Part II Quick Reference

All Causal Inference Variations - At a Glance

December 7, 2025

Method 1: Randomized Controlled Trials (RCTs)

What She ASKED	What She COULD ASK
Check balance table - need controls?	Interpret p-values - threshold?
Design RCT for Airbnb photos	Design for different context
Randomization level?	Individual vs cluster trade-offs
Worried about take-up?	Selection vs compliance vs spillover
Calculate ATE from means	Calculate ATT and explain vs ATE
Why randomization works	When can ATE ATT?
Perfect compliance assumed	ITT vs TOT with non-compliance

Method 2: Matching Methods

What She ASKED	What She COULD ASK
Calculate ATE and ATT from table	Different weighting schemes
Assumptions needed	Which assumptions testable?
Is PSM convincing for job training?	When PSM vs IV/RD?
Common support condition	Violation consequences
Conditional independence	Unobserved confounders problem
Direct matching on X	Propensity score - why useful?
Exact matching	Nearest neighbor vs radius vs kernel

Method 3: Instrumental Variables (IV)

What She ASKED	What She COULD ASK
Relevance & independence	Add exclusion & monotonicity
Calculate IV from table	Calculate with regression output
Identify compliance types	Which groups estimable?
Why instrument needed?	Weak instruments (F-stat)
First stage: Cov(Z,D) 0	F-statistic rule of thumb
IV estimates LATE	Why not ATE? Explain simply
Monotonicity rules out defiers	What if monotonicity violated?

Method 4: Regression Discontinuity (RD)

Method 5: Difference-in-Differences (DiD)

What She ASKED	What She COULD ASK
Sharp vs fuzzy - which?	When prob jumps vs changes
Continuity & discontinuity	Why need continuity?
Graph regions	Bandwidth selection trade-offs
Running variable	Manipulation test implications
Local effect at cutoff	External validity concerns
Visual inspection	Formal discontinuity tests
Fuzzy RD uses IV	How fuzzy relates to IV

What She ASKED	What She COULD ASK
Calculate DiD from 2×2 table	Multiple time periods/groups
Draw graph with parallel trends	Event study interpretation
Valid if both affected by tariffs?	Triple-difference solution
Parallel trends assumption	Test with pre-treatment data
Single treatment period	Staggered adoption issues
Two-way fixed effects	Regression specification

Key Formulas by Method

CRITICAL FORMULAS

RCT:

- ATE $= E[Y|D=1] - E[Y|D=0] = \bar{Y}_1 - \bar{Y}_0$
- ATT $= E[Y(1) - Y(0)|D=1]$ (equals ATE with randomization)

Matching:

- ATE $= \sum_j (\bar{Y}_{j1} - \bar{Y}_{j0}) \times \frac{N_j}{N}$
- ATT $= \sum_j (\bar{Y}_{j1} - \bar{Y}_{j0}) \times \frac{N_{j1}}{N_1}$

IV:

- $\hat{\beta}_{IV} = \frac{E[Y|Z=1] - E[Y|Z=0]}{E[D|Z=1] - E[D|Z=0]}$
- LATE $= E[Y(1) - Y(0)|D(1) > D(0)]$ (compliers only)

RD:

- $\tau = \lim_{z \to z_0^+} E[Y|Z=z] - \lim_{z \to z_0^-} E[Y|Z=z]$

DiD:

- DiD $= (\bar{Y}_{treat,after} - \bar{Y}_{treat,before}) - (\bar{Y}_{control,after} - \bar{Y}_{control,before})$

Critical Assumptions Comparison

Common Threats by Method

Method	Main Assumption	Testable?
RCT	Random assignment	**YES** - balance
Matching	Conditional independence	**NO**
	Common support	**YES** - overlap
IV	Relevance	**YES** - F-stat
	Exclusion restriction	**NO**
RD	Continuity	**PARTIAL**
	No manipulation	**YES** - McCrary
DiD	Parallel trends	**PARTIAL**

Method	Watch Out For...
RCT	Non-compliance • Attrition • Spillover • Hawthorne effects
Matching	Unobserved confounders • Common support violations • Model dependence
IV	Weak instruments (F ¡ 10) • Exclusion violations • Estimating LATE not ATE
RD	Manipulation • Bandwidth sensitivity • Other discontinuities • Functional form
DiD	Parallel trends violations • Common shocks • Pre-existing trends

How to Use This Reference

For Each Scenario Question:

1. **Identify the method** - Which technique is being used?
2. **List the assumptions** - What must hold for validity?
3. **Check for violations** - Which assumptions threatened?
4. **Direction of bias** - Estimate too high or too low?
5. **Suggest improvements** - How to strengthen design?

Your Strengths (Keep Doing!):

✓ Strong conceptual understanding

✓ Good intuition about validity threats

✓ Able to identify appropriate methods

Areas to Sharpen:

→ More precision on formulas

→ Explicit statement of ALL assumptions

→ Direction of bias

85/100 average → Target 95/100!

Master these variations and you'll ace it! ✓