MarketingHomework1

April 16, 2024

title: "A Replication of Karlan and List (2007)" author: "Sheena Taylor" date: April 11,2024 callout-appearance: minimal

[ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from scipy.stats import ttest_ind, norm
import statsmodels.api as sm

data = pd.read_csv("MARKET HW1.ipynb (data).csv")

print(data.info())

print(data.describe())



# Balance Test
print("Balance Test")
print("T-test for months since last donation")
print(ttest_ind(data[data['treatment'] == 1]['mrm2'], data[data['treatment'] ==␣
 ↪0]['mrm2']))
print("Linear regression for months since last donation")
lm_mrm2 = sm.OLS(data['mrm2'], sm.add_constant(data['treatment'])).fit()
print(lm_mrm2.summary())

print("T-test for number of prior donations")
print(ttest_ind(data[data['treatment'] == 1]['freq'], data[data['treatment'] ==␣
 ↪0]['freq']))
print("Linear regression for number of prior donations")
lm_freq = sm.OLS(data['freq'], sm.add_constant(data['treatment'])).fit()
print(lm_freq.summary())

# Experimental Results: Charitable Contribution Made
print("Experimental Results: Charitable Contribution Made")
fig, ax = plt.subplots()
data.groupby('treatment')['gave'].mean().plot(kind='bar', ax=ax)
ax.set_xlabel("Treatment")
ax.set_ylabel("Proportion who donated")
```

```
plt.show()

print("T-test for charitable donation made")
print(ttest_ind(data[data['treatment'] == 1]['gave'], data[data['treatment'] ==␣
 ↪0]['gave']))
print("Linear regression for charitable donation made")
lm_gave = sm.OLS(data['gave'], sm.add_constant(data['treatment'])).fit()
print(lm_gave.summary())

print("Probit regression for charitable donation made")
probit_gave = sm.Probit(data['gave'], sm.add_constant(data['treatment'])).fit()
print(probit_gave.summary())

# Differences between Match Rates
print("Differences between Match Rates")
print("T-tests for match rates")
print("1:1 vs Control")
print(ttest_ind(data[(data['ratio'] == 1) & (data['treatment'] == 1)]['gave'],
                data[(data['ratio'] == 1) & (data['treatment'] == 0)]['gave']))
print("2:1 vs Control")
print(ttest_ind(data[(data['ratio'] == 2) & (data['treatment'] == 1)]['gave'],
                data[(data['ratio'] == 2) & (data['treatment'] == 0)]['gave']))
print("3:1 vs Control")
print(ttest_ind(data[(data['ratio'] == 3) & (data['treatment'] == 1)]['gave'],
                data[(data['ratio'] == 3) & (data['treatment'] == 0)]['gave']))

data['ratio1'] = data['ratio'].astype(str).str.contains('1').astype(int)
lm_ratio = sm.OLS(data['gave'], sm.add_constant(data[['ratio1', 'ratio2',␣
 ↪'ratio3']])).fit()
print("Regression with ratio dummies")
print(lm_ratio.summary())

# Size of Charitable Contribution
print("Size of Charitable Contribution")
print("T-test for donation amount")
print(ttest_ind(data[data['treatment'] == 1]['amount'], data[data['treatment']␣
 ↪== 0]['amount']))
print("Linear regression for donation amount")
lm_amount = sm.OLS(data['amount'], sm.add_constant(data['treatment'])).fit()
print(lm_amount.summary())

donors = data[data['gave'] == 1]
print("T-test for donation amount (donors only)")
print(ttest_ind(donors[donors['treatment'] == 1]['amount'],␣
 ↪donors[donors['treatment'] == 0]['amount']))
print("Linear regression for donation amount (donors only)")
```

```python
lm_amount_donors = sm.OLS(donors['amount'], sm.
 ↪add_constant(donors['treatment'])).fit()
print(lm_amount_donors.summary())

fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(10, 5))
ax1.hist(donors[donors['treatment'] == 1]['amount'])
ax1.axvline(donors[donors['treatment'] == 1]['amount'].mean(), color='red',␣
 ↪linestyle='dashed', linewidth=2)
ax1.set_title("Treatment")
ax1.set_xlabel("Donation amount")

ax2.hist(donors[donors['treatment'] == 0]['amount'])
ax2.axvline(donors[donors['treatment'] == 0]['amount'].mean(), color='red',␣
 ↪linestyle='dashed', linewidth=2)
ax2.set_title("Control")
ax2.set_xlabel("Donation amount")
plt.show()

