3. Analyses Plan

true

2021-06-30

```
knitr::opts_chunk$set(echo = TRUE)

library(data.table)
library(magrittr)
library(kableExtra)
library(downloadthis)
library(ggplot2)
library(patchwork)
library(stargazer)
```

Background

In an attempt to incorporate uncertainty to Gächter et al. (2017)'s dynamic public goods game (DPGG), I plan to run a series of remote online experiments using oTree (Chen, Schonger, and Wickens 2016). The first experiment will replicate Gächter et al.'s NOPUNISH 10-period version as close as possible (given the remote circumstances). The current demo version of the experiment can be found here. Click here to visit the corresponding Github repository.

This report is the third in a series of reports covering this project. It reads the data prepared in the previous reports and analyzes them.

```
base::load(file="../../../data/processed/rda/GMTV2017.rda")               # read GMTV
base::load(file="../../../data/processed/rda/GMTV2017_R1.rda")            # read GMTVFirstRound
base::load(file="../../../data/processed/rda/GMTV2017_COVS.rda")          # read GMTVCovariates
base::load(file="../../../data/processed/rda/replication2021.rda")        # read replication
base::load(file="../../../data/processed/rda/replication2021_R1.rda")     # read replicationFirstRound
base::load(file="../../../data/processed/rda/replication2021_COVS.rda")   # read replicationCovariates
```

```
main <- rbindlist(list(replication, GMTV),
                  use.names = TRUE)

R1   <- rbindlist(list(replicationFirstRound, GMTVFirstRound),
                  use.names = TRUE)

covs <- rbindlist(list(replicationCovariates, GMTVCovariates),
                  use.names = TRUE,
                  fill = TRUE)

rm(list = c("replication", "GMTV", "replicationFirstRound", "GMTVFirstRound", "GMTVCovariates", "replica
```

Results

```
layout <- theme(panel.background = element_rect(fill = "white"),
                panel.grid = element_blank(),
                panel.grid.major.y = element_line(colour="gray", size=0.25),
                legend.key = element_rect(fill = "white"),
                axis.line.x.bottom = element_line(size = 0.25),
                axis.line.y.left = element_line(size = 0.25),
                axis.title.y = element_text(size = rel(0.75)),
                plot.margin = unit(c(0.25,0.25,0.25,0.25), "cm"),
                legend.title = element_blank()
                )

colors <- c("#F3B05C", "#1E4A75", "#65B5C0", "#AD5E21")
```

First Round

```
ggplot(R1, aes(y=ownContribution, x=othersContribution/3)) +
  layout +
  geom_abline(intercept = 0, slope = 1, linetype="dashed", alpha = 0.66) +
  geom_point(color = colors) +
  scale_y_continuous(expand = c(0, 0), limits = c(-1, 25)) +
  scale_x_continuous(expand = c(0, 0), limits = c(-1, 25))
```

Provision of the public good and wealth creation

```
SUM <- main[,
            lapply(.SD, mean, na.rm = TRUE),
            by = c("round", "treatment"),
            .SDcols = "contribution"]

SUM[,
    sum := round(contribution/4)]

upperLimit <- SUM$contribution %>% max() %>% round() + 10

p1 <- ggplot(data = SUM,
             aes(x = round, y = contribution, fill = treatment, color = treatment, lty = treatment)) +
  layout +
  theme(legend.position="bottom") +
  geom_line(show.legend=FALSE) +
  geom_point() +
  scale_x_continuous(name="",  breaks = 1:15) +
  scale_y_continuous(limits = c(0, upperLimit), expand = c(0, 0)) +
  labs(y = "Average Amount of Tokens contributed") +
  scale_color_manual(values = colors) +
  theme(plot.margin = margin(0.25,1,0.25,0.25, "cm"))

rm(list = c("SUM"))
```

```
SHARE <- main[,
            lapply(.SD, mean, na.rm = TRUE),
            by = c("round", "treatment"),
```

```
            .SDcols = "share"]

upperLimit <- 1

p2 <- ggplot(data = SHARE,
             aes(x = round, y = share, fill = treatment, color = treatment, lty = treatment)) +
  layout +
  theme(legend.position="bottom") +
  geom_line(show.legend=FALSE) +
  geom_point() +
  scale_x_continuous(name="",  breaks = 1:15) +
  scale_y_continuous(limits = c(0, upperLimit), expand = c(0, 0)) +
  labs(y = "Share of Current Endowment contributed") +
  scale_color_manual(values = colors)

p1 + p2 + plot_layout(guides = "collect") & theme(legend.position = "bottom")
```

