PAP Analysis for Disrupting Compliance: The Impact of a Randomized Tax Holiday in Uruguay

2023-05-06

```
################################################################################
# PAP 1 & 2 code execution
# Last revised April 2023
################################################################################

# Basic setup --
rm(list=ls())
set.seed(1234)
options(scipen=99999, digits=3)


################################################################
message("required libraries, setwd & load functions")
```

```
## required libraries, setwd & load functions
```

```
# Load/install packages --
if (!require("pacman")) install.packages("pacman")
```

```
## Loading required package: pacman
```

```
pacman::p_load(
  plyr,
  ggplot2,
  reshape2,
  zoo,
  sandwich,
  AER,
  xtable,
  stats,
  tidyr,
  dplyr,
  weights,
  estimatr
)

conflicted::conflicts_prefer(dplyr::filter)
```

```
## [conflicted] Will prefer dplyr::filter over any other package.
```

```r
#Set wd ---
home <-dirname(rstudioapi::getActiveDocumentContext()$path)
setwd(home)

#load functions ---
source("t_test.R")

################################################################################
# PAP 1 - NATURAL AND FIELD EXPERIMENTS

message("load data")
```

```
## load data
```

```r
load("panel_taxtime.Rda")
load("naturalex_debt_gtp.Rda")
load("fieldex_data.Rda")

#################################################################
message("Clean & add new variables")
```

```
## Clean & add new variables
```

```r
# switch tax names to english
taxes_panel$tax <- taxes_panel$TRIBUTO
taxes_panel$tax <- as.factor(taxes_panel$tax)
levels(taxes_panel$tax) <-  c("Property", "Vehicle", "Sewage", "Head")

# check when the holiday takes place for each tax
holiday <- taxes_panel %>% dplyr::filter(cuota_exonerada==1) %>% group_by(tax) %>%
  dplyr::summarise(
    holiday_start = min(t),
    holiday_end = max(t)
  )

holiday
```

```
## # A tibble: 4 x 3
##   tax      holiday_start holiday_end
##   <fct>            <int>       <int>
## 1 Property             1           4
## 2 Vehicle             -2           3
## 3 Sewage               1           7
## 4 Head                 2           8
```

