

# Stage 11: Evaluation & Risk Communication under Assumptions

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*Applied Financial Engineering Lifecycle (Aug 19–25)*

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## Objectives

- Evaluate models under uncertainty
  - Explore impact of different **assumptions**
  - Use bootstrap, confidence intervals, and scenario comparisons
  - Learn how to **communicate risk and sensitivity** to stakeholders
  - Assess **subgroup heterogeneity** to detect hidden risks
  - Practice translating analysis into stakeholder-ready commentary
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## 1. Why Assumptions Matter

Every model depends on assumptions about:

- **Data distribution** (e.g., normal vs fat-tailed)
- **Missing values** (mean/median imputation, or dropping rows)
- **Model form** (linear vs nonlinear)
- **Stationarity, independence, and subgroup homogeneity**

**Key point:** Different assumptions → different results → different decisions.

Ignoring or miscommunicating assumptions can mislead stakeholders and hide risks.

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## 2. Scenario Comparisons

We explore “what if” cases to test sensitivity:

- What if data are Gaussian vs fat-tailed?
- What if missing values are filled with mean vs median vs dropped?
- What if we use linear regression vs nonlinear models?
- How do results differ by **subgroup**?

**Best practices:**

- Compare **side-by-side results**
  - Keep axes consistent for easy interpretation
  - Annotate each chart with **assumptions** and **takeaways**
  - Report **direction and magnitude** of change (e.g., MAE +12% under median imputation)
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## 3. Distributional Assumptions

- **Gaussian assumption:** Confidence intervals are narrow → may underestimate risk.
- **Fat-tailed assumption:** Bootstrapped CIs are wider → extreme outcomes more likely.

✧ **Takeaway:** Overconfidence from assuming Gaussian errors can lead to underpreparedness.

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## 4. Handling Missing Data

- **Mean fill:** Pulls estimates toward the average, reduces variance.
- **Median fill:** More robust to skew, but can shift regression coefficients.
- **Dropping missing rows:** Reduces sample size, may bias results.

✧ **Takeaway:** Handling missing data is not just preprocessing—it affects risk and conclusions.

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## 5. Model Form Assumptions

- **Linear model:** Constant slope, interpretable, may miss curvature.
- **Polynomial model:** Captures curvature, but risk of overfitting and unstable forecasts.

✧ **Takeaway:** Stakeholders should understand sensitivity to the chosen model form.

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## 6. Subgroup Diagnostics

- Global model fit may hide poor performance in specific segments.
- Use residual boxplots, per-segment MAE, or classification metrics.
- Compare results across scenarios to detect hidden vulnerabilities.

✧ **Takeaway:** Subgroup analysis strengthens credibility and avoids misleading conclusions.

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## 7. Communicating Uncertainty

Stakeholders need clarity, not technical details:

- Use **visuals**: CI bands, error bars, bootstrap distributions.
  - Explain in **plain language**:
    - "Prediction holds if volatility stays within X"
    - "Model is sensitive to missing rate"
  - Emphasize uncertainty ranges, not just point estimates.
  - Use phrases that build trust:
    - "Model is sensitive to..."
    - "Prediction holds if..."
    - "We tried two strategies and saw..."
    - "Changing assumptions X vs Y produces different outcomes..."
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## 8. Bootstrap in a Nutshell

- Resample data **with replacement** → recompute statistic → repeat many times.

- Use percentiles of the resamples to compute confidence intervals.
- Estimates **uncertainty**, not accuracy.
- Works even when Gaussian assumptions fail.

✂ **Takeaway:** Bootstrap is essential for realistic risk quantification under non-normal errors.

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## 9. Scenario & Sensitivity Analysis

- Run at least two **plausible assumption scenarios** side-by-side.
  - Label axes, highlight assumptions, and provide clear takeaways.
  - Document **direction and magnitude** of changes (e.g., MAE, RMSE, AUC).
  - Include subgroup-level analyses to detect heterogeneity in results.
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## 10. Wrap-Up & Best Practices

- Always ask: *What if our assumptions are wrong?*
  - Compare multiple treatments side-by-side.
  - Document assumptions, risks, and sensitivity results.
  - Show risks both **visually** and **quantitatively**.
  - Build stakeholder trust by explaining **assumption dependence**.
  - Translate findings into concise, actionable commentary.
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## 11. Deliverables / Practice

- Produce at least **one uncertainty visualization** (CI or bootstrap).
  - Conduct **two scenario comparisons** and annotate with captions.
  - Write a **stakeholder-ready summary** listing assumptions, risks, and recommended next steps.
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### Key Messages

- Model performance alone does not guarantee trust.
- Sensitivity analysis under different assumptions reveals hidden risks.
- Transparent communication of assumptions and uncertainty is essential for stakeholder confidence.
- Always combine **visual, numerical, and narrative evidence** when presenting evaluation and risk findings.