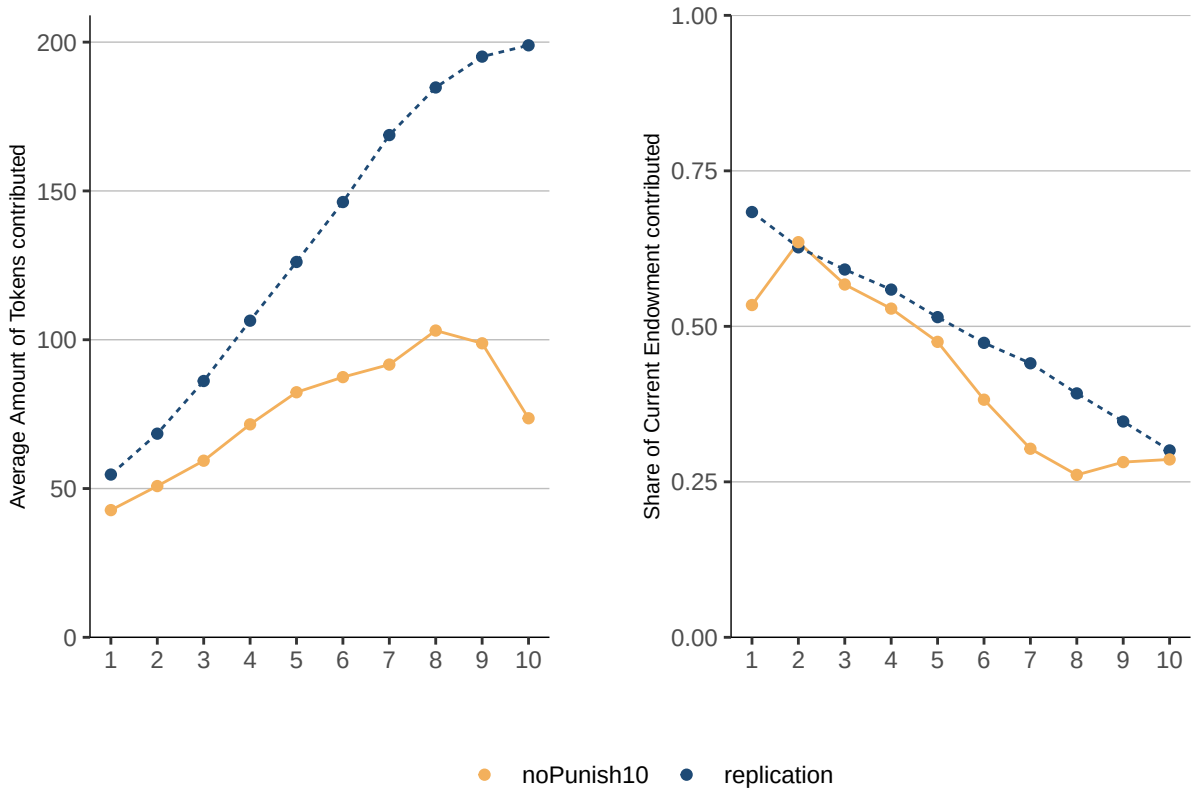

Figure 1: The average amount of tokens contributed over time in treatments.

```
rm(list = c("SHARE", "p1", "p2"))
```

```
if(knitr::is_html_output()){
  type <- "html"
} else {
  type = "latex"
}

replication <- main[treatment == "replication" & round == 10, stock]
```

```
GMTV    <- main[treatment == "noPunish10" & round == 10, stock]


rows <- sapply(X = list(replication, GMTV), FUN = NROW) %>% max()
temp <- data.frame(replication = c(replication, rep(NA, rows - NROW(replication))),
                   GMTV = c(GMTV, rep(NA, rows - NROW(GMTV))))

stargazer(temp,
          summary.stat = c("mean", "median","sd", "max", "min", "n"),
          type = type,
          flip = TRUE,
          header=FALSE)
```

Table 1:

Statistic	replication	GMTV
Mean	764.333	478.087
Median	774.5	304.000
St. Dev.	41.790	393.575
Max	833	1,792.000
Min	646	161.000
N	30	23

```
rs1 <- wilcox.test(replication,
                   GMTV,
                   exact = FALSE)$p.value %>%
  round(digits = 4) %>%
  formatC(format = "f",
          digits = 4)
```