```r
# For the treatment group, we replace with NAs the observations under the holiday
taxes_panel <- taxes_panel %>% inner_join(holiday)
```

```
## Joining with `by = join_by(tax)`
```

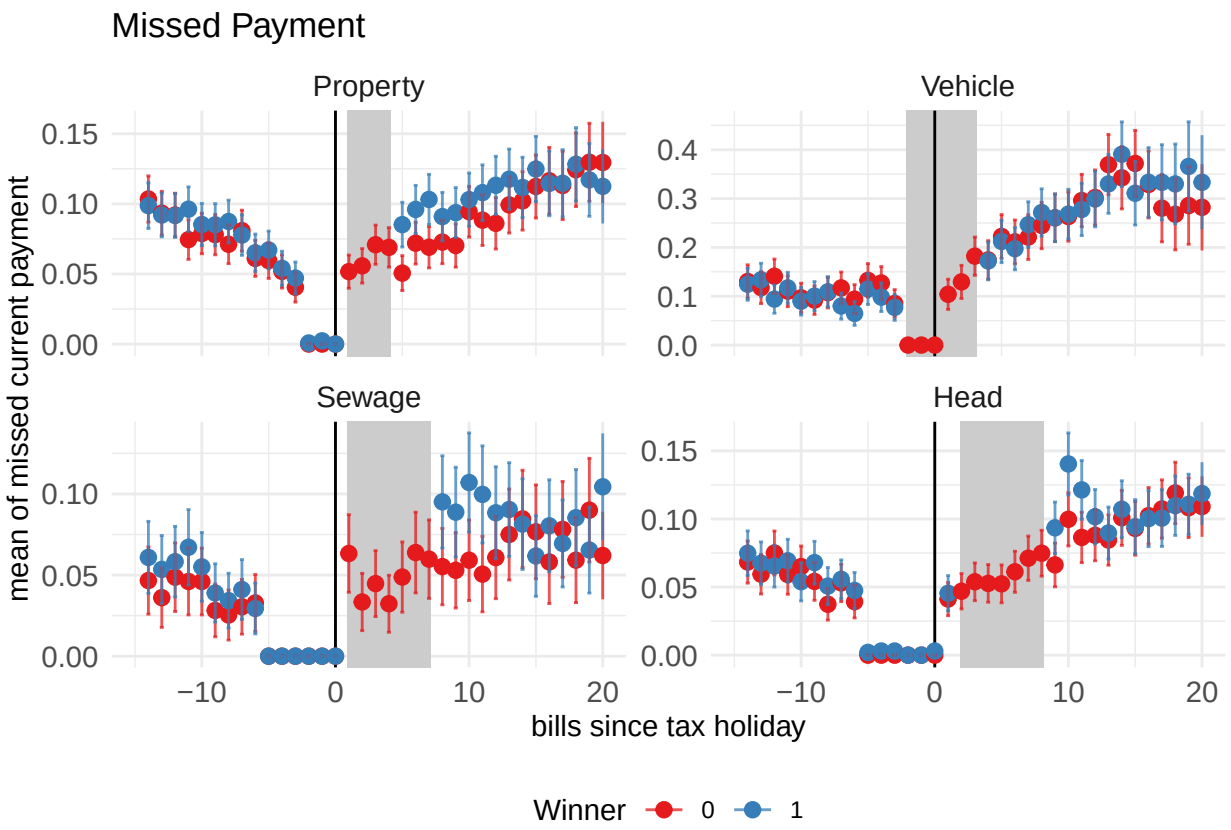
```r
taxes_panel$en_fecha[taxes_panel$TREATMENT==1 &
                       taxes_panel$t>=taxes_panel$holiday_start &
                       taxes_panel$t<=taxes_panel$holiday_end] <- NA
taxes_panel$nr_paymntsowed[taxes_panel$TREATMENT==1 &
                             taxes_panel$t>=taxes_panel$holiday_start &
                             taxes_panel$t<=taxes_panel$holiday_end] <- NA

# missed payment variable
taxes_panel$missed_payment <- as.numeric(taxes_panel$en_fecha==0)

# compliance variable
taxes_panel$compliance <- as.numeric(taxes_panel$nr_paymntsowed==0)

# drop some rows
taxes_panel <- taxes_panel[!(taxes_panel$tax=="Vehicle" &
                             taxes_panel$t %in% c(23,24)),]


#################################################################
# GRAPHICAL ANALYSIS - NATURAL EXPERIMENT. Impact of the tax holiday lottery

#Missed current payments
#Compliance
#Cumulative missed payments

## By type of tax

#prep data
plot_data <- taxes_panel %>% filter(ES_BP==1) %>%
  group_by(tax, t, TREATMENT) %>% dplyr::summarize(
    N = n(),

    # missed current payment
    missed_payment_mean = mean(missed_payment, na.rm=T),
    se_missed_payment_mean = sd(missed_payment, na.rm=T)/sqrt(N),
    missed_payment_upper= missed_payment_mean + qnorm(.975)*(se_missed_payment_mean),
    missed_payment_lower= missed_payment_mean - qnorm(.975)*(se_missed_payment_mean),

    compliance_mean = mean(compliance, na.rm=T),
    se_compliance_mean = sd(compliance, na.rm=T)/sqrt(N),
    compliance_upper= compliance_mean + qnorm(.975)*se_compliance_mean,
    compliance_lower= compliance_mean - qnorm(.975)*se_compliance_mean,

    nr_missed_mean = mean(nr_paymntsowed, na.rm=T),
    se_nr_missed_mean = sd(nr_paymntsowed, na.rm=T)/sqrt(N),
    nr_missed_upper= nr_missed_mean + qnorm(.975)*(se_nr_missed_mean),
    nr_missed_lower= nr_missed_mean - qnorm(.975)*(se_nr_missed_mean)

  )
```