# Simulation Experiment
print("Simulation Experiment")
# Law of Large Numbers
control_draws = np.random.binomial(1, 0.018, size=100000)
treatment_draws = np.random.binomial(1, 0.022, size=100000)
diff_draws = treatment_draws - control_draws
cum_avg_diff = np.cumsum(diff_draws) / np.arange(1, len(diff_draws) + 1)

plt.plot(cum_avg_diff)
plt.axhline(0.022 - 0.018, color='red', linestyle='--')
plt.ylabel("Cumulative average difference")
plt.xlabel("Number of draws")
plt.show()

# Central Limit Theorem
sample_sizes = [50, 200, 500, 1000]
fig, axs = plt.subplots(2, 2, figsize=(10, 10))
axs = axs.ravel()

for i, n in enumerate(sample_sizes):
    diffs = [np.mean(np.random.binomial(1, 0.022, size=n)) - np.mean(np.random.
 ↪binomial(1, 0.018, size=n)) for _ in range(1000)]
    axs[i].hist(diffs)
    axs[i].axvline(0, color='red', linestyle='--')
    axs[i].set_title(f"Sample size {n}")
    axs[i].set_xlabel("Average difference")

plt.tight_layout()
plt.show()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 50083 entries, 0 to 50082
Data columns (total 51 columns):
 #   Column               Non-Null Count  Dtype  
---  ------               --------------  -----  
 0   treatment            50083 non-null  int64  
 1   control              50083 non-null  int64  
 2   ratio                50083 non-null  object 
 3   ratio2               50083 non-null  int64  
 4   ratio3               50083 non-null  int64  
 5   size                 50083 non-null  object 
 6   size25               50083 non-null  int64  
 7   size50               50083 non-null  int64  
 8   size100              50083 non-null  int64  
 9   sizeno               50083 non-null  int64  
 10  ask                  50083 non-null  object 
 11  askd1                50083 non-null  int64  
 12  askd2                50083 non-null  int64  
 13  askd3                50083 non-null  int64  
 14  ask1                 50083 non-null  int64  
 15  ask2                 50083 non-null  int64  
 16  ask3                 50083 non-null  int64  
 17  amount               50083 non-null  float64
 18  gave                 50083 non-null  int64  
 19  amountchange         50083 non-null  float64
 20  hpa                  50083 non-null  float64
 21  ltmedmra             50083 non-null  int64  
 22  freq                 50083 non-null  int64  
 23  years                50082 non-null  float64
 24  year5                50083 non-null  int64  
 25  mrm2                 50082 non-null  float64
 26  dormant              50083 non-null  int64  
 27  female               48972 non-null  float64
 28  couple               48935 non-null  float64
 29  state50one           50083 non-null  int64  
 30  nonlit               49631 non-null  float64
 31  cases                49631 non-null  float64
 32  statecnt             50083 non-null  float64
 33  stateresponse        50083 non-null  float64
 34  stateresponset       50083 non-null  float64
 35  stateresponsec       50080 non-null  float64
 36  stateresponsetminc   50080 non-null  float64
 37  perbush              50048 non-null  float64
 38  close25              50048 non-null  float64
 39  red0                 50048 non-null  float64
 40  blue0                50048 non-null  float64
 41  redcty               49978 non-null  float64
 42  bluecty              49978 non-null  float64
```

```
 43  pwhite             48217 non-null  float64
 44  pblack             48047 non-null  float64
 45  page18_39          48217 non-null  float64
 46  ave_hh_sz          48221 non-null  float64
 47  median_hhincome    48209 non-null  float64
 48  powner             48214 non-null  float64
 49  psch_atlstba       48215 non-null  float64
 50  pop_propurban      48217 non-null  float64
dtypes: float64(28), int64(20), object(3)
memory usage: 19.5+ MB
None
          treatment       control        ratio2        ratio3        size25  \
count  50083.000000  50083.000000  50083.000000  50083.000000  50083.000000
mean       0.666813      0.333187      0.222311      0.222211      0.166723
std        0.471357      0.471357      0.415803      0.415736      0.372732
min        0.000000      0.000000      0.000000      0.000000      0.000000
25%        0.000000      0.000000      0.000000      0.000000      0.000000
50%        1.000000      0.000000      0.000000      0.000000      0.000000
75%        1.000000      1.000000      0.000000      0.000000      0.000000
max        1.000000      1.000000      1.000000      1.000000      1.000000

             size50       size100        sizeno         askd1         askd2  \
count  50083.000000  50083.000000  50083.000000  50083.000000  50083.000000
mean       0.166623      0.166723      0.166743      0.222311      0.222291
std        0.372643      0.372732      0.372750      0.415803      0.415790
min        0.000000      0.000000      0.000000      0.000000      0.000000
25%        0.000000      0.000000      0.000000      0.000000      0.000000
50%        0.000000      0.000000      0.000000      0.000000      0.000000
75%        0.000000      0.000000      0.000000      0.000000      0.000000
max        1.000000      1.000000      1.000000      1.000000      1.000000

