PROBLEM SET 1

Jacob Jameson

Due on Tuesday, February 14, 2023

IDENTIFICATION

(1) Your information

Jacob Jameson

(2) Group Members (please list below the classmates you worked with on this problem set):

Bohan Li, Jenna Rogers

(3) Compliance with Harvard Kennedy School Academic Code

I certify that my work in this problem set complies with the Harvard Kennedy School Academic Code

Conceptual Questions (30 points + 8 extra points)

1. Read the paper. Clearly state the primary research question that the authors are trying to answer. What makes this an interesting question? (2 points)

The primary research question that the authors are trying to answer is whether or not capital in the form of in-kind grants such as inventory, supplies, and tangible resources – or cash is more effective in spurring economic growth for male and female owned organizations. The reason that this is an interesting question is because standard models of investment state that for credit-constrained it should not matter whether or not the firm is receiving capital in the form of cash or in-kind grants, either should lead to the same increase in growth.

2. Explain the main finding of the paper (including what the 'flypaper effect' is) using non-technical jargon, as if you were writing a brief policy memo. Provide two versions:

a. In 3-5 sentences (without copying the article abstract or the text): (2 points)

The flypaper effect, which is a term used to describe the tendency of agents to keep money received instead of investing it, was found to exist among microenterprises in Ghana. The main finding of the paper is that the form in which is grant is given (cash or in-kind) impacts microenterprise profits. The authors find that this finding is only statistically significant amonog women-owned enterprises who earned above-mean profits prior to the experiment.

b. In a tweet, i.e. 280 characters or less: (1 point)

In-kind grants are better for profit growth than cash grants, especially among female-owned enterprises who earned above-mean profits prior to the experiment in Ghana.

3. Summarize the specific details of the treatment that participating businesses in this country underwent. (2 points)

There were two treatment groups in the study. The first treatment group received 150 cedis in cash and the other treatment group received 150 cedis in inventory, supplies, and tangible resources selected by the business owner.

4. The authors note that their experimental design is very similar to an earlier study in Sri Lanka. What reasons do they give to conduct a separate study, rather than expecting the findings of that research to apply in this context? (2 points)

The reasons that they give is that each country has a different history of involvement of women in business. In Ghana, women have similar labor force participation rates as men and are more likely to be self-employed, which was not true of Sri Lanka.

5. The authors used a randomized control trial because they believed an observational analysis of similar policies would be insufficient. Imagine that another country implemented the investment program without randomizing treatment, and that you were trying to understand the effect of this program on food security in that country. What are two possible confounders (omitted variables) that would bias the results from your observational analysis? Explain the mechanism of the omitted variable and use the omitted variable bias formula to argue whether it would lead to an understatement or overstatement of the true effect. (3 points)

The omitted variable formula is given by: $\alpha_1 = \beta_1 + \beta_2\gamma_1$.

Where α_1 is the coefficient we recover from our regression, β_1 is the true coefficient, β_2 is the coefficient of the omitted variable in the "true" regression (aka the one without any omitted variables) and γ_1 is the coefficient on the variable of interest (treatment) in an auxiliary regression of the omitted variable on the variable of interest.

Without randomization, the two possible omitted variables are:

- Business aptitude: Individuals who select into the treatment may have higher business aptitude (positive association between business aptitude and treatment $\gamma_1 > 0$). Since there is a positive association between business aptitude and food security ($\beta_2 > 0$), this would lead us to overestimate the true effect.
- Existing food security: Individuals who select into the treatment may have pre-existing lower food security. Pre-existing food security would have a positive association with measured post-treatment food security ($\beta_2 > 0$). Since pre-existing food security would have a negative association with treatment ($\gamma_1 < 0$), this would lead us to understate the true effect.

6. Let Y_{0i} be the business profits in the absence of the grants program and let $D_i = 1$ denote participation in the program. If there were no RCT and individuals were allowed to opt-in to the program, critics might point out that: (3 points)

$$E(Y_{0i}|D_i = 1) < E(Y_{0i}|D_i = 0)$$

Explain this equation in words, explain why it is a problem, and give a plausible scenario in which that may be the case.