```
## `summarise()` has grouped output by 'tax', 't'. You can override using the
## `.groups` argument.
```

```r
plot_data <- plot_data %>% inner_join(holiday)
```

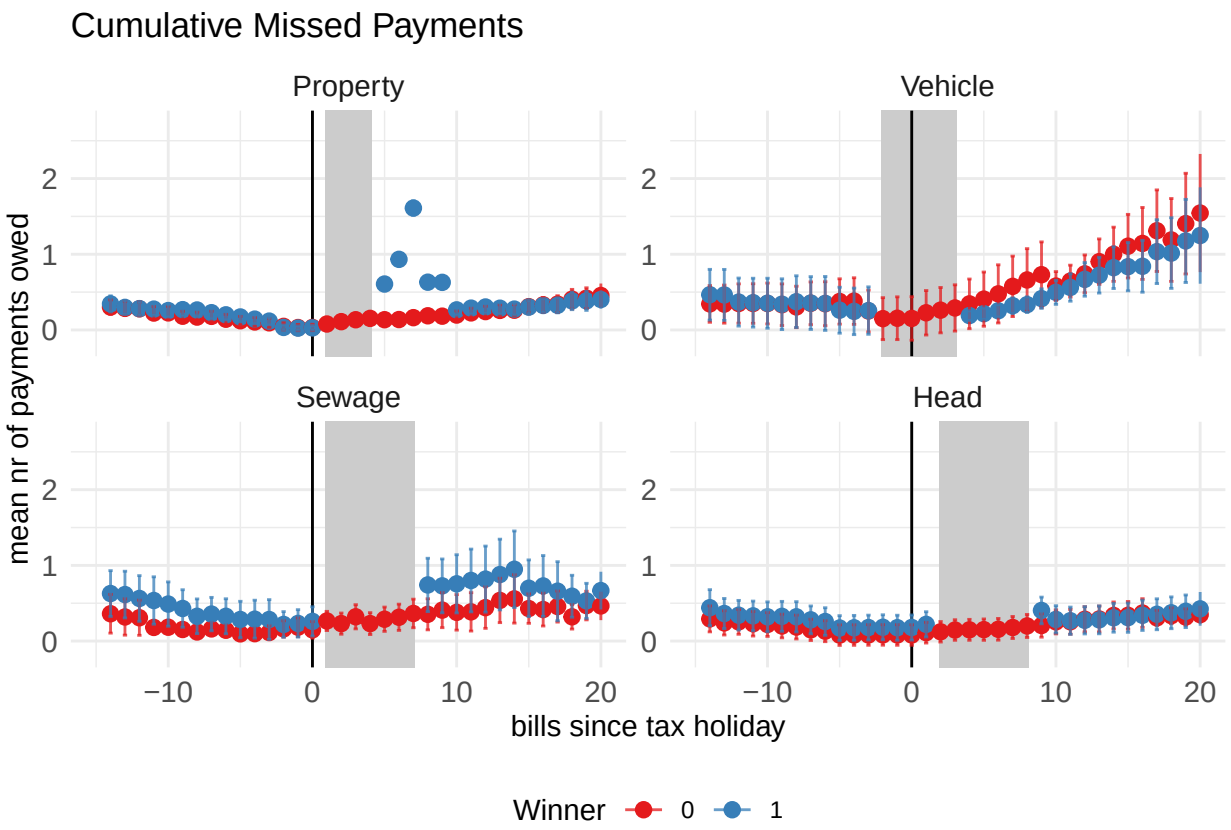
```
## Joining with `by = join_by(tax)`
```

```r
plot_data$Winner <- as.factor(plot_data$TREATMENT)

# missed payment figure ---
plot_data %>% filter(t>-15 & t<21) %>%
  ggplot(aes(x=t, y=missed_payment_mean, color=Winner)) +
  facet_wrap(tax ~ . , scales = "free_y") +
  geom_rect(aes(xmin=holiday_start, xmax=holiday_end, ymin=-Inf, ymax=Inf),
            fill="gray80", color="gray80", alpha=.1) +
  geom_vline(aes(xintercept = 0)) +
  geom_point(size=2.4) +
  #ylim(0, .5) +
  xlim(-15,20) +
  xlab("bills since tax holiday") +
  ylab("mean of missed current payment") +
  geom_errorbar(aes(ymin=missed_payment_lower,
                    ymax=missed_payment_upper), # colour="blue",
                width=.3, alpha=.75) +
  scale_color_brewer(palette="Set1") +
  ggtitle("Missed Payment") +
  theme_minimal() +
  theme(plot.title = element_text(size = rel(1.2)),
        axis.text = element_text(size = rel(1)),
        axis.title.y = element_text(size = rel(1)),
        axis.title.x = element_text(size = rel(1)),
        strip.text.x = element_text(size = rel(1.2)),
        legend.position = "bottom")
```




```
# compliance figure ---
plot_data %>% filter(t>-15 & t<21) %>%
  ggplot(aes(x=t, y=compliance_mean, color=Winner)) +
  facet_wrap(tax ~ . , scales = "free_y") +
  geom_rect(aes(xmin=holiday_start, xmax=holiday_end, ymin=-Inf, ymax=Inf),
            fill="gray80", color="gray80", alpha=.1) +