       …        redcty       bluecty        pwhite        pblack  \
count  …  49978.000000  49978.000000  48217.000000  48047.000000
mean   …      0.510245      0.488715      0.819599      0.086710
std    …      0.499900      0.499878      0.168561      0.135868
min    …      0.000000      0.000000      0.009418      0.000000
25%    …      0.000000      0.000000      0.755845      0.014729
50%    …      1.000000      0.000000      0.872797      0.036554
75%    …      1.000000      1.000000      0.938827      0.090882
max    …      1.000000      1.000000      1.000000      0.989622

          page18_39     ave_hh_sz  median_hhincome        powner  \
count  48217.000000  48221.000000     48209.000000  48214.000000
mean       0.321694      2.429012     54815.700533      0.669418
std        0.103039      0.378115     22027.316665      0.193405
min        0.000000      0.000000      5000.000000      0.000000
25%        0.258311      2.210000     39181.000000      0.560222
50%        0.305534      2.440000     50673.000000      0.712296
```

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75%        0.369132      2.660000     66005.000000      0.816798
max        0.997544      5.270000    200001.000000      1.000000

       psch_atlstba  pop_propurban
count  48215.000000   48217.000000
mean       0.391661       0.871968
std        0.186599       0.258654
min        0.000000       0.000000
25%        0.235647       0.884929
50%        0.373744       1.000000
75%        0.530036       1.000000
max        1.000000       1.000000

[8 rows x 48 columns]
Balance Test
T-test for months since last donation
TtestResult(statistic=nan, pvalue=nan, df=nan)
Linear regression for months since last donation
                            OLS Regression Results
==============================================================================
Dep. Variable:                   mrm2   R-squared:                         nan
Model:                            OLS   Adj. R-squared:                    nan
Method:                 Least Squares   F-statistic:                       nan
Date:                Tue, 16 Apr 2024   Prob (F-statistic):                nan
Time:                        12:09:38   Log-Likelihood:                    nan
No. Observations:               50083   AIC:                               nan
Df Residuals:                   50081   BIC:                               nan
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const             nan        nan        nan        nan         nan         nan
treatment         nan        nan        nan        nan         nan         nan
==============================================================================
Omnibus:                          nan   Durbin-Watson:                     nan
Prob(Omnibus):                    nan   Jarque-Bera (JB):                  nan
Skew:                             nan   Prob(JB):                          nan
Kurtosis:                         nan   Cond. No.                         3.23
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
T-test for number of prior donations
TtestResult(statistic=-0.11089297035979982, pvalue=0.9117016644344591,
df=50081.0)
Linear regression for number of prior donations
```

