

PROBLEM SET 1

Due on Monday, February 13, 2023, 10:00 am

I - INSTRUCTIONS

To successfully complete this problem set, please follow these steps:

1. Download this Word document file into your computer
2. Insert all your answers into this Word document. Guidance [here](#) on how to insert non-Word objects such as handwritten work or screenshot images in your answers.
3. **Once your document is complete, please save it as a PDF.** This is important to make sure all your work is preserved in the process of submission to Canvas.
4. Please submit an electronic copy of the PDF and your **replicable R script** to the Canvas assignment page.

II - IDENTIFICATION

(1) Your information

Your Last Name: *Chaturvedi*

Your First Name: *Shreya*

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

Manisha Jha, Neha Verma

(3) Compliance with Harvard Kennedy School Academic Code¹ (mark with an X below)

	Yes	No
I certify that my work in this problem set complies with the Harvard Kennedy School Academic Code	X	

For this problem set, we will be examining the methods used in the following paper:

¹ We abide by the Harvard Kennedy School Academic [code](#) for all aspects of the course. In terms of problem sets, unless explicitly written otherwise, the norms are the following: You are free (and encouraged) to discuss problem sets with your classmates. However, you must hand in your own unique written work and code in all cases. Any copy/paste of another's work is plagiarism. In other words, you can work with your classmate(s), sitting side-by-side and going through the problem set question-by-question, but you must each type your own answers and your own code. For more details, please see syllabus.

Fafchamps, Marcel, David McKenzie, Simon Quinn and Christopher Woodruff. 2014.
“Microenterprise growth and the flypaper effect: Evidence from a randomized experiment in Ghana.” *Journal of Development Economics*, 106: 211-226

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 is to study how providing capital (cash vs in kind) to firms owned by male and female microenterprise owners that are credit constrained influences their investment and capital consumption. This is an interesting question because we theoretically expect there to be no difference based on the form of transfer (cash or in kind), but we can empirically test out the impact of various forms of this policy and its interaction with gender, size of the firm, etc.

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 study reveals supportive evidence for the presence of a "Flypaper Effect" in the distribution of grants among microenterprises in Ghana. This effect refers to the idea that the impact of a grant is influenced by the manner in which it is given. In this research, it was found that the largest returns were generated when the grants were given in the form of tangible items such as physical capital, inventories, and raw materials, particularly for female-owned businesses with profits above the median. On the other hand, the impact of in-kind grants compared to cash grants was not as significant for male-owned enterprises.

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

Ghana based RCT shows in-kind transfers to generate more growth for microenterprises owned by males and females, caused by lack of self control.

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

The study was divided into two treatment groups:

- *The first group received a cash grant of 150 Ghanaian cedis, which they could use for any purpose of their choosing.*
- *The second group received in-kind grants, consisting of equipment, materials, or inventories worth the same amount as the cash grant (150 Ghanaian cedis). The*

firm owners were allowed to make their own choices as to what they needed for their businesses and were not provided with any recommendations. The purchases were made directly by the business owners and the research assistant.

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 Ghanaian study has a larger sample size, with twice as many participants compared to the study conducted in Sri Lanka. This increase in sample size provides the authors with a greater statistical power in determining the differences between the effects of cash and in-kind grants.*
- *Ghana is known for its thriving female entrepreneurship culture, making it an ideal location for the study. This unique characteristic allows the authors to explore the possibility of differing impacts of capital investments on microenterprises beyond South Asia, providing external validity to the Sri Lankan paper.*

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)

Some confounders or omitted variables for an observational study in this context that influence the selection bias term are:

- *Individuals with lower income levels are more likely to participate in investment programs. This is because low income is often associated with low levels of food security. As a result, the observed impact of the investment program on food security in this scenario may be overestimated due to a positive selection bias term.*
$$E[Y_i | D_i=1] - E[Y_i | D_i=0] = TOT + \text{Selection Bias}$$
- *Firm profits: It is possible that the grant attracts owners who are struggling to keep their businesses running and are using the grant to meet their basic needs, such as securing a sufficient level of nutrition. This could result in an overestimation of the true impact of the grants, in a mechanism similar to the previous case.*

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.