  geom_vline(aes(xintercept = 0)) +
  geom_point(size=2.4) +
  #ylim(0, .5) +
  xlim(-15,20) +
  xlab("bills since tax holiday") +
  ylab("mean of compliance") +
  geom_errorbar(aes(ymin=compliance_lower,
                    ymax=compliance_upper), # colour="blue",
                width=.3, alpha=.75) +
  scale_color_brewer(palette="Set1") +
  ggtitle("Compliance") +
  theme_minimal() +
  theme(plot.title = element_text(size = rel(1.2)),
        axis.text = element_text(size = rel(1)),
        axis.title.y = element_text(size = rel(1)),
        axis.title.x = element_text(size = rel(1)),
        strip.text.x = element_text(size = rel(1.2)),
        legend.position = "bottom")
```

```
# nr missed payments figure ---
plot_data %>% filter(t>-15 & t<21) %>%
  ggplot(aes(x=t, y=nr_missed_mean, color=Winner)) +
  facet_wrap(tax ~ . , scales = "free_y") +
  geom_rect(aes(xmin=holiday_start, xmax=holiday_end, ymin=-Inf, ymax=Inf),
            fill="gray80", color="gray80", alpha=.1) +
  geom_vline(aes(xintercept = 0)) +
  geom_point(size=2.4) +
  ylim(-.2, 2.75) +
  xlim(-15,20) +
  xlab("bills since tax holiday") +
  ylab("mean nr of payments owed") +
  geom_errorbar(aes(ymin=nr_missed_lower,
                    ymax=nr_missed_upper), # colour="blue",
                width=.3, alpha=.75) +
  scale_color_brewer(palette="Set1") +
  ggtitle("Cumulative Missed Payments") +
  theme_minimal() +
  theme(plot.title = element_text(size = rel(1.2)),
        axis.text = element_text(size = rel(1)),
        axis.title.y = element_text(size = rel(1)),
        axis.title.x = element_text(size = rel(1)),
        strip.text.x = element_text(size = rel(1.2)),
