Noncompliance

1. Terms
   1. **Noncompliance**: sometimes units assigned to treatment do not actually receive treatment
      1. **One-sided non-compliance**: subjects in the treatment group do not receive the treatment
      2. **Two-sided noncompliance**: some subjects in the assigned treatment group do not receive treatment and some subjects in the control group receive the treatment.
      3. **Compliers**: received the treatment in the treatment group; did not receive treatment and assigned to the control group
      4. **Never-Takers**: never take the treatment regardless if they are in the treatment or control group, but usually treatment group only
   2. **Intent-to-treat (ITT)**: difference of the average outcomes in the group assigned to receive treatment and the group assigned to receive control. . The estimate will be diluted compared to the actual treatment effect for the people who receive treatment.
      1. **ITTD/take-up rate/α** is the effect of being assigned to treatment on receiving a dose of treatment. Because receiving a dose happens after random treatment assignment, it meets all the requirements of a causal effect. .
         1. There is some bias in the take-up rate because it is a statistic with random variation. Thus, CACE will also have some uncertainty. Direction of the bias is the opposite direction from the correlation between ITT and α.
         2. ATE (average treatment effect for the whole population, which is the ITTY) vs. **CACE**/complier-average-causal-effect (average treatment effect for the population who comply with their assignment). We can only learn about compliers, which is why we focus on the CACE. CACE = ITT/take-up rate.
            1. When there is non-compliance, cannot measure potential outcomes for non-compliers. No guarantee that ATE = CACE
            2. CACE standard errors are dividing the same standard errors with the take-up rate.
            3. 2SLS/two stage least squares is a method for estimating the CACE.
   3. Placebo Designs: employ a placebo to estimate giving a treatment to the control group. The take-up rate should be approximately the same and the covariates should have the same distribution between treatment and control. Increases precision: shrinks standard errors and confidence intervals.
      1. In a placebo design, compare compliers in treatment to compliers in control. Directly compute the average treatment effect on the treated (ATET). Does not change our estimated treatment effect as this is unbiased.
      2. Standard error using an intent-to-treat design will be larger than the standard error from using a placebo design by the factor .
      3. Technology to apply placebo: ghost ads (a low-cost way to implement a placebo design in digital advertising, logged the counterfactual ad impressions that would have occurred in the control group). If they were supposed to play a treatment ad, but were in the control group, then select the next best ad (log the fact that they would have received a treatment ad if they were in the control group).
      4. Placebo effect should have no causal outcome.
   4. Two-sided Noncompliance: treatment group receives control and control group receives treatment.
      1. Compliers (do exactly what we want), never-takers (never gets treatment regardless of assignment), always-takers (always gets treatment regardless of assignment), and defiers (do the opposite of what we want).
         1. Key assumption: no defiers. Monoticity assumption: dosage d is monotonically increasing in the treatment assignment z. If there are no defiers, then the only treatment effect is on the compliers.
            1. Always-takers and never-takers experience no treatment effect because their dosage is the same in treatment as in control.
            2. The only people affected are the compliers, so once again, we compute the ITT across all individuals, and then we rescale our estimate by dividing the share of compliers.
         2. The take-up rate is now the difference in take-up rates between treatment and control. Same formula for CACE.
   5. **Encouragement Designs** (encourage subjects to follow recommendations) and **Downstream Experiments** (large treatment effect can be observed in subsequent experiments later in time)
2. Examples
   1. GOTV (Get-out-the-vote): assigned at random. Canvassers knocked on the doors of 1000 people (treatment) and skipped 1000 people (control). 750 people in the treatment group did not receive the treatment even though they were supposed to and 250 subjects answered the door.
      1. Three groups of individuals: Group A (250 who answered the doors), Group B (750 people who didn’t answer their doors), and Group C (1000 people in the control group on whose doors no one knocked)
         1. Compare Group A to Group C
         2. Compare Group A to Groups B+C
         3. Compare Group A+B to Group C: correct answer for unbiased estimate.
      2. Placebo: talk about something other than voting.
   2. Yahoo! Ad Effectiveness
      1. Group A: Assigned to treatment and received treatment (64% of treatment group, purchased $1.81 per person).   
         Group B: Assigned to treatment, *but did not receive* treatment (36% of treatment group, purchased $2.04 per person)  
         Group C: Assigned to control *but did not receive treatment* (100% of the control group, purchased $1.84 per person)
      2. Intent-to-treat (ITT) treatment effect of .
         1. The treatment effect on those who were actually treated must have been larger than $0.05.
         2. Producing an unbiased estimate of the treatment effect on those actually treated requires reweighing this ITT.
      3. The (fraction of compliers reached with ads). Treatment effect only comes from the 64% of population who received ads.
         1. Never-takers should have zero treatment effect (if the exclusion restriction were true).
         2. The .
      4. Placebo: run unrelated ads. Ran a placebo campaign.
   3. Blood Pressure: 100 patients in each control and treatment groups. 60 treatment compliers (mean=150) and 40 treatment never-takers (mean=100), giving total mean of 130 for treatment. There is a given 140 mean for control.
      1. From inference by randomization, can figure out equivalent proportion of compliers/never-takers in the control group.
      2. Inferred control group mean=100. Medicine can’t affect people who don’t take it.
      3. The data tells us nothing about the treatment effect on non-compliers, so we can’t ever know the full ATE.
         1. The exclusion restriction is that assignment to treatment has no impact on blood pressure, unless they actually taking their pills. Only taking pills affect blood pressure.
      4. CACE calculation: where 0 is the effect of the drug. .
   4. The KIPP Lottery
      1. Instrumental variables: way to purge the dirty variation and be left only with the clean variation
         1. Clean variation: random variation generated by the lottery
         2. Dirty variation: endogenous variation generated by heterogenous student behavior.

