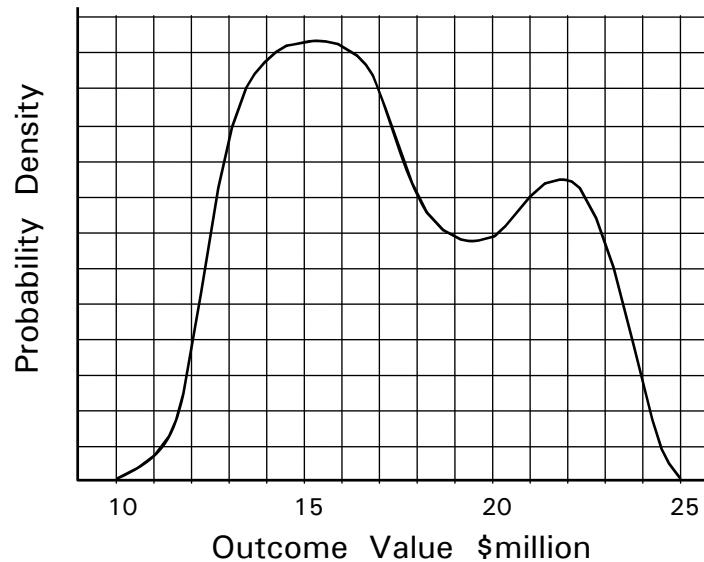
- 0-1 fraction
- “I judge a 30% chance of success for the well. But I may be wrong.”
- You will always be wrong!
- A probability represents judgment about degree of belief.
- Calibration chart