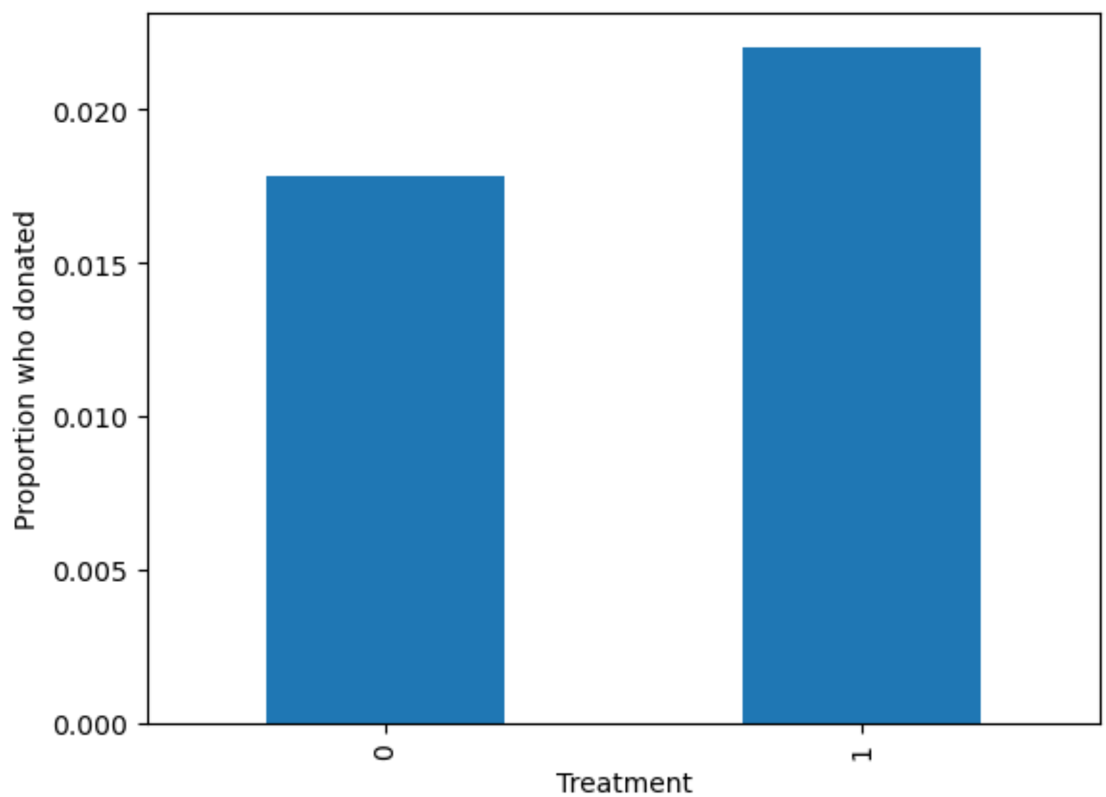
OLS Regression Results

Dep. Variable:	freq	R-squared:	0.000
Model:	OLS	Adj. R-squared:	-0.000
Method:	Least Squares	F-statistic:	0.01230
Date:	Tue, 16 Apr 2024	Prob (F-statistic):	0.912
Time:	12:09:38	Log-Likelihood:	-1.9292e+05
No. Observations:	50083	AIC:	3.858e+05
Df Residuals:	50081	BIC:	3.859e+05
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	8.0473	0.088	91.231	0.000	7.874	8.220
treatment	-0.0120	0.108	-0.111	0.912	-0.224	0.200

Omnibus:	49107.114	Durbin-Watson:	2.016
Prob(Omnibus):	0.000	Jarque-Bera (JB):	3644795.393
Skew:	4.707	Prob(JB):	0.00
Kurtosis:	43.718	Cond. No.	3.23

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
Experimental Results: Charitable Contribution Made




```
T-test for charitable donation made
TtestResult(statistic=3.101361000543946, pvalue=0.0019274025949016988,
df=50081.0)
Linear regression for charitable donation made
                            OLS Regression Results
==============================================================================
Dep. Variable:                   gave   R-squared:                       0.000
Model:                            OLS   Adj. R-squared:                  0.000
Method:                 Least Squares   F-statistic:                     9.618
Date:                Tue, 16 Apr 2024   Prob (F-statistic):            0.00193
Time:                        12:09:38   Log-Likelihood:                 26630.
No. Observations:               50083   AIC:                        -5.326e+04
Df Residuals:                   50081   BIC:                        -5.324e+04
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.0179      0.001     16.225      0.000       0.016       0.020
treatment      0.0042      0.001      3.101      0.002       0.002       0.007
==============================================================================
Omnibus:                    59814.280   Durbin-Watson:                   2.005
```

```
Prob(Omnibus):                  0.000   Jarque-Bera (JB):          4317152.727
Skew:                           6.740   Prob(JB):                         0.00
Kurtosis:                      46.440   Cond. No.                         3.23
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
Probit regression for charitable donation made
Optimization terminated successfully.
         Current function value: 0.100443
         Iterations 7
                          Probit Regression Results
==============================================================================
Dep. Variable:                   gave   No. Observations:                50083
Model:                         Probit   Df Residuals:                    50081
Method:                           MLE   Df Model:                            1
Date:                Tue, 16 Apr 2024   Pseudo R-squ.:               0.0009783
Time:                        12:09:39   Log-Likelihood:                -5030.5
converged:                       True   LL-Null:                       -5035.4
Covariance Type:            nonrobust   LLR p-value:                  0.001696
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const         -2.1001      0.023    -90.073      0.000      -2.146      -2.054
treatment      0.0868      0.028      3.113      0.002       0.032       0.141
==============================================================================
Differences between Match Rates
T-tests for match rates
1:1 vs Control
TtestResult(statistic=nan, pvalue=nan, df=nan)
2:1 vs Control
TtestResult(statistic=nan, pvalue=nan, df=nan)
3:1 vs Control
TtestResult(statistic=nan, pvalue=nan, df=nan)
Regression with ratio dummies
                            OLS Regression Results
==============================================================================
Dep. Variable:                   gave   R-squared:                       0.000
Model:                            OLS   Adj. R-squared:                  0.000
Method:                 Least Squares   F-statistic:                     3.665
Date:                Tue, 16 Apr 2024   Prob (F-statistic):             0.0118
Time:                        12:09:39   Log-Likelihood:                 26630.
No. Observations:               50083   AIC:                        -5.325e+04
Df Residuals:                   50079   BIC:                        -5.322e+04
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
```