        legend.position = "bottom")
```




```
## All taxes together
#Prep data

#for this we first need to standardize the timeline
taxes_panel$t_st <- taxes_panel$t

# drop data within holiday window for all eligible taxpayers
taxes_panel <- taxes_panel %>% filter(!(ES_BP==1 & t>0 & t<=holiday_end))
# for eligibles, fix full timeframe so that first payment period after holiday is always 3
taxes_panel$t_st[taxes_panel$ES_BP==1 & taxes_panel$t > 0] <-
  taxes_panel$t - taxes_panel$holiday_end + 3

# drop data within holiday window (but outside the standard 3 payment period holiday)
# for all ineligible taxpayers
taxes_panel <- taxes_panel %>% filter(!(ES_BP==0 & t>=4 & t<= holiday_end))

holiday
```

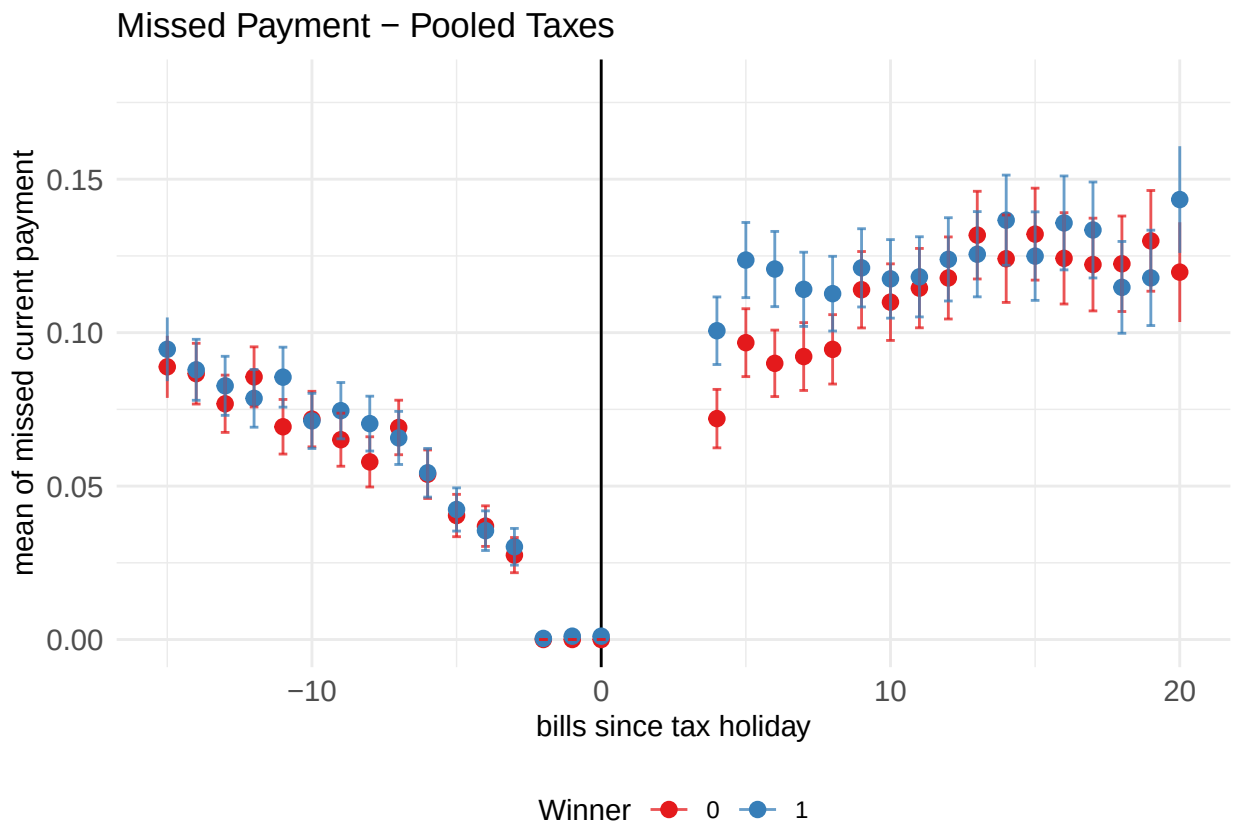
```
## # A tibble: 4 x 3
##   tax      holiday_start holiday_end
##   <fct>            <int>       <int>
## 1 Property             1           4
## 2 Vehicle             -2           3
## 3 Sewage               1           7
## 4 Head                 2           8
```

```r
taxes_panel$st <- taxes_panel$holiday_end - 3

taxes_panel$t_st <- ifelse((taxes_panel$ES_BP==1 & taxes_panel$t > 0) |
                             (taxes_panel$ES_BP==0 & taxes_panel$t > 4),
                           taxes_panel$t - taxes_panel$st, taxes_panel$t)


plot_data <- taxes_panel %>% filter(ES_BP==1) %>%
  group_by(t_st, TREATMENT) %>% dplyr::summarize(
    N = n(),

    # missed current payment
    missed_payment_mean = mean(missed_payment, na.rm=T),
    se_missed_payment_mean = sd(missed_payment, na.rm=T)/sqrt(N),
    missed_payment_upper= missed_payment_mean + qnorm(.975)*(se_missed_payment_mean),