This equation states that the expected profits for businesses who participated in the program had they not participated in the program is smaller than the expected profits for businesses who did not participate in the program. The reason that this is a problem is that it is impossible to observe this counterfactual. A plausible scenario in which this might be the case could be where businesses that financially struggle ar more likely to seek to participate in a grant program.

7. Defining treatment as being assigned to the grants program, what is the difference between the ITT and TOT in this context? Which do the authors report and why do they make this decision? Write an equation (using potential outcomes notation) that shows what the authors are trying to estimate. (3 points)

The difference between the ITT (Intent-to-Treat) and TOT (Treatment-on-the-Treated) is as that the ITT estimates the average treatment effect among all individuals who were randomly assigned to the grants program, regardless of whether they actually received the treatment (participation in the program) or not, where the TOT estimates the average treatment effect among only those individuals who actually received the treatment (participated in the program).

Fafchamps et al. report the ITT, as they aim to estimate the average effect of being assigned to the grants program, rather than just the effect of participating in the program.

The equation showing what the authors are trying to estimate can be expressed as (note that this is a simplification of the actual model the authors ran):

$$Y_{it} = \beta_0 + D\beta_1 + \varepsilon_i$$

Where Y_{it} is the potential outcome (profits) of individual i in wave t if they were assigned to the grants program, D is a binary variable indicating treatment assignment (1 if assigned to the grants program, 0 otherwise), β_0 is the average potential outcome in the control group, β_1 is the average treatment effect, and ε_i is the error term.

Hence the authors are estimating β_1, the average treatment effect of being assigned to the grants program on the potential outcome Y_{it}.

8. At what level do the authors clustered their standard errors of the main results of the paper (if at all)? Briefly note why the authors cluster the standard errors and why this is the appropriate level to cluster at. (2 extra points)

In the main results of their paper, the authors cluster their standard errors at the firm level. This is an appropriate level to cluster at given this is also the level of treatment (each firm is assigned to treatment or control).

9. To assess whether treatment was actually randomly assigned, we can examine the results of a balance test, presented in Table 2. Do the results in this table make you more or less confident about the validity of the paper's results? Interpret one of the p-values from column (5). (3 points)

Looking at Table 2, the results of the balance test, I am made more confident about the results that estimate using the full sample, but the trimmed sample seems less balanced (especially on baseline profits). That poor balance makes me skeptical of results that come from estimates on the trimmed sample. In the full sample, the p-value corresponding to the F-test of equality of means across the three groups is 0.985 for baseline profits, which indicates that we cannot reject the null hypothesis that the means are equal.

10. Attrition in experiments like this one is often a concern for internal validity. Does the particular sort of attrition mentioned in this article give you reason to be concerned about the validity in this study? Describe using particular aspects of the experiment or its implementation. (1 point)

The attrition mentioned in this paper refers to the fact that only 730 of the original 793 firms who completed the first two waves answered the final wave survey. This does not give me reason to be concerned about internal validity of this experiment since it does not impact the pre-treatment randomization and the authors show robustness checks of main treatment effects to correct for attrition.

11. What other threats to internal validity may have affected this this experiment? Choose one threat and explain how it might bias the coefficient of interest. (2 points)

For those in the in-kind transfer arm of the treatment, it is possible that being part of this study induced a behavior change. This introduces a source of bias where the measured effect actually includes effects of being part of the study, conversing with research staff, etc. If we believe that that this led the subject to purchase equipment leading to higher profits, then this would cause us to overestimate the coefficient of interest.