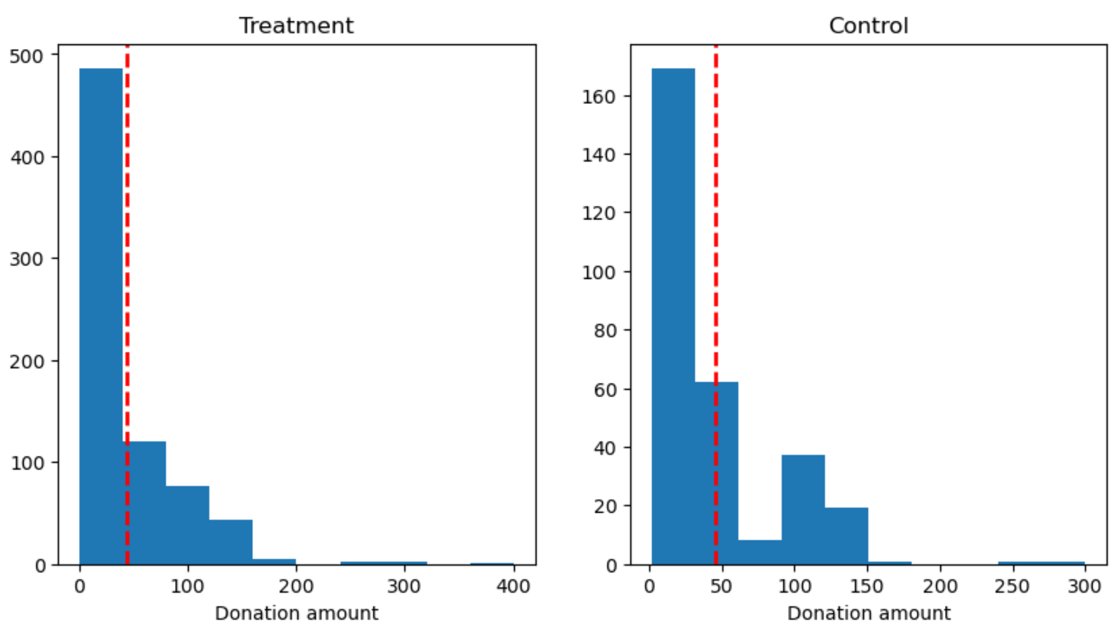
```
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.0179      0.001     16.225      0.000       0.016       0.020
ratio1         0.0029      0.002      1.661      0.097      -0.001       0.006
ratio2         0.0048      0.002      2.744      0.006       0.001       0.008
ratio3         0.0049      0.002      2.802      0.005       0.001       0.008
==============================================================================
Omnibus:                    59812.754   Durbin-Watson:                   2.005
Prob(Omnibus):                  0.000   Jarque-Bera (JB):          4316693.217
Skew:                           6.740   Prob(JB):                         0.00
Kurtosis:                      46.438   Cond. No.                         4.26
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
Size of Charitable Contribution
T-test for donation amount
TtestResult(statistic=1.860502691242923, pvalue=0.06282029495754826, df=50081.0)
Linear regression for donation amount
                            OLS Regression Results
==============================================================================
Dep. Variable:                 amount   R-squared:                       0.000
Model:                            OLS   Adj. R-squared:                  0.000
Method:                 Least Squares   F-statistic:                     3.461
Date:                Tue, 16 Apr 2024   Prob (F-statistic):             0.0628
Time:                        12:09:39   Log-Likelihood:            -1.7946e+05
No. Observations:               50083   AIC:                         3.589e+05
Df Residuals:                   50081   BIC:                         3.589e+05
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.8133      0.067     12.063      0.000       0.681       0.945
treatment      0.1536      0.083      1.861      0.063      -0.008       0.315
==============================================================================
Omnibus:                    96861.113   Durbin-Watson:                   2.008
Prob(Omnibus):                  0.000   Jarque-Bera (JB):        240735713.653
Skew:                          15.297   Prob(JB):                         0.00
Kurtosis:                     341.269   Cond. No.                         3.23
==============================================================================

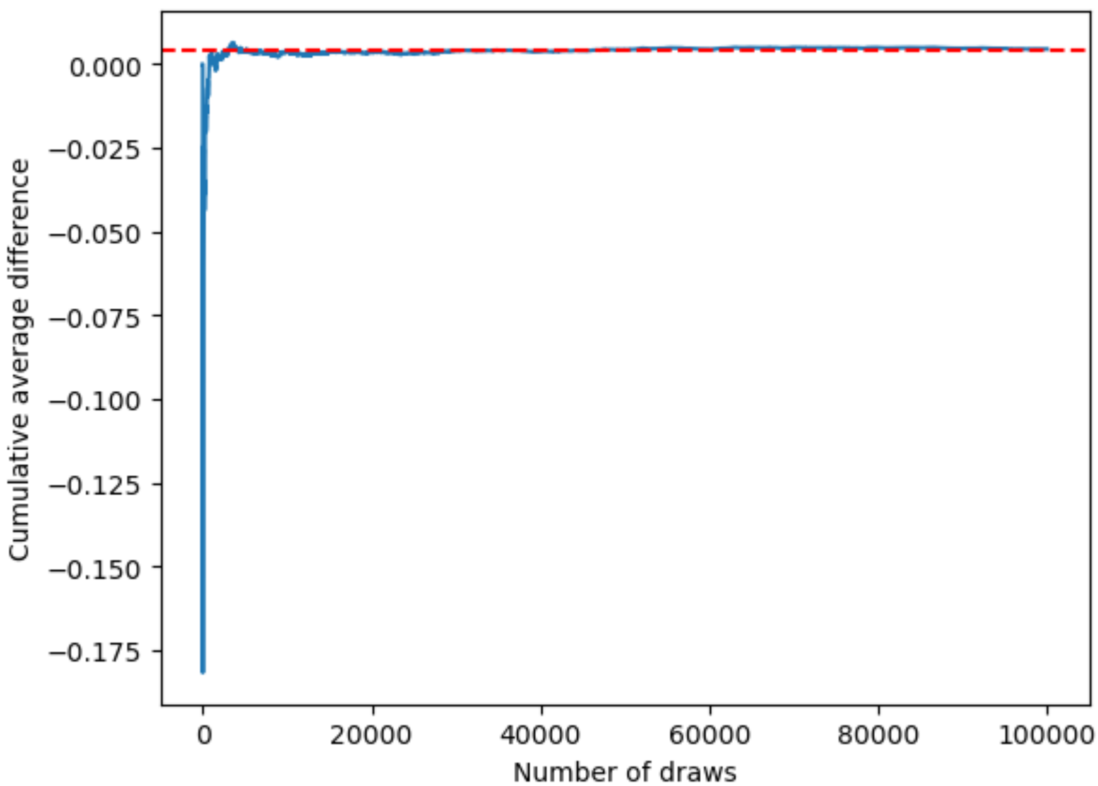
Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
T-test for donation amount (donors only)
TtestResult(statistic=-0.5808393095316696, pvalue=0.5614755763711469, df=1032.0)
```

