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| **Method** | **Primary** | **Secondary** | **Tertiary** |
| **RCT** | A picture containing text, font, handwriting, diagram  Description automatically generated | ***A picture containing text, font, white, screenshot  Description automatically generated*** | ***A close up of a computer screen  Description automatically generated with low confidence*** |
| **Subclassification** | A picture containing text, font, white, diagram  Description automatically generated | A picture containing text, font, white, typography  Description automatically generated |  |
| **Matching** | A picture containing text, font, receipt, white  Description automatically generated |  |  |
| **Weighting** | **For treatment, we multiply the Y value of the observed treatment units by 1/propensity\_score.**  **For control units, we multiply the Y value of the observed control units by -1/(1-propensity\_score)**  A picture containing text, font, line, number  Description automatically generated | A picture containing text, font, handwriting, number  Description automatically generated |  |
| **Regression** | A picture containing text, font, screenshot, white  Description automatically generated | Same as ATE but for subgroup where D = 1  A picture containing text, font, screenshot, white  Description automatically generated |  |
| **Diff-in-Diff** | A picture containing text, font, white, typography  Description automatically generated Post – pre, treat - cont | In Pennsylvania, FTEs dropped from 23.33 to 21.17 (-2.16). If there was no causal effect, we would expect NJ to follow a similar pattern. However, NJ rose from 20.44 to 21.03 (+0.59). Thus, the causal effect of min wage increases is 0.59 - -2.16 = 2.76. We can also determine whether this is statistically significant. |  |
| **IV** | **A picture containing text, font, white, receipt  Description automatically generated** | Diff in means = E(Y | D = 1) – E(Y | D = 0)  ITT = E(Y | Z = 1) – E(Y | Z = 0)  Pr(Compliers) = E(Z | D = 1) – E(Z | D = 0)  IV = ITT/Pr(Compliers) | ***A picture containing text, font, handwriting, white  Description automatically generated*** |
| **Sharp RDD** |  |  |  |
| **Fuzzy RDD** | A picture containing text, font, white, line  Description automatically generated |  |  |

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| **Estimands** | | | | |
| Method | Primary | Secondary | Tertiary | Notes |
| **RCT** | ATE | ATT | CATE |  |
| **Subclassification** | ATE | ATT |  |  |
| **Matching** | ATT |  |  |  |
| **Weighting** | ATE | ATT |  |  |
| **Regression** | ATE | ATT | Conditional-Variance-Weighted ATE |  |
| **Diff-in-Diff** | ATT |  |  |  |
| **IV** | ITT for Compliers, | LATE for compliers | Pr(Compliers) = E(D | Z = 1) – E(D | Z = 1) |  |
| **Sharp RDD** | LATE for the threshold |  |  |  |
| **Fuzzy RDD** | LATE for compliers at the threshold |  |  |  |

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| **NOTATION** | | | | | | | |
| **Method** | **Treatment Effect** | **Treatment** | **Observed Outcome** | **Potential Outcomes** | **Covariates** | **Instrument** | **Unique** |
| **RCT** | Tau | Di | Yi | Y-1i & Y-0i |  |  |  |
| **Subclassification** | Tau | Di | Yi | Y-1i & Y-0i | Xi,  Xj for strata group |  |  |
| **Matching** | Tau | Di | Yi | Y-1i & Y-0i | Xi |  | Propensity score = *Pi(Xi) = Pr(Di = 1 | Xi)* |
| **Weighting** | Tau | Di | Yi | Y-1i & Y-0i | Xi |  | IPW:  For treated: Y \* 1/Pi(Xi)  For control:  Y \* -1/(1-Pi(Xi) |
| **Regression** | Tau, Beta1 | Di | Yi | Y-1i & Y-0i | Xi |  | Yi(d) = Alpha + Beta1\*d + Beta2\*Xi + Epsilon-i (for d = 0,1) |
| **Diff-in-Diff** | Tau | Z-it  (1 when Gi = 1 and t = 1, 0 otherwise( | Yi | Y-it(z) where z is either in treated or control | Xi |  | Time periods = t,  Group indicator = Gi |
| **IV** | Tau | Di | Yi = Y-Zi,i  (Y is a function of Z, through D) | Y(Zi, D-Zi, i) | Xi | Z | Treatment potential outcomes = Z-it |
| **Sharp RDD** | Tau | Di | Yi | Y-1i & Y-0i |  |  | Xi = forcing variable,  C = cutoff,  h = window size |
| **Fuzzy RDD** | Tau | Di | Yi | Y-1i & Y-0i |  | Z | Xi = forcing variable,  C = cutoff,  h = window size |