12. Describe four specific problems involved with generalizing the results of this study as a result of using an RCT. Hint: review the Muralidharan and Niehaus (2017) or Banerjee et al. (2017) papers discussed in class. (4 points)

- Firms were studied in two geographies in Ghana, abd thus results may not generalize to other countries that may have different entrepreneurial cultures.
- Effects may differ if the government were to implement the program instead of researchers
- Firms studied in this paper were microenterprises; this result may not generalize to medium-sized or large-sized firms with more employees
- Study cannot be generalized for larger sum of cash or equipment

13. List at least two strategies the authors use to address some of the concerns you described above. (2 points)

The authors picked two different geographies in Ghana in which to run their experiments. One was a large city and the other was an industrial city. This helps mitigate point 1 above. The authors also separately examined high vs. low initial profit firms. This helps indicate what it may look like to generalize for larger injections of transfers.

14. Why do the authors include Table 4? (2 extra points)

The authors include Table 4 to examine treatment effect heterogeneity across gender mix of the industry that firms are in, high versus low capture, initial capital stock, and initial size of profits. From these results the authors are able to draw their conclusion that in-kind grants only increase profits for female-owned firms that were larger initially.

15. Do you think the main results would be the same if this experiment were expanded to slightly larger businesses? Describe plausible scenarios in which providing the same transfer to these different businesses could both lead to (i) a larger increase in profits, and (ii) a smaller increase in profits. (2 extra points)

- If owners of larger businesses have very good business acumen and would use grants (either given in cash or in-kind) to engage in profitable capital investments, the result would be a larger increase in profits for both types of treatment.
- If larger businesses have largely hit their steady-state capital stock levels and neither a cash nor in-kind grant would have significant positive impacts on profits, the result would be a smaller increase in profits for both types of treatment

16. If you were a researcher at the World Bank interested in scaling up one or several of these treatments, what follow-up study would you propose to expand on these findings? Explain in 4-5 sentences as if you were trying to convince a policymaker of the need for additional research. (2 extra points)

As a researcher at the World Bank, I would propose a further examination of the efficacy of both cash transfers and in-kind transfers for medium-sized businesses. If in-kind transfers are found to be effective for larger businesses, then this could support the use of equipment transfers in lending programs for businesses of varying sizes. However, if cash transfers are deemed more suitable for larger companies, this would avoid overgeneralizing the current findings and help ensure that lending programs result in better outcomes for businesses of all sizes in developing countries.

Data Analysis Questions (22 points + 2 extra points)

17. Produce a well-organized descriptive statistics table that includes (i) the number of households, (ii) the number of geographic units, (iii) the number of units of randomization, alongside (iv) the sample mean and standard error of the income and revenue index in the control group, and (v) the same sample mean and standard error of the same index but in the treatment group. In other words, the table should have one row (countries), and six columns (including country).

    a. Print your table below. (6 points)

```
data <- read_dta("data/ReplicationDataGhanaJDE.dta")

num_obs <- data %>%
  filter(wave == 2) %>%
  mutate(count = sum(experimentsample)) %>%
  select(count)
num_obs <- num_obs[[1]][1]

country <- 'Ghana'
units <- length(unique(data$groupnum))

baseline.control.mean <- round(mean(filter(data, wave==2,
                                    assigntreat == 0)$realfinalprofit, na.rm=T),3)

baseline.control.se <- round(sd(filter(data, wave==2,
                                    assigntreat == 0)$realfinalprofit,na.rm=T)/
  sqrt(length(filter(data, wave==2, assigntreat == 0)$realfinalprofit) - 1), 3)

baseline.control = paste(baseline.control.mean,
                         paste0(paste0('(', baseline.control.se), ')'))

baseline.treat.mean <- round(mean(filter(data, wave==2,
                                  assigntreat == 1)$realfinalprofit, na.rm=T),3)

baseline.treat.se <- round(sd(filter(data, wave==2,
                                  assigntreat == 1)$realfinalprofit, na.rm=T)/
  sqrt(length(filter(data, wave==2, assigntreat == 1)$realfinalprofit) - 1), 3)


baseline.treat = paste(baseline.treat.mean,
                       paste0(paste0('(', baseline.treat.se), ')'))

temp <- data.frame (`Country`  = country,
                    `N Firms` = num_obs,
                    `N Geographical Units` = 2,
                    `Units of Randomization` = units,
                    `Control Profits` = baseline.control,
                    `Treat Profits` = baseline.treat)

row.names(temp) <- 'Ghana'

knitr::kable(temp, align='cccccc',
             col.names = c("Counry",
                           "Households (N)",
```

```
                          "Geographies (N)",
                          "Randomization Units",
                          "Control Profits Mean (SE)",
                          "Treat Profits Mean (SE)"))
```