Probability Distributions

● Discrete

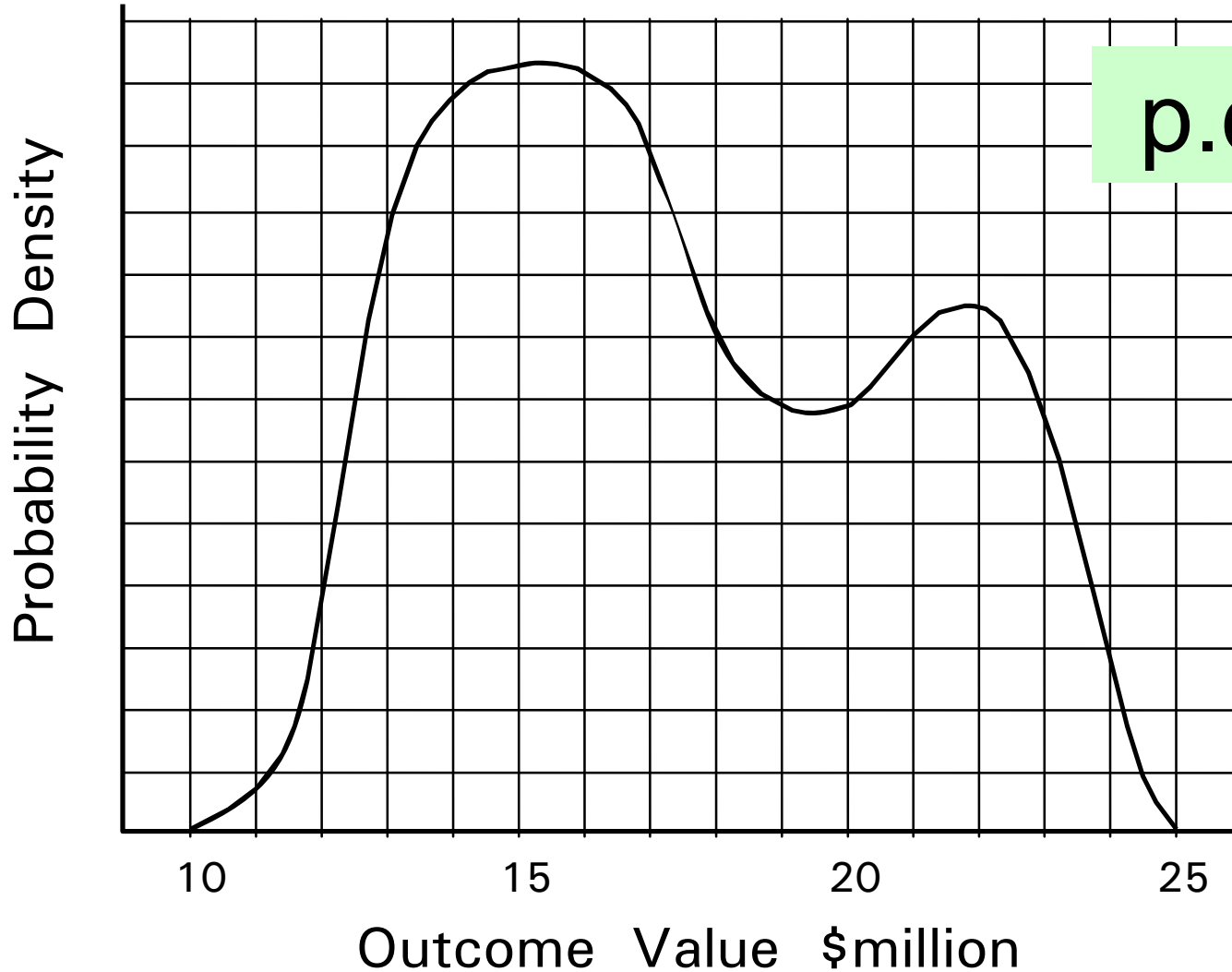


● Continuous

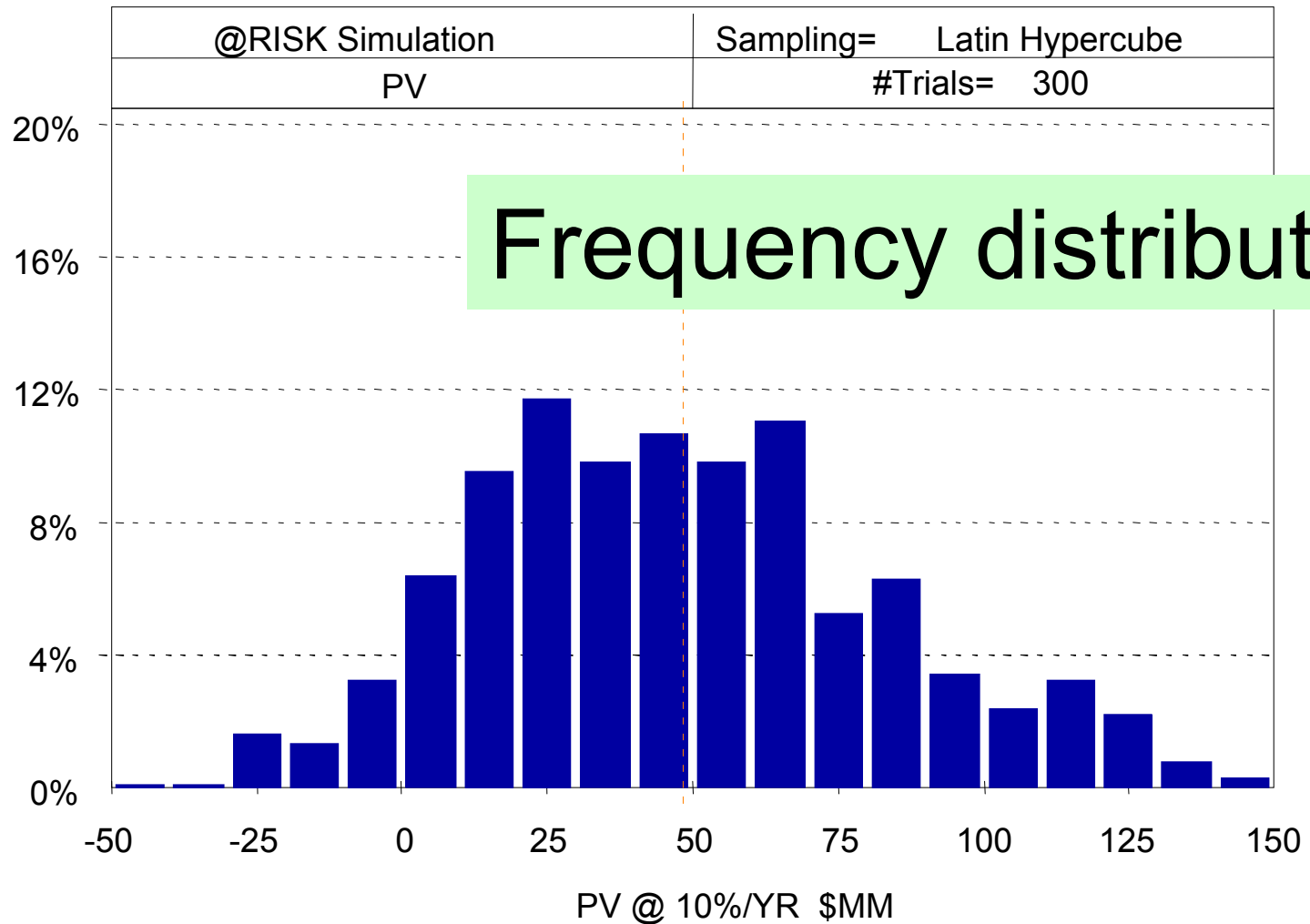


Larger next

Probability Distributions



Analysis Result - Histogram



Domain Experts - SMEs

- Problem and system description
 - ▶ Structure
- Judgments about input values
 - ▶ Probabilities and probability distributions
- Correlation (association) between variables

It's all structured and quantified.

Judgment biases

- Overconfidence
- Motivation
- Anchoring
- Recall
- Etc.

Often, an interviewer will help elicit the judgment.

Distribution Shapes

- Hundreds have been defined
- Additive processes → **normal** distribution
- Multiplicative processes → **lognormal**
 - ▶ Truncate long tail?
 - ▶ *The Black Swan* by Nicholas Taleb

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Decision Analysis (DA)

“Tools and techniques to help the decision maker choose wisely under uncertainty.”

—Paul Newendorp

Three Characteristics of DA

- Probabilities represent judgments
- Decision policy based upon maximizing value ... and a way of measuring
 - ▶ Objective
 - ▶ Time preference **(not risking!)**
 - ▶ Risk attitude **(to be conservative)**
- Expected value calculation

Why do DA?