The equation suggests that the average business profits in the absence of the grants program would be higher for individuals who do not participate in the program compared to those who do. This could occur when individuals who do not participate in the program are firms that are already operating at their steady state level of capital stock and are not credit-constrained. These firms may be running well and do not require an increase in capital as it would likely result in little to no return. On the other hand, firms that participate in the program may be credit-constrained, and their profits may be stuck at a low equilibrium. In the absence of the program, these firms may perform worse than those who do not participate in the 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)

In this context, the ITT (Intention-to-Treat) effect refers to the impact of being randomly assigned to receive the grant, while the TOT (Treatment-on-the-Treated) effect refers to the impact of actually receiving the grant. The authors chose to report the ITT effect, despite compliance being almost 100%, because of convention and to err on the conservative side of their estimates. Only 2% of those firm owners who were assigned to receive the grant did not end up receiving it, and it was found that three women were unable to accept the grant due to their husband's objections. Despite this being a minimal non-compliance rate, the authors believed it was a sound decision to report the ITT effect instead of the TOT effect. This decision aligns with the convention of reporting ITT effects and ensures that the results are estimated conservatively.

Equation: $E[Y_i \text{ (Individuals offered grants)} - Y_i \text{ (Individuals not offered grants)}]$

8. **[Optional]** 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)

The authors chose to cluster the standard errors at the firm level because the treatment (either in-kind or cash grant) is assigned to the firms, rather than individuals. Clustering

at the firm level takes into account the fact that there may be correlations within firms, such as shared cultural or economic characteristics, and helps to reduce the standard errors of the estimates.

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)

The balance tests conducted by the authors suggest that the random assignment of the participants to the different treatment groups (cash vs in-kind grants) was successful in achieving equal baseline characteristics between the groups. The test on the total capital stock in January 2009, for example, produced a p -value of 0.771, meaning there is a high likelihood (77%) that the means of the three groups are actually equal. This supports the validity of the random assignment and provides confidence in the equivalence of the groups at the start of the study.

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 low levels of attrition in the study at 2% do not seem to be concerning for issues of internal validity. However, if the rate of attrition were higher and the reasons for it were related to profit levels, such as "refusal of grants by husbands" or "migration", this would create a potential for confounding factors in the results. In that case, ITT would not be a reliable estimator for measuring the impact and would raise concerns about the internal validity of the study.

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)

A common threat to internal validity that applies in this case would be the contamination of control group, wherein the control group would have learnt of the treatment and either dropped out or obtained the grant from the researchers or elsewhere. This might have led to underreporting the true impact of the treatment.

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)

Some limitations to the external validity of this study include:

- *Unrepresentative sample: The study was conducted in Accra and Tema, the capital and largest city in Ghana, respectively. Ghana is relatively favorable towards female entrepreneurship, and this may not be representative of other populations or regions where female entrepreneurship culture is less prevalent. The researchers used specific criteria to select full-time microenterprise owners, and the results may not be generalizable beyond this specific population.*
- *Limited scalability: The study had a relatively small sample size of 792 firms, which may limit the external validity of the results. Further studies with larger sample sizes may be necessary to better understand the generalizability of the findings.*
- *Unaccounted for spillover effects: The study does not capture any general equilibrium effects that may arise from providing grants to firms. If this program was scaled up, there may be broader effects on the economy that are not captured in the study.*
- *Different implementer effects: The study mentions that research assistants accompanied firm owners in the in-kind treatment arm to purchase capital goods. This may not be feasible at a larger scale, as there may not be enough state capacity to personally accompany firm owners. The impact of in-kind treatment may be different from cash, and the feasibility of implementation is in question.*

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

Some strategies that the authors use to these concerns include:

- *Extensive literature reviews: The authors conduct extensive reviews of existing literature wherever possible and also highlight the shortcomings of their approach explicitly.*
- *Follow up surveys: the authors can conduct follow-up research to examine the results of the experiment when scaled up to a larger sample size. This will provide more robust and generalizable results, which can then be used by policymakers to make more informed decisions regarding the implementation of programs like the one studied.*

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

The authors are investigating if the factors utilized for randomization (gender, initial profits, initial capital) have a differential or heterogenous impact on the profits of the enterprise when compared with in-kind and cash grants. For example, the results

indicate that there is a statistically significant increase in profits for female-owned firms that are large in size at the start.