The rank sum test yields a p-Value of 0.0001 for the mean `stock` a.k.a *Wealth* during the last period of the game.

```
# create subsets
main_all  <- main[round == 10]
main_poor <- main[round == 10 & rich == FALSE]
main_rich <- main[round == 10 & rich == TRUE]

# create table
if(knitr::is_html_output()){
  type <- "html"
} else {
  type = "latex"
}

stargazer(lm(formula = stock ~ treatment, data = main_all),
          lm(formula = stock ~ treatment, data = main_poor),
          lm(formula = stock ~ treatment, data = main_rich),

          column.labels = c("All", "Below median", "Above median"),
          model.numbers = FALSE,
          dep.var.labels = "Wealth",
          header=FALSE,
```

```
          covariate.labels = c("Replication"),

          type = type, digits = 2, omit.stat = c("adj.rsq", "f"), df = FALSE
          )
```

Table 2:

	Dependent variable:		
		Wealth	
	All	Below median	Above median
Replication	286.25***	499.03***	63.93
	(72.17)	(15.61)	(115.74)
Constant	478.09***	234.70***	731.00***
	(54.30)	(12.09)	(87.91)
Observations	53	25	26
R^2	0.24	0.98	0.01
Residual Std. Error	260.41	38.24	291.56
Note:			*p<0.1; **p<0.05; ***p<0.01

```
STOCK <- main[,
              lapply(.SD, mean, na.rm = TRUE),
              by = c("round", "treatment"),
              .SDcols = "stock"]

STOCKr <- main[rich == TRUE,
               lapply(.SD, mean, na.rm = TRUE),
               by = c("round", "treatment"),
               .SDcols = "stock"]

STOCKp <- main[rich == FALSE,
               lapply(.SD, mean, na.rm = TRUE),
               by = c("round", "treatment"),
               .SDcols = "stock"]

upperLimit <- STOCKr$stock %>% max() %>% round() + 20

p1 <- ggplot(data = STOCK,
       aes(x = round, y = stock, fill = treatment, color = treatment, lty = treatment)) +
          layout +
          theme(legend.position="bottom") +
          # geom_vline(xintercept = 10, alpha = 0.66) +
          geom_line(show.legend=FALSE) +
          geom_point() +
          scale_x_continuous(name="",  breaks = 1:10) +
          scale_y_continuous(limits = c(0, upperLimit), expand = c(0, 0)) +
          labs(y = "Wealth") +
          scale_color_manual(values = colors) +
          theme(plot.margin = margin(0.25,1,0.25,0.25, "cm"))
```

```
p2 <- ggplot(data = STOCKr,
       aes(x = round, y = stock, fill = treatment, color = treatment, lty = treatment)) +
          layout +
          theme(legend.position="bottom") +
          # geom_vline(xintercept = 10, alpha = 0.66) +
          geom_line(show.legend=FALSE) +
          geom_point() +
          scale_x_continuous(name="",  breaks = 1:10) +
          scale_y_continuous(limits = c(0, upperLimit), expand = c(0, 0)) +
          labs(y = "Wealth (Rich)") +
          scale_color_manual(values = colors)

p3 <- ggplot(data = STOCKp,
       aes(x = round, y = stock, fill = treatment, color = treatment, lty = treatment)) +
          layout +
          theme(legend.position="bottom") +
          # geom_vline(xintercept = 10, alpha = 0.66) +
          geom_line(show.legend=FALSE) +
          geom_point() +
          scale_x_continuous(name="",  breaks = 1:10) +
          scale_y_continuous(limits = c(0, upperLimit), expand = c(0, 0)) +
          labs(y = "Wealth (Poor)") +
          scale_color_manual(values = colors)

(p1 | (p2 / p3)) + plot_layout(guides = "collect") & theme(legend.position = "bottom")
```