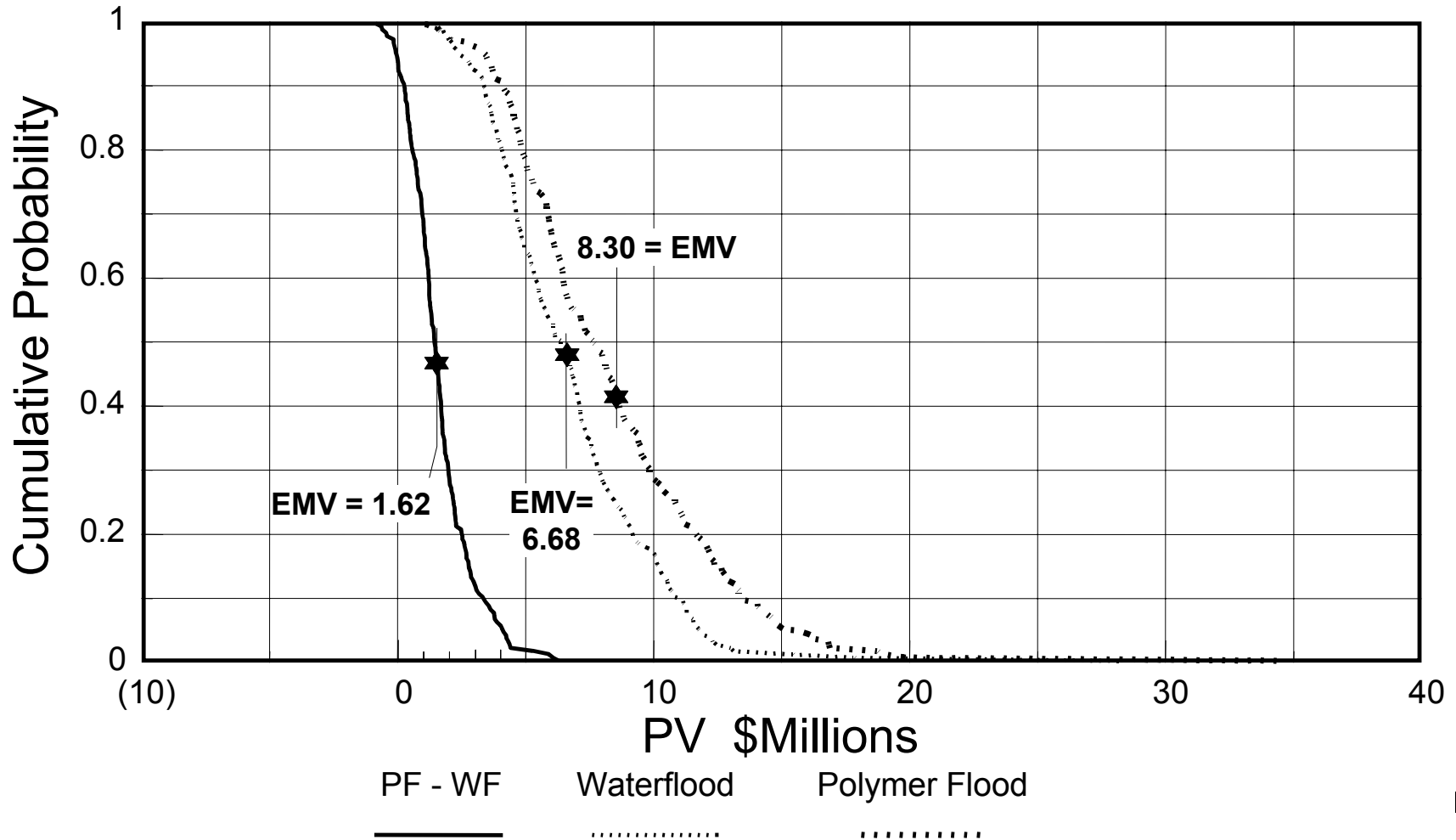
- Characterize uncertainty in the results
- Get a better outcome assessment
→ avoids a simplistic model error
revealed by the **stochastic variance**

Expected Value

- Probability-weighted average
- Mean (μ) is identical
- Choose the alternative with the highest EV, e.g., $EMV = EV \text{ NPV}$
- Main calculation tools
 - ▶ Decision trees
 - ▶ Monte Carlo simulation

Comparing Curves

Comparison to Waterflood



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Price Behavior

- Model to represent our best understanding
- Synthetic data look like real data

Benoit Mandelbrot

- Yale U. math professor
- IBM Research Fellow Emeritus
- *The (Mis)Behavior of Markets* (1995)
- *The Fractal Geometry of Nature* (1982)

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Price Modeling

Model:

A simplified representation of a system, e.g., industry, business, project, or proposed transaction