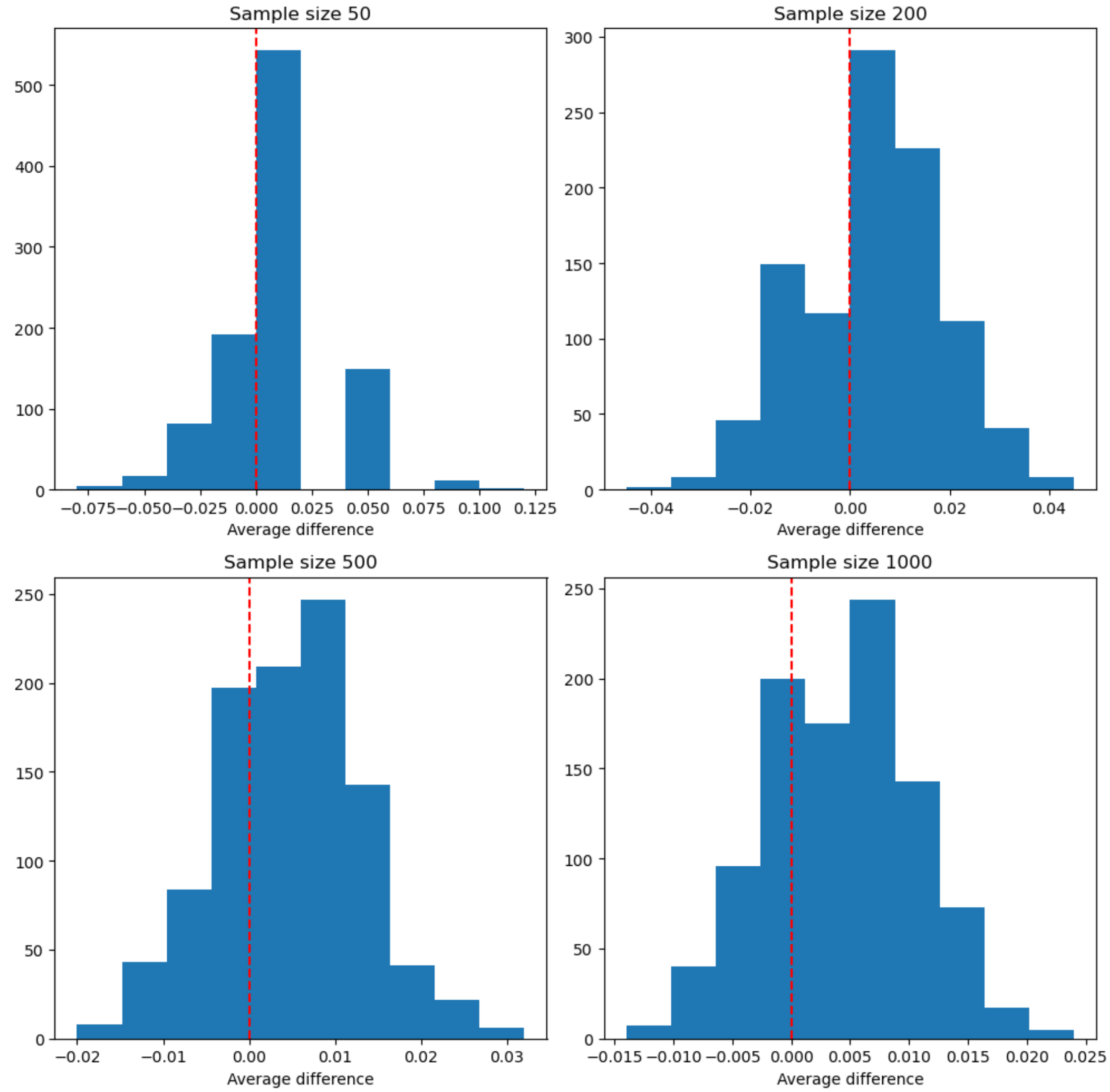
```
Linear regression for donation amount (donors only)
                            OLS Regression Results
==============================================================================
Dep. Variable:                 amount   R-squared:                       0.000
Model:                            OLS   Adj. R-squared:                 -0.001
Method:                 Least Squares   F-statistic:                    0.3374
Date:                Tue, 16 Apr 2024   Prob (F-statistic):              0.561
Time:                        12:09:39   Log-Likelihood:                -5326.8
No. Observations:                1034   AIC:                         1.066e+04
Df Residuals:                    1032   BIC:                         1.067e+04
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         45.5403      2.423     18.792      0.000      40.785      50.296
treatment     -1.6684      2.872     -0.581      0.561      -7.305       3.968
==============================================================================
Omnibus:                      587.258   Durbin-Watson:                   2.031
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             5623.279
Skew:                           2.464   Prob(JB):                         0.00
Kurtosis:                      13.307   Cond. No.                         3.49
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
```