15. **[Optional]** 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)

No, the main results may not be the same when applied to larger businesses. A bigger boost in profits may be observed if the grant size is large enough to push the business into the next level of scale and if economies of scale are in play. On the other hand, a smaller increase in profits may occur if large businesses are already at their optimal level of capital and are unable to absorb more capital.

16. **[Optional]** 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)

If I was an implementer at the World Bank I would be especially interested in understanding the impact of the implementer effect and spillover/general equilibrium effect described above as they would be all the more important once the study grows in sample size.

Data Analysis Questions (22 points + 2 extra points)

In this part, you will replicate the central results from the paper. You will be asked to analyze the data, present results, and submit a replicable R script separately.

In the problem set link, we have provided a lightly cleaned version of their main analysis files: `ReplicationDataGhanaJDE.dta`. Keep the file in a subfolder called `data` of your problem set Rstudio Project; this will facilitate our submission verification described at the end of this part. The data we are using comes from the public [study page](#) in the World Bank microdata library. There are several new programming topics that this part will require:

- i. Defining your own function
 - ii. Fixed effects and clustered standard errors
 - iii. String concatenation and extraction
- i. To get started on writing your own function, please go through:
- RStudio [Primer for writing functions](#), and
 - An additional [screencast on functions](#) tailored to this problem
- ii. And to familiarize with fixed effects and clustered standard errors, please make use of our screencasts walking through `lfe::felm()`, which is the function we recommend in the HKS [cheat-sheet](#).
- [Fixed effects with `felm`](#)
 - [Clustered standard errors with `felm`](#)

Please also make use of the Appendix of this problem set for more details about the data.

1. Produce a well-organized descriptive statistics table that includes (i) the number of households, (ii) the number of units of randomization, alongside (iii) the sample mean and standard error of the *profits* in the control group, and (iv) the same sample mean and standard error of the same variable but in the treatment group. In other words, the table should have one row (countries), and five columns (including country).

- a. Print your table below. (6 points)

Country	Households	Randomization Units	Control Mean (SE)	Treatment Mean (SE)
Ghana	793	195	124 (17.1)	118 (7.7)

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

No, since the p value of the t-test is 0.773, which is definitely much greater than 0.05, the differences in baseline are not statistically significant at the 5% level (or even at the 10% level)

2. 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)

Without trimming:

term	estimate	std.error	statistic	p.value
atreatcash	14.50273	8.679065	1.671001	0.094796
atreatequip	38.59707	11.206145	3.444277	0.000578