Counry	Households (N)	Geographies (N)	Randomization Units	Control Profits Mean (SE)	Treat Profits Mean (SE)
Ghana Ghana	793	2	195	128.12 (12.334)	131.537 (15.71)

b. Are the differences in baseline profits between the control and treatment groups significant at the 0.05 level? (3 points)

```
data <- data %>%
  filter(experimentsample == 1) %>%
   mutate(`Study Arm` = case_when(
     cashtreat == 1 ~ 0,
     equiptreat == 1 ~ 1,
     assigntreat == 0 ~ 2),
     `Study Arm` = recode_factor(`Study Arm`,
                                 "0" = "Cash",
                                 "1" = "In-kind",
                                 "2" = 'Control')) %>%
  arrange(sheno, questionnaire_date)

data$baseline_profit <- data$realfinalprofit
var_label(data$baseline_profit) <- "Baseline Profit"

data %>%
  filter(wave == 2) %>%
  select(baseline_profit, `Study Arm`) %>%
  tbl_summary(by = `Study Arm`, type = all_continuous() ~ "continuous2",
              statistic = all_continuous() ~ c("{mean} ({sd})"),
              missing_text = "(Missing)") %>%
  add_p(pvalue_fun = ~style_pvalue(.x, digits = 2),
        test = list(all_continuous() ~ "aov")) %>%
  add_overall() %>%
  modify_header(label ~ "**Variable**") %>%
  modify_caption("**Balance Test for Baseline Profits**") %>%
  bold_labels()
```

Table 2: **Balance Test for Baseline Profits**

Variable	**Overall**, N = 793	**Cash**, N = 198	**In-kind**, N = 198	**Control**, N = 397	**p-value**
Baseline Profit					0.98
Mean (SD)	130 (281)	132 (395)	131 (200)	128 (245)	
(Missing)	12	5	2	5	

There are no observable differences in baseline profits between the control and treatment groups. Using an ANOVA test we can see that the difference are not significant at the 0.05 level. This table matches the results in Table 2 by Fafchamps et. all.

18. Reproduce the coefficient estimate and standard error estimates in columns (1-2) of Table 3: these correspond to the main pooled OLS specifications (Equation 5 in the paper) without and with sample trimming respectively. (3 points)

```
reg1 <- felm(realfinalprofit ~ atreatcash + atreatequip |groupnum + wave|0|sheno,
             data)

reg2 <- felm(realfinalprofit ~ atreatcash + atreatequip|groupnum + wave |0|sheno,
             filter(data, is.na(trimgroup)))

fe.reg1 <- felm(realfinalprofit ~ atreatcash + atreatequip |groupnum +
               wave + sheno|0|sheno, data)

fe.reg2 <- felm(realfinalprofit ~ atreatcash + atreatequip|groupnum +
               wave + sheno |0|sheno,filter(data, is.na(trimgroup)))

stargazer(reg1, reg2, fe.reg1, fe.reg2,
          type = "latex", title = 'Main Treatment Effects',
          column.labels = c('OLS Full',
                            'OLS Trimmed',
                            'FE Full','FE Trimmed'),
          dep.var.labels = 'Real monthly profits (cedi)',
          covariate.labels = c('Cash Treatment', 'In-kind Treatment'),
          style = 'qje')
```