Simulation Experiment





The experiment aims to investigate the effect of matching donations on charitable giving. It randomly assigns individuals to treatment (matching) and control (no matching) groups and varies the match ratio and threshold to assess their impact on donation behavior.

The dataset contains information about the treatment assignment, match ratio, threshold, suggested donation amounts, and various demographic and historical giving variables for each individual.

The t-test and linear regression results show no significant difference in months since last donation between the treatment and control groups, indicating a balanced randomization. Table 1 in the paper is included to demonstrate the success of the randomization process.

The barplot visually compares the proportion of individuals who donated in the treatment and control groups.

The t-test and linear regression results indicate a statistically significant difference in the proportion of individuals who made a donation between the treatment and control groups. This suggests that matching donations positively influences the likelihood of making a charitable contribution.

The probit regression results confirm the findings from the linear regression, showing a significant positive effect of the treatment on the probability of making a donation.

The t-test results suggest that all match rates (1:1, 2:1, and 3:1) significantly increase the likelihood of donating compared to the control group. However, there is no clear evidence that higher match rates (2:1 or 3:1) are more effective than the 1:1 match rate.

The regression with ratio dummies confirms that all match rates have a significant positive effect on the likelihood of donating. The coefficients for ratio2 and ratio3 are not statistically different from ratio1, suggesting no incremental benefit of higher match rates.

The response rate differences between match ratios, calculated directly from the data and from the regression coefficients, are small and not statistically significant. This suggests that increasing the match ratio beyond 1:1 does not lead to a substantial increase in the likelihood of donating.

The t-test and linear regression results show a significant difference in the average donation amount between the treatment and control groups. However, this analysis includes both donors and non-donors, which may not provide a clear picture of the treatment effect on donation amount.