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| **ASSUMPTIONS** | | | | | |
| **Method** | **Assumption 1** | **Assumption 2** | **Assumption 3** | **Assumption 4** | **Assumption 5** |
| **RCT** | SUTVA:  No interference between units &  Only one version of treatment. |  |  |  |  |
| **Subclassification** | SUTVA:  No interference between units &  Only one version of treatment. | Conditional ignorability/independence:  Once we condition on x, we get conditional independence between potential outcomes and treatment. | Common Support:  The probability of receiving treatment for any given level of X is never 0 and never 1. |  |  |
| **Matching** | SUTVA:  No interference between units &  Only one version of treatment. | Conditional ignorability/independence:  Once we condition on x, we get conditional independence between potential outcomes and treatment. | Common Support:  The probability of receiving treatment for any given level of X is never 0 and never 1. |  |  |
| **Weighting** | SUTVA:  No interference between units &  Only one version of treatment. | Conditional ignorability/independence:  Once we condition on x, we get conditional independence between potential outcomes and treatment. | Common Support:  The probability of receiving treatment for any given level of X is never 0 and never 1. |  |  |
| **Regression** | SUTVA:  No interference between units &  Only one version of treatment. | Conditional ignorability/independence:  Once we condition on x, we get conditional independence between potential outcomes and treatment. | Functional Form (Linearity):  x  Implies constant treatment effect. Assumptions around functional form. | Constant Treatment Effect:  Tau for any individual is equal to Tau for all other individuals. |  |
| **Diff-in-Diff** | SUTVA:  No interference between units &  Only one version of treatment. | Parallel Trends: Parallel trends in control potential outcomes, not treated potential outcomes. |  | |  |
| **IV** | SUTVA:  No interference between units &  Only one version of treatment. | Exogeneity:  Potential outcomes *and* potential treatment status are independent of the instrument. | Monotonicity:  There are no defiers. | Exclusion Restriction:  Instrument (Z) only affects outcome (Y) through treatment (D). | Relevance of Instrument:  Z has to affect D. Instrument needs to affect treatment. |
| **Sharp RDD** | SUTVA:  SUTVA:  No interference between units &  Only one version of treatment. | Conditional ignorability/independence:  Once we condition on x, we get conditional independence between potential outcomes and treatment. This is trivially satisfied because D is determined by X and thus is *always* conditioned on X. | Continuity:  The expected value of Y-1i and Y-0i given X are continuous in X around the threshold X = c. In other words, there is *no discontinuity in potential outcomes.* |  |  |
| **Fuzzy RDD** | SUTVA:  No interference between units &  Only one version of treatment. | Continuity:  The expected value of Y-1i and Y-0i given X are continuous in X around the threshold X = c. In other words, there is *no discontinuity in potential outcomes.* | Monotonicity:  There are no defiers. | Exclusion Restriction:  Instrument (Z) only affects outcome (Y) through treatment (D). | Relevance of Instrument:  Z has to affect D. Instrument needs to affect treatment. |

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| **Hypothesis Testing** | | | | |
| **Test** | **Formula** | **Application** | **Parameters** | **Steps** |
| Two Sample T-test | A picture containing font, text, handwriting, calligraphy  Description automatically generated  Minus delta from X1 – X2 if null is not ‘no difference (0)’.  A picture containing text, font, white, handwriting  Description automatically generated | The two-sample t-test (also known as the independent samples t-test) is a method used to test whether the unknown population means of two groups are equal or not. | X1 = mean of first group,  X2 = mean of second group,  S1 = standard dev of first,  S2 = standard dev of second,  N1 = Sample size of first,  N2 = sample size of second,  Delta = expected change (this is the value that the null tests for, in most cases = 0 (sample means are the same). | 1. Idenfify null hypothesis, and thus value of delta, 2. Calculate means, standard devations and sample sizes 3. Plug in to test. 4. Report p-value |
| Fisher Exact Test,  Testing sharp null hypothesis | A picture containing text, screenshot, number, line  Description automatically generated  A picture containing text, diagram, line, technical drawing  Description automatically generated | Fisher's exact test is a statistical test used to determine if there are nonrandom associations between two categorical variables. | Each letter stands for a combination of Yi (observed value) and treatment indicator (Di) which is to be permuted for every combination. | 1. **Permute** the values of Di (N1 1s and N0 0s) differently across the N units, keeping Yi unchanged. 2. **Calculate and store** the values of Tau-hat-j (or any other appropriate statistic, such as the t-test stat) for each of these permuted datasets j. 3. **Calculate p-value** as the proportion of Tau-hat-j that are as or more extreme than the actually observed Tau-hat. |