Table 3: Main Treatment Effects

	Real monthly profits (cedi)			
	OLS Full	OLS Trimmed	FE Full	FE Trimmed
	(1)	(2)	(3)	(4)
Cash Treatment	14.503*	9.589	3.962	0.482
	(8.679)	(7.318)	(13.882)	(8.223)
In-kind Treatment	38.597***	36.752***	43.227***	30.873***
	(11.206)	(10.670)	(12.306)	(10.725)
N	4,354	4,203	4,354	4,203
R^2	0.277	0.327	0.520	0.616
Adjusted R^2	0.242	0.294	0.379	0.503
Residual Std. Error	180.116 (df = 4152)	118.825 (df = 4007)	163.066 (df = 3361)	99.698 (df = 3244)

Notes:

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

19. Represent the values of column (5), rows 3 onward in Table 3 as a well-labeled coefficient plot. This corresponds to the main (untrimmed) OLS analysis finding treatment effects by gender and treatment type (Equation 6 in the paper). The figure must: (6 points)

- Print the rounded coefficients and standard errors next to each point.
- Define and use your own function for at least one part to avoid repetition.
- Be estimated from the regression specification described in the paper. Therefore, all the numbers should match exactly as reported in Table 3.
- Be clean and well-labeled (i.e., have clear axis labels, no chartjunk, understandable to a reader who has not read the paper).

```
outcome <- "realfinalprofit"

vars <- c("atreatcashfemale", "atreatequipfemale",
          "atreatcashmale", "atreatequipmale")

fe_1 <- ("groupnum + wave + wave2_female +
         wave3_female + wave4_female + wave5_female + wave6_female")

fe_2 <- ("groupnum + sheno + wave + wave2_female +
         wave3_female + wave4_female + wave5_female + wave6_female")

iv <- "0"
cluster <- "sheno"

# helper function to create formula
helper <- function(outcome, vars, fe, iv, cluster) {
  as.formula(
    paste(paste(paste(outcome, ' ~ '), paste(vars, collapse = ' + ')),
          fe, iv, cluster, sep = ' | ')
  )
}
reg.1 <- felm(helper(outcome, vars, fe_1, iv, cluster), data)
reg.2 <- felm(helper(outcome, vars, fe_1, iv, cluster), filter(data, is.na(trimgroup)))

reg.3 <- felm(helper(outcome, vars, fe_2, iv, cluster), data)
reg.4 <- felm(helper(outcome, vars, fe_2, iv, cluster), filter(data, is.na(trimgroup)))

stargazer(reg.1, reg.2, reg.3, reg.4,
          type = "latex", title = 'Main Treatment Effects',
          column.labels = c('OLS Full',
                            'OLS Trimmed',
                            'FE Full','FE Trimmed'),
          dep.var.labels = 'Real monthly profits (cedi)',
          covariate.labels = c('Cash Treatment*female',
                               'In-kind Treatment*female',
                               'Cash Treatment*male',
                               'In-kind Treatment*male'),
          style = 'qje')
```