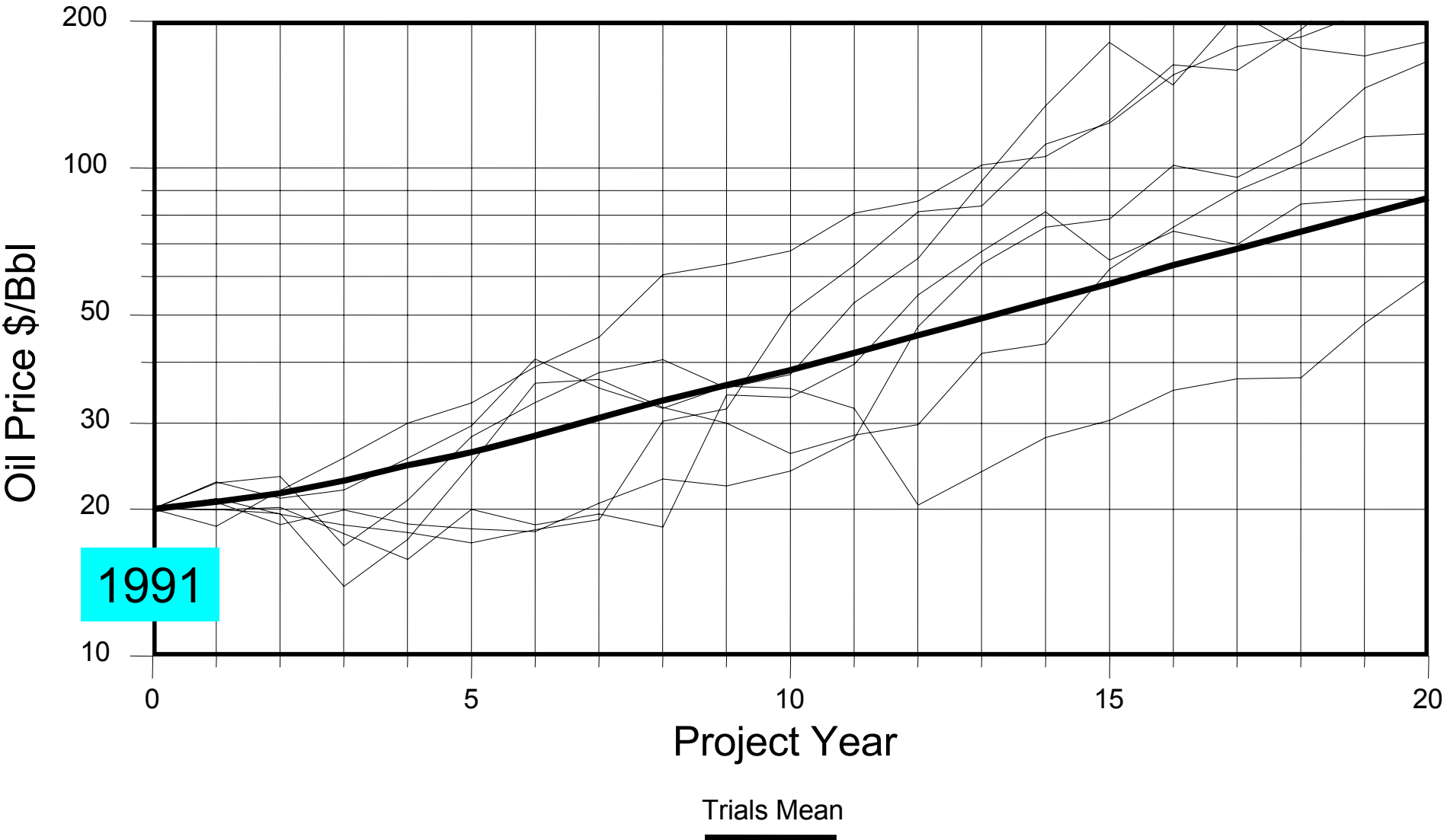
- To predict behavior
- Constructed of variables and formulas

Benefits of Modeling

- Can experiment without involving the real system
 - ▶ You get only one chance
 - ▶ Too fast or too slow
 - ▶ Cannot solve otherwise
 - ▶ Not invented yet
 - ▶ Cannot observe