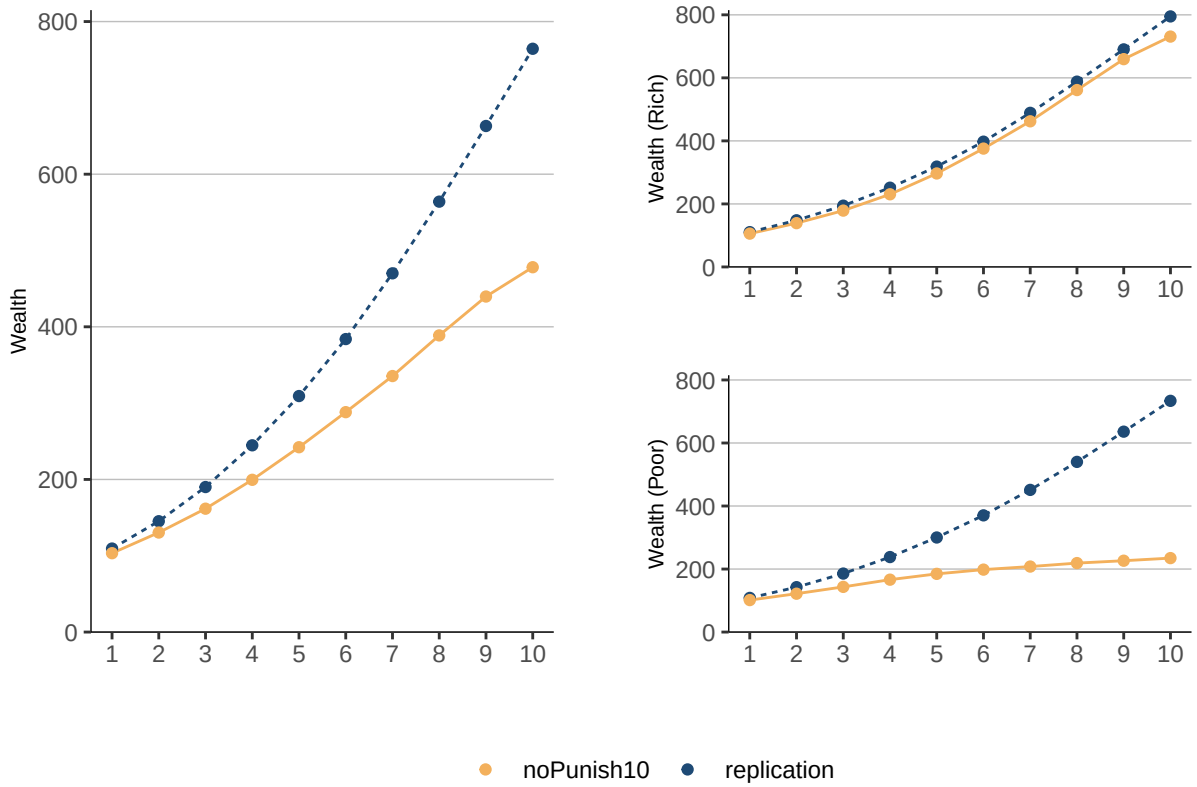

Figure 2: Average wealth over time across treatments.

```
rm(list = c("STOCK", "STOCKr", "STOCKp", "p1", "p2", "p3"))
```

Inequality

```
GINI <- main[,
             lapply(.SD, mean, na.rm = TRUE),
             by = c("round", "treatment"),
             .SDcols = "gini"]

GINIr <- main[rich == TRUE,
              lapply(.SD, mean, na.rm = TRUE),
              by = c("round", "treatment"),
              .SDcols = "gini"]

GINIp <- main[rich == FALSE,
              lapply(.SD, mean, na.rm = TRUE),
              by = c("round", "treatment"),
              .SDcols = "gini"]

upperLimit <- GINI$gini %>% max() %>% round(digits = 1) + 0.10

p1 <- ggplot(data = GINI,
       aes(x = round, y = gini, fill = treatment, color = treatment, lty = treatment)) +
          layout +
          theme(legend.position="bottom") +
          # geom_vline(xintercept = 10, alpha = 0.66) +
          geom_line(show.legend=FALSE) +
          geom_point() +
          scale_x_continuous(name="",  breaks = 1:10) +
          scale_y_continuous(limits = c(0, upperLimit), expand = c(0, 0)) +
          labs(y = "Gini Coefficient") +
          scale_color_manual(values = colors) +
          theme(plot.margin = margin(0.25,1,0.25,0.25, "cm"))

p2 <- ggplot(data = GINIr,
       aes(x = round, y = gini, fill = treatment, color = treatment, lty = treatment)) +
          layout +
          theme(legend.position="bottom") +
          # geom_vline(xintercept = 10, alpha = 0.66) +
          geom_line(show.legend=FALSE) +
          geom_point() +
          scale_x_continuous(name="",  breaks = 1:10) +
          scale_y_continuous(limits = c(0, upperLimit), expand = c(0, 0)) +
          labs(y = "Gini (Rich)") +
          scale_color_manual(values = colors)

p3 <- ggplot(data = GINIp,
       aes(x = round, y = gini, fill = treatment, color = treatment, lty = treatment)) +
          layout +
          theme(legend.position="bottom") +
          # geom_vline(xintercept = 10, alpha = 0.66) +
          geom_line(show.legend=FALSE) +
          geom_point() +
```

```
          scale_x_continuous(name="",  breaks = 1:10) +
          scale_y_continuous(limits = c(0, upperLimit), expand = c(0, 0)) +
          labs(y = "Gini (Poor)") +
          scale_color_manual(values = colors)

(p1 | (p2 / p3)) + plot_layout(guides = "collect") & theme(legend.position = "bottom")
```