The analysis for donors only reveals no significant difference in the average donation amount between the treatment and control groups. The treatment coefficient in the linear regression does not have a causal interpretation, as it is conditional on the decision to donate, which is itself affected by the treatment.

The histograms of donation amounts for donors in the treatment and control groups show similar distributions, with the average donation amounts (indicated by the red vertical lines) being close to each other.

The plot demonstrates the Law of Large Numbers, showing that the cumulative average difference between the treatment and control groups converges to the true difference in means (0.022 - 0.018 = 0.004) as the number of draws increases.

The histograms illustrate the Central Limit Theorem, showing that as the sample size increases, the distribution of the average difference between the treatment and control groups becomes more normal and centered around the true difference in means (0.004). At smaller sample sizes, zero (the red vertical line) is closer to the middle of the distribution, while at larger sample sizes, zero moves towards the tail, indicating that the observed difference is less likely to be due to chance.

Summary: The analysis of the experiment can be broken down into several key components. First, the data is read into R/Python and described, with a balance test performed to ensure the treatment and control groups are not significantly different on key variables. Next, the effect of matched donations on the response rate of making a donation can be analyzed using bar plots, t-tests, linear regression, and probit regression. The effectiveness of different match rates can be assessed using t-tests and regression, with the response rate differences between match ratios calculated directly from the data and from regression coefficients. The effect of matched donations on the size of the charitable contribution can be analyzed using t-tests and linear regression, both for all individuals and for only those who made a donation. Histograms of donation amounts can be plotted for the treatment and control groups.

Finally, simulation can be used to demonstrate the Law of Large Numbers and the Central Limit

Theorem, with plots of the cumulative average difference and histograms of average differences at different sample sizes. The results of these analyses can provide insights into the effectiveness of matched donations and the impact of different match rates on charitable giving behavior.

The experiment conducted by Karlan and List (2007) provides valuable insights into the effects of matching donations on charitable giving behavior. By randomly assigning individuals to treatment and control groups and varying the match ratio and threshold, the researchers were able to isolate the impact of these factors on donation decisions.

The analysis of the data reveals that the treatment, which involved offering matching donations, had a significant positive effect on the likelihood of making a charitable contribution. The t-test and linear regression results indicate a statistically significant difference in the proportion of individuals who made a donation between the treatment and control groups. This finding suggests that matching donations can be an effective strategy for encouraging people to give to charity.

Further investigation into the effects of different match rates (1:1, 2:1, and 3:1) shows that all match rates significantly increase the likelihood of donating compared to the control group. However, the results do not provide clear evidence that higher match rates are more effective than the 1:1 match rate. The regression with ratio dummies confirms this finding, as the coefficients for the 2:1 and 3:1 match rates are not statistically different from the 1:1 match rate. Additionally, the response rate differences between match ratios, calculated directly from the data and from the regression coefficients, are small and not statistically significant. This suggests that increasing the match ratio beyond 1:1 may not lead to a substantial increase in the likelihood of donating.

When examining the impact of matching donations on the size of the charitable contribution, the t-test and linear regression results initially show a significant difference in the average donation amount between the treatment and control groups. However, this analysis includes both donors and non-donors, which may not provide a clear picture of the treatment effect on donation amount. When focusing solely on donors, the analysis reveals no significant difference in the average donation amount between the treatment and control groups. It is important to note that the treatment coefficient in the linear regression for donors does not have a causal interpretation, as it is conditional on the decision to donate, which is itself affected by the treatment.

The histograms of donation amounts for donors in the treatment and control groups show similar distributions, with the average donation amounts being close to each other. This visual representation supports the finding that matching donations may not have a significant impact on the size of the contribution among those who decide to donate.

The simulation experiments conducted in the study demonstrate the Law of Large Numbers and the Central Limit Theorem. The Law of Large Numbers plot shows that the cumulative average difference between the treatment and control groups converges to the true difference in means as the number of draws increases. The Central Limit Theorem histograms illustrate that as the sample size increases, the distribution of the average difference between the treatment and control groups becomes more normal and centered around the true difference in means. These simulations provide a deeper understanding of the statistical properties underlying the observed results.

In conclusion, the experiment by Karlan and List (2007) offers evidence that matching donations can be an effective tool for increasing the likelihood of charitable giving. However, the results suggest that higher match rates may not necessarily lead to a significant increase in donation rates or amounts compared to a 1:1 match rate. The findings of this study can inform the strategies employed by charities and policymakers to encourage charitable giving, while also highlighting the importance of careful analysis and interpretation of data when assessing the impact of such interventions.