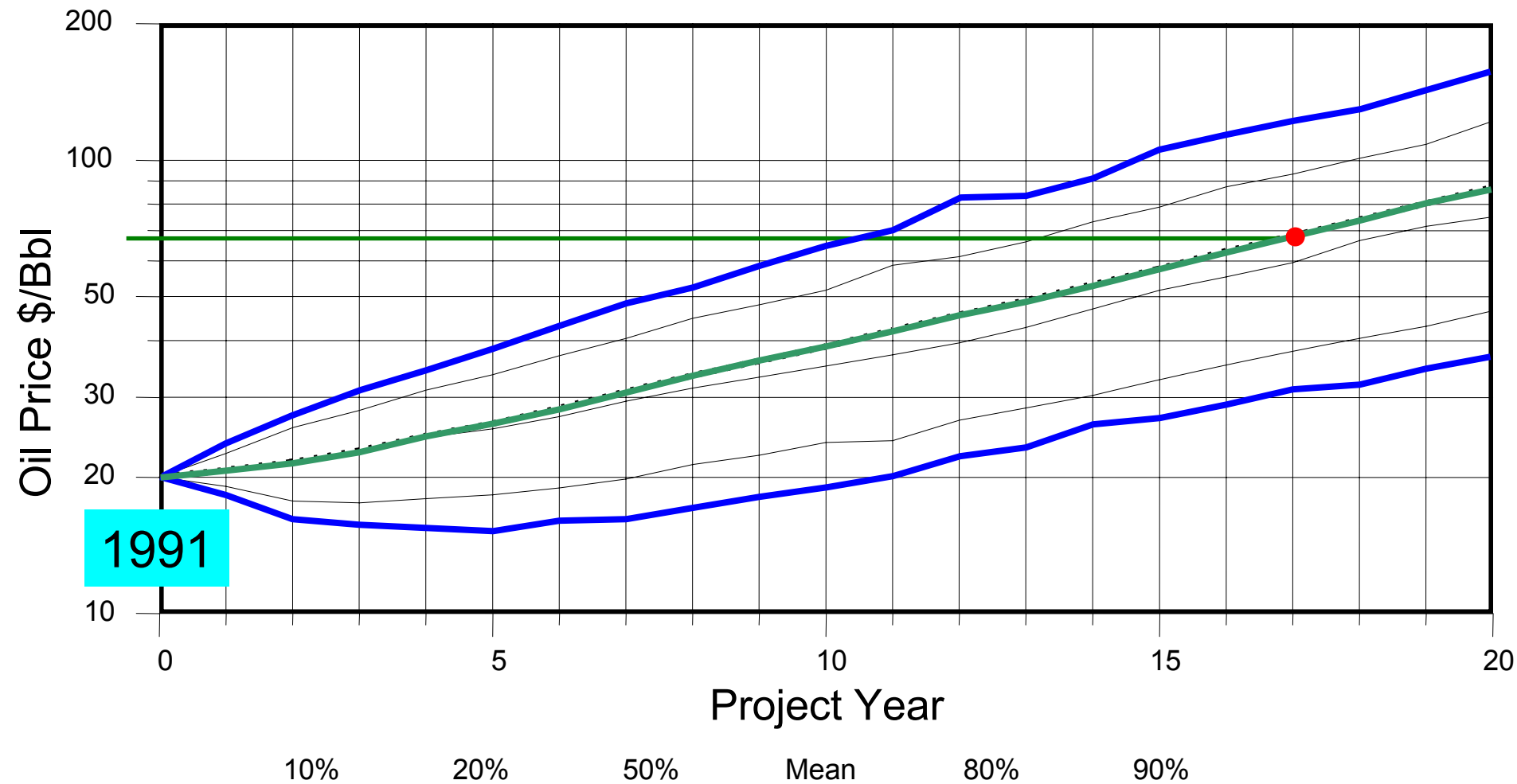
OIL PRICE SIMULATION

Seven Trial Scenarios and Trial Mean



OIL PRICE SIMULATION

Net Nominal Price Confidence Bands
(Net of WPT-like Tax Effect)