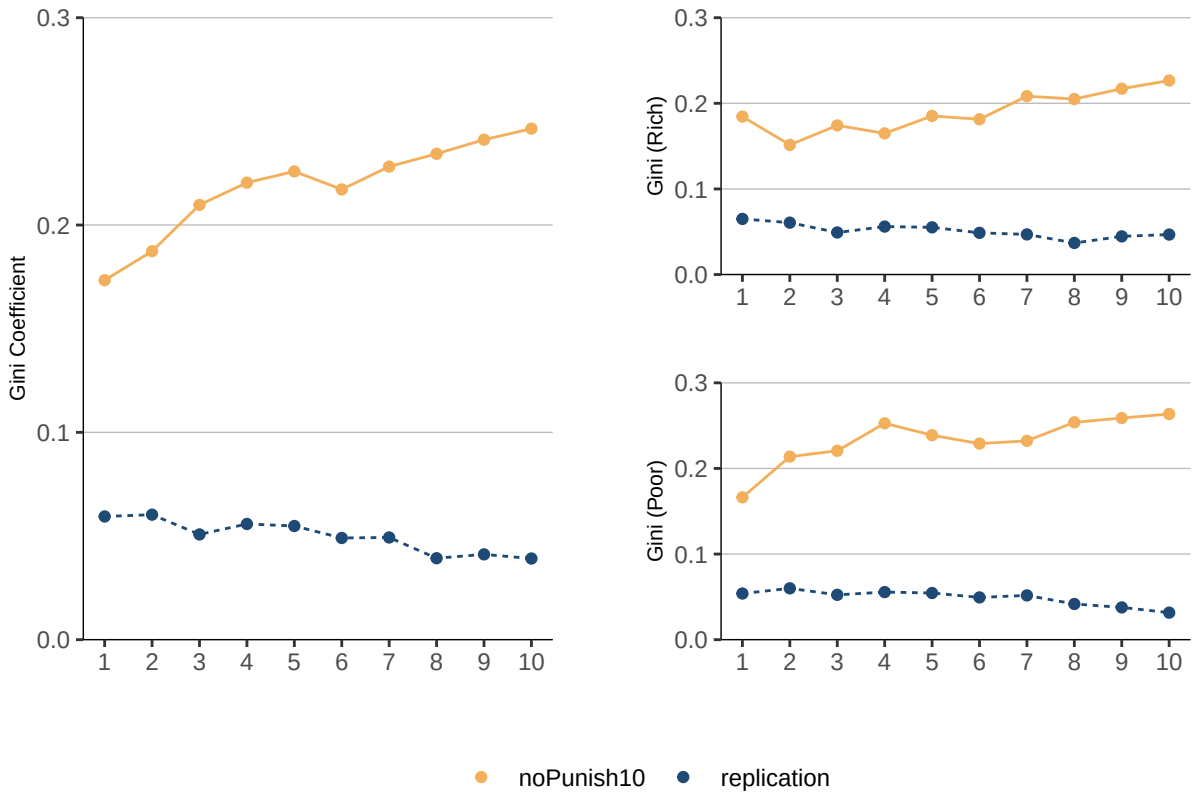

Figure 3: Average Gini coefficient over time across treatments.

```
rm(list = c("GINI", "GINIp", "GINIr", "p1", "p2", "p3"))
```

```
# create subsets
main_all  <- main[round == 10]
main_poor <- main[round == 10 & rich == FALSE]
main_rich <- main[round == 10 & rich == TRUE]

# create table
if(knitr::is_html_output()){
  type <- "html"
} else {
  type = "latex"
}

stargazer(lm(formula = gini ~ treatment, data = main_all),
          lm(formula = gini ~ treatment, data = main_poor),
          lm(formula = gini ~ treatment, data = main_rich),

          column.labels = c("All", "Below median", "Above median"),
```

```
          model.numbers = FALSE,
          dep.var.labels = "Gini",
          header=FALSE,
          covariate.labels = c("Replication"),

          type = type, digits = 2, omit.stat = c("adj.rsq", "f"), df = FALSE
          )
```