Table 4: Main Treatment Effects

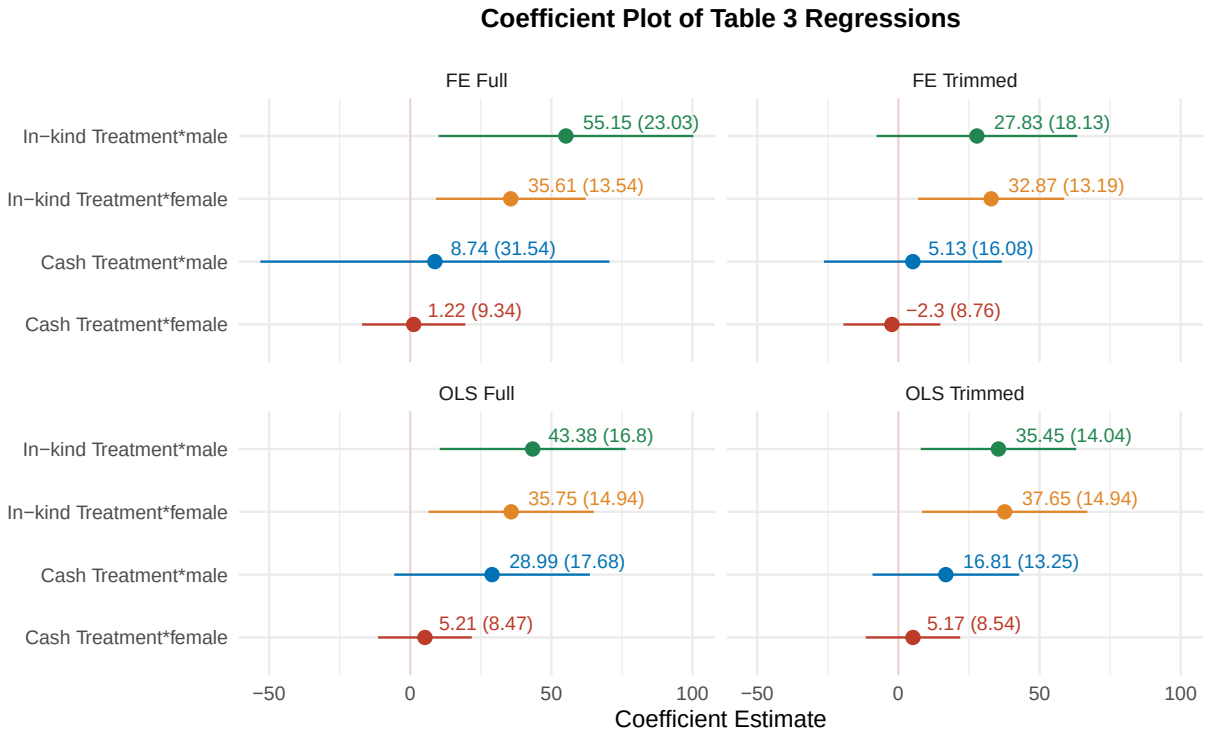
	Real monthly profits (cedi)			
	OLS Full	OLS Trimmed	FE Full	FE Trimmed
	(1)	(2)	(3)	(4)
Cash Treatment*female	5.206	5.167	1.224	−2.298
	(8.469)	(8.545)	(9.335)	(8.758)
In-kind Treatment*female	35.753**	37.653**	35.609***	32.867**
	(14.937)	(14.943)	(13.541)	(13.194)
Cash Treatment*male	28.993	16.814	8.739	5.132
	(17.683)	(13.253)	(31.545)	(16.083)
In-kind Treatment*male	43.377***	35.451**	55.146**	27.825
	(16.801)	(14.044)	(23.030)	(18.130)
N	4,354	4,203	4,354	4,203
R^2	0.280	0.328	0.523	0.617
Adjusted R^2	0.244	0.294	0.415	0.530
Residual Std. Error	179.947 (df = 4145)	118.839 (df = 4000)	158.322 (df = 3548)	96.916 (df = 3425)

Notes:

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

```
coefs_se_1 <- as.data.frame(summary(reg.1)$coefficients[ , c("Estimate", "Cluster s.e.")])
coefs_se_1 <- rownames_to_column(coefs_se_1, "variable")

coefs_se_2 <- as.data.frame(summary(reg.2)$coefficients[ , c("Estimate", "Cluster s.e.")])
coefs_se_2 <- rownames_to_column(coefs_se_2, "variable")

coefs_se_3 <- as.data.frame(summary(reg.3)$coefficients[ , c("Estimate", "Cluster s.e.")])
coefs_se_3 <- rownames_to_column(coefs_se_3, "variable")

coefs_se_4 <- as.data.frame(summary(reg.4)$coefficients[ , c("Estimate", "Cluster s.e.")])
coefs_se_4 <- rownames_to_column(coefs_se_4, "variable")

coefs_se_all <- rbind(coefs_se_1, coefs_se_2, coefs_se_3, coefs_se_4)
coefs_se_all$reg <- rep(c('OLS Full', 'OLS Trimmed', 'FE Full', 'FE Trimmed'),
                        each = nrow(coefs_se_1))

coefs_se_all <- coefs_se_all %>%
  mutate(variable = case_when(
    variable == 'atreatcashfemale' ~ 'Cash Treatment*female',
    variable == 'atreatequipfemale' ~ 'In-kind Treatment*female',
    variable == 'atreatcashmale' ~ 'Cash Treatment*male',
    variable == 'atreatequipmale' ~ 'In-kind Treatment*male'
  ))

ggplot(coefs_se_all, aes(x = variable, y = Estimate, color = variable)) +
  facet_wrap(~reg, nrow=2) + scale_color_nejm() +
```

```
geom_pointrange(aes(ymin = Estimate - 1.96 * `Cluster s.e.`,
                    ymax = Estimate + 1.96 * `Cluster s.e.`)) +
geom_text(aes(label = paste(round(Estimate, 2),
                            paste0(paste0('(', round(`Cluster s.e.`,2), ')')))),
          hjust = -0.15, vjust = -0.5, size = 3) +
labs(title="Coefficient Plot of Table 3 Regressions\n") +
ylab("Coefficient Estimate") +
xlab("") +
theme_bw() + theme_minimal() +
coord_flip() +
geom_hline(yintercept = 0, color = 'red', alpha = 0.1) +
theme(legend.position = "none",
      plot.title = element_text(
      color = "black",
      size = 12,
      face = "bold",
      margin = margin(t = 15),
      hjust = 0.5) )
```



Try implementing the fixed effects specification either for question 18 or 19 above, and report your coefficients as a table or coefficient plot respectively. (2 extra points)

Done (see FE regression in 18 and 19)

20. Submit your R script to the Canvas assignment as a separate .R file (or .Rmd file, if you used Rmarkdown). We may pass submissions through a program to check if they run. To pre-test your code, you can verify it runs on our environment. Go to the math camp space and copy the project API-210_PS-01_eval. The dataset is already uploaded in that project, so if you copy your R code and source/run everything after aligning the file paths, it should produce the correct figures and tables. (4 points)

Done

RCTs in Your Own Work (8 points)

21. Propose a specific policy question that could best be answered using an RCT. Explain the question in non-technical terms in no more than 3-5 sentences. Write out the empirical specification you would use. (4 points)

A speciic policy question that could best be answered using an RCT would be– what is the effect of free/reduced dental care on non dental-insured Medicare beneficiaries. To test this question, I would seek to enroll a large sample of Medicare beneficiaries who do not currently have dental insurance and randomize them into two arms: control arm where enrollees get gift cards for completing health surveys, and treatment group where they receive free/reduced dental care.

I would then estimate

$$Y_{it} = \beta_0 + D\beta_1 + \varepsilon_i$$

Where Y_{it} is the potential outcome (health gains) of individual i in wave t if they were assigned to the dental program, D is a binary variable indicating treatment assignment (1 if assigned to the dental program, 0 otherwise), β_0 is the average potential outcome in the control group, β_1 is the average treatment effect, and ε_i is the error term.

22. Describe your treatment group. Propose a comparison group and explain why you chose that group. (2 points)

My treatment group would be non-dental insured Medicare beneficiaries that have been recruited and randomized to the free/reduced dental care arm of the experiment. The comparison group would be those that were randomized to the control arm. This comparison makes sense because after randomization, the two groups should be balanced on characteristics that impact overall health.

23. Is it possible that the control group could be "contaminated" as a result of interacting with the treatment group? Explain which measures you would take to limit this contamination. (2 points)

In this case, it is very unlikely that the control group could be contaminated. The reason is because the treatment is being offered free/reduced dental care, and that benefit to the treatment group will not make those in the control group more likely to pursue dental care that they were not previously receiving.