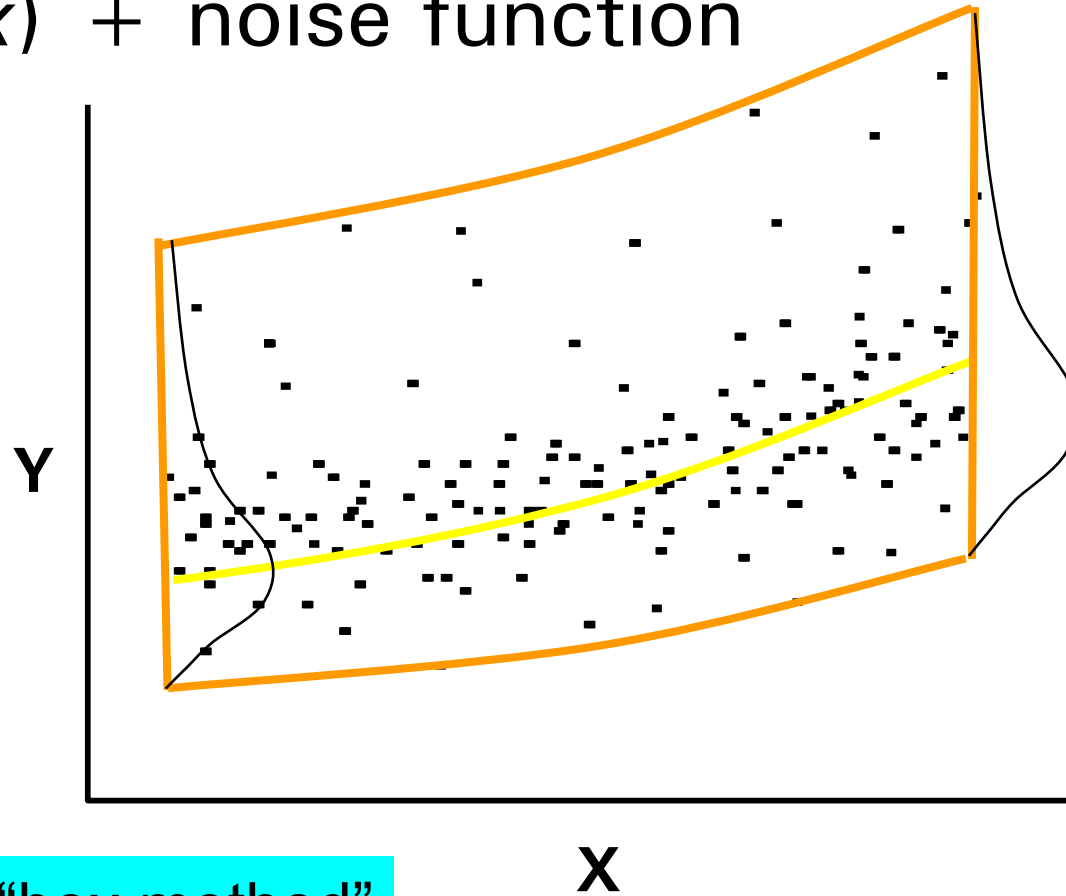


John's oil price model

- Real oil price and Inflation modeled separately, then combined
→ nominal forecast
- Trend
- Volatility
- Mean reversion to the base trend
- Auto-correlation to prior year's change (momentum element)

4. Fit to data

$$Y = Y(x) + \text{noise function}$$



Newendorp's "box method"

Modeling concepts

- Decomposition
- Sensitivity analysis
- Time-series analysis
 - ▶ Regression; curve-fitting, SA, GA, NN
- Econometrics
 - ▶ I/O analysis, fundamentals, lead/lag relationships, equilibrium equations

Price Model — Application

- Objective and realistic Monte Carlo simulation model of oil price behavior
- Extract H,M,L cases for decision tree analysis
- Match price projections for aggregating projects and properties, etc.

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Turmoil

Oil prices — one opinion

- Substantial fossil HC substitutes are long off.
- Diminishing resource
 - ▶ Positive real price growth
- History provides a guide for modeling volatility and other near-term behavior
 - ▶ Cycles of perceived scarcity and abundance.

Credit markets

- Models provided false security
 - ▶ Illusion of stability and control
- “During times of crisis, correlations increase.”
- Is Washington modeling to evaluate alternative actions?

End