Table 3:

	Dependent variable:		
	Gini		
	All	Below median	Above median
Replication	-0.21^{***}	-0.23^{***}	-0.18^{***}
	(0.02)	(0.04)	(0.03)
Constant	0.25^{***}	0.26^{***}	0.23^{***}
	(0.02)	(0.03)	(0.02)
Observations	53	25	26
R^2	0.59	0.61	0.56
Residual Std. Error	0.09	0.10	0.08
Note:			*p<0.1; **p<0.05; ***p<0.01

```
if(knitr::is_html_output()){
  type <- "html"
} else {
  type = "latex"
}

replication <- main[treatment == "replication" & round == 10, gini]
GMTV    <- main[treatment == "noPunish10" & round == 10, gini]


rows <- sapply(X = list(replication, GMTV), FUN = NROW) %>% max()
temp <- data.frame(replication = c(replication, rep(NA, rows - NROW(replication))),
                   GMTV = c(GMTV, rep(NA, rows - NROW(GMTV))))

stargazer(temp,
          summary.stat = c("mean", "median","sd", "max", "min", "n"),
          type = type,
          flip = TRUE,
          header=FALSE)
```

```
rs2 <- wilcox.test(replication,
                   GMTV,
                   exact = FALSE)$p.value %>%
  round(digits = 4) %>%
  formatC(format = "f",
          digits = 4)
```

The rank sum test yields a p-Value of 0.0000 for the mean `gini` during the last period of the game.

Table 4:

Statistic	replication	GMTV
Mean	0.039	0.246
Median	0.035	0.245
St. Dev.	0.016	0.131
Max	0.074	0.479
Min	0.012	0.044
N	30	23

Sample Properties

```
covariates <- data.table::merge.data.table(x  = covs,
                                           y  = main[round == 10, .(groupID, stock, gini)],
                                           by = c("groupID"),
                                           allow.cartesian = TRUE)

covariates[,
           gender := gender %>% as.numeric()]
```

In addition to the summary statistics a regression table for each covariate as a dependent variable is needed. The independent variable will then be the data source (i.e. GMTV vs replication).

```
# create table
if(knitr::is_html_output()){
  type <- "html"
} else {
  type = "latex"
}

temp <- covariates[treatment == "replication",
                   .(gender, age, switching_row, education, donation, pq01, pq02, pq03, pq04,
                     pq05, pq06, pq07, pq08, pq09, pq10, pq11, pq12, pq13, pq14)]
stargazer(temp, type = type, flip = FALSE)
```

% Table created by stargazer v.5.2.2 by Marek Hlavac, Harvard University. E-mail: hlavac at fas.harvard.edu
% Date and time: Mi, Jun 30, 2021 - 20:35:14

```
# create table
if(knitr::is_html_output()){
  type <- "html"
} else {
  type = "latex"
}

olsStock1 <- lm(formula = stock ~ gender + age + switching_row + pq01 + pq02 + pq03 + pq04 +
                  pq05 + pq06 + pq07 +pq08 + pq09 + pq10 + pq11 + pq12 + pq13 + pq14,
                data = covariates[treatment == "replication"])
olsStock2  <- lm(formula = stock ~ gender + age + switching_row,
                data = covariates[treatment == "replication"])
olsGINI1  <- lm(formula = gini ~ gender + age + switching_row + pq01 + pq02 + pq03 + pq04 +
                  pq05 + pq06 + pq07 + pq08 + pq09 + pq10 + pq11 + pq12 + pq13 + pq14,
                data = covariates[treatment == "replication"])
olsGINI2  <- lm(formula = gini ~ gender + age + switching_row,
```

Table 5:

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
gender	120	0.250	0.435	0	0	0.2	1
age	120	44.125	14.817	18	31.8	59	66
switching_row	120	6.525	0.501	6	6	7	7
education	120	3.858	2.642	0	2	6	8
donation	120	1.992	1.131	0.000	1.150	2.938	4.200
pq01	120	2.683	1.996	0	1	4	6
pq02	120	3.317	1.801	0	2	5	6
pq03	120	3.133	2.000	0	1	5	6
pq04	120	2.883	1.902	0	1	4.2	6
pq05	120	3.033	2.021	0	1	5	6
pq06	120	2.667	2.039	0	1	5	6
pq07	120	3.100	1.968	0	2	5	6
pq08	120	2.950	2.033	0	1	5	6
pq09	120	2.917	2.064	0	1	5	6
pq10	120	3.100	1.964	0	1.8	5	6
pq11	120	2.967	2.086	0	1	5	6
pq12	120	2.917	1.977	0	1	5	6
pq13	120	3.375	1.949	0	2	5	6
pq14	120	3.075	2.063	0	1	5	6

```
               data = covariates[treatment == "replication"])

stargazer(olsStock1, olsStock2,
          olsGINI1, olsGINI2,

          se = list(coef(summary(olsStock1, cluster = c("groupID")))[, 2],
                    coef(summary(olsStock2, cluster = c("groupID")))[, 2],
                    coef(summary(olsGINI1,  cluster = c("groupID")))[, 2],
                    coef(summary(olsGINI2,  cluster = c("groupID")))[, 2]),

          column.labels   = c("Wealth", "Gini"),
          dep.var.labels.include = FALSE,
          column.separate = c(2, 2),
          model.numbers = FALSE,
          header=FALSE,
          covariate.labels = c("female", "age", "risk",
                               "I am a quick thinker",
                               "I get easily offended",
                               "very satisfied",
                               "very dependent",
                               "generally happy",
                               "work important",
                               "family important",
                               "friends important",
                               "religion important",
                               "politics important",
                               "most people trusted",
                               "hard work better",
```

```
                            "government responsible",
                            "incomes equal"),
          notes = "Robust standard errors in parentheses, clustered by group ID.",

          type = type, digits = 2, omit.stat = c("adj.rsq", "f"), df = FALSE
          )
```

Chen, Daniel L., Martin Schonger, and Chris Wickens. 2016. "oTree-an Open-Source Platform for Laboratory, Online, and Field Experiments." *Journal of Behavioral and Experimental Finance* 9: 88–97. https://doi.org/10.1016/j.jbef.2015.12.001.

Gächter, Simon, Friederike Mengel, Elias Tsakas, and Alexander Vostroknutov. 2017. "Growth and Inequality in Public Good Provision." *Journal of Public Economics* 150: 1–13. https://doi.org/10.1016/j.jpubeco.2017.03.002.

Table 6:

	Dependent variable:			
	Wealth		Gini	
female	−9.36	−10.53	0.001	0.001
	(8.99)	(8.62)	(0.004)	(0.003)
age	−0.66**	−0.51**	−0.0000	−0.0000
	(0.28)	(0.25)	(0.0001)	(0.0001)
risk	−7.43	−9.54	−0.001	−0.001
	(8.01)	(7.43)	(0.003)	(0.003)
I am a quick thinker	1.36		0.001	
	(2.06)		(0.001)	
I get easily offended	1.08		−0.0001	
	(2.18)		(0.001)	
very satisfied	0.72		0.001	
	(1.97)		(0.001)	
very dependent	−4.86**		0.0005	
	(2.03)		(0.001)	
generally happy	0.64		0.0004	
	(1.88)		(0.001)	
work important	3.65*		0.002**	
	(1.95)		(0.001)	
family important	2.57		0.0000	
	(2.06)		(0.001)	
friends important	−1.56		−0.001	
	(1.97)		(0.001)	
religion important	−2.73		−0.001	
	(1.85)		(0.001)	
politics important	−3.62*		−0.0001	
	(2.03)		(0.001)	
most people trusted	1.93		0.0004	
	(1.90)		(0.001)	
hard work better	1.71		−0.0002	
	(1.99)		(0.001)	
government responsible	−1.03		0.0000	
	(2.06)		(0.001)	
incomes equal	−0.93		0.001	
	(1.92)		(0.001)	
Constant	848.76***	851.75***	0.03	0.04**
	(58.45)	(49.57)	(0.02)	(0.02)
Observations	120	120	120	120