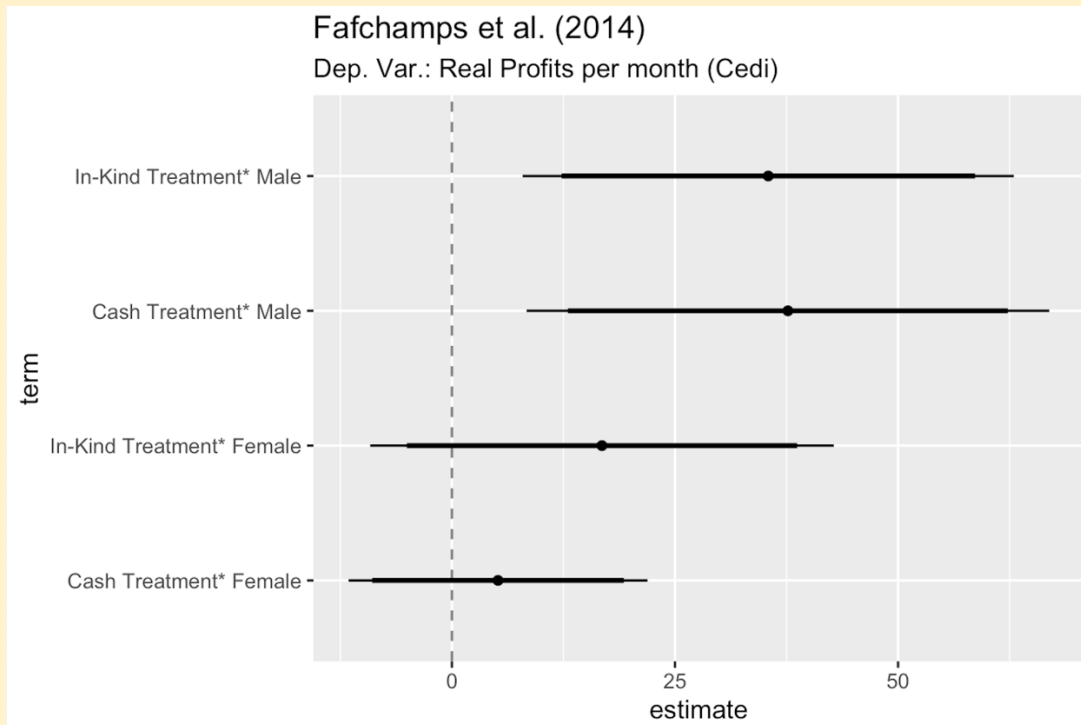
With trimming:

term	estimate	std.error	statistic	p.value
atreatcash	9.58924	7.318445	1.310284	0.190174
atreatequip	36.75243	10.670489	3.444306	0.000578

3. 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 3.²
 - Be clean and well-labeled (i.e., have clear axis labels, no chartjunk, understandable to a reader who has not read the paper).

² Rounded to the third decimal place.

term	estimate	std.error	statistic	p.value
atreatcashfemale	5.167286	8.544784	0.6047298	0.54539282
atreatequipfemale	37.652905	14.943414	2.5196989	0.01178416
atreatcashmale	16.813963	13.252784	1.2687118	0.20461771
atreatequipmale	35.451264	14.044187	2.5242659	0.01163240



[Optional] 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)

- 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)

RCTs in Your Own Work (8 points)

5. 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 specific and interesting question that I have actually working on scoping involves the use of an RCT to understand the impact of information on COVID19 vaccination rates. Here, different treatment groups randomly receive different kinds of information on the COVID19 vaccine and the outcome of interest is the vaccination rate in the group. By randomly assigning the information, we can causally estimate its impact on immunization rate.

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

Here, the treatment groups can be individuals, households, or villages. The main benefit of choosing villages is that there is minimal spillover of information within a village since everyone receives the same content, whereas if different members of a household receive different information (such as different aspects of the vaccine), they are surely going to discuss among themselves and come to a decision jointly.

7. 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)

Yes, definitely, As described above, by not randomizing at the village level, the study is more prone to contamination or spillover of information. Another measure that can be used is to introduce buffer control villages between different treatment villages to further reduce the likelihood of spillovers.

Appendix for Data Analysis

Packages to install

Code for the data analysis portion will necessarily vary by student, and there are multiple packages available which could be used to construct solutions. However, the following packages have been tested by the teaching staff and are used in the sample solutions:

```
library(haven)
library(broom)
library(lfe)
library(tidyverse)
library(forcats)
library(glue)
library(ggplot2)
```

Documentation embedded in Stata dta files

The dataset is a Stata .dta file. Stata .dta files often encode the description of each variable in a separate attribute, which are often very useful to understand what each variable represents. When one reads in a .dta file via `haven::read_dta()`, these variable attributes are stored as separate attributes associated with each variable. These can be checked by, for example, applying `str()` to each vector of a variable, but other packages provide convenience functions to more easily tabulate this data. We recommend the `labelled::lookfor()` function.

Variables in Regression

Equation (5) in the paper defines the main regression to be run.