    missed_payment_lower= missed_payment_mean - qnorm(.975)*(se_missed_payment_mean),

    compliance_mean = mean(compliance, na.rm=T),
    se_compliance_mean = sd(compliance, na.rm=T)/sqrt(N),
    compliance_upper= compliance_mean + qnorm(.975)*se_compliance_mean,
    compliance_lower= compliance_mean - qnorm(.975)*se_compliance_mean,

    nr_missed_mean = mean(nr_paymntsowed, na.rm=T),
    se_nr_missed_mean = sd(nr_paymntsowed, na.rm=T)/sqrt(N),
    nr_missed_upper= nr_missed_mean + qnorm(.975)*(se_nr_missed_mean),
    nr_missed_lower= nr_missed_mean - qnorm(.975)*(se_nr_missed_mean)

  )
```

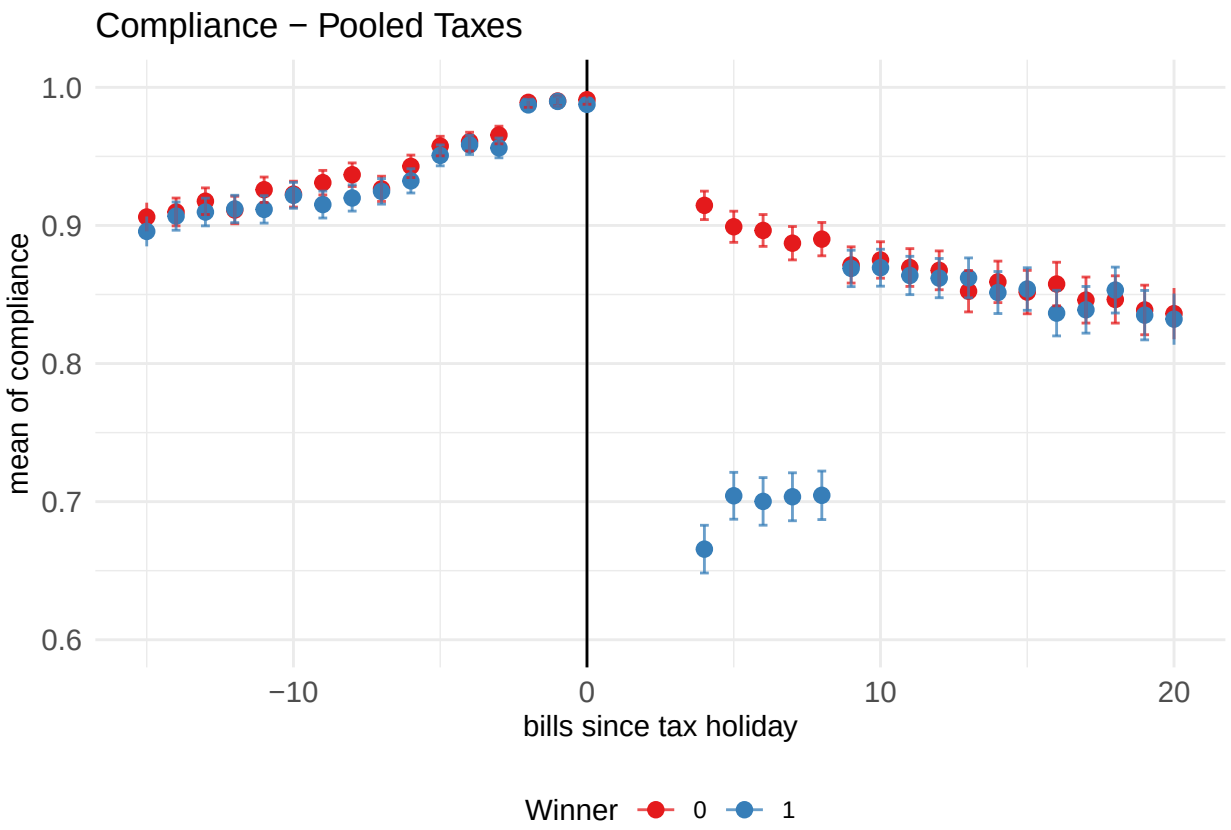
```
## `summarise()` has grouped output by 't_st'. You can override using the
## `.groups` argument.
```

```r
plot_data$Winner <- as.factor(plot_data$TREATMENT)

# missed payment figure ---
ggplot(plot_data, aes(x=t_st, y=missed_payment_mean, color=Winner)) +
  geom_vline(aes(xintercept = 0)) +
  geom_point(size=2.4) +
  ylim(0, .18) +
  xlim(-15,20) +
  xlab("bills since tax holiday") +
  ylab("mean of missed current payment") +
  geom_errorbar(aes(ymin=missed_payment_lower,
                    ymax=missed_payment_upper), # colour="blue",
                width=.3, alpha=.75) +
  scale_color_brewer(palette="Set1") +
  ggtitle("Missed Payment - Pooled Taxes") +
  theme_minimal() +
  theme(plot.title = element_text(size = rel(1.2)),
        axis.text = element_text(size = rel(1)),
        axis.title.y = element_text(size = rel(1)),
        axis.title.x = element_text(size = rel(1)),
        strip.text.x = element_text(size = rel(1.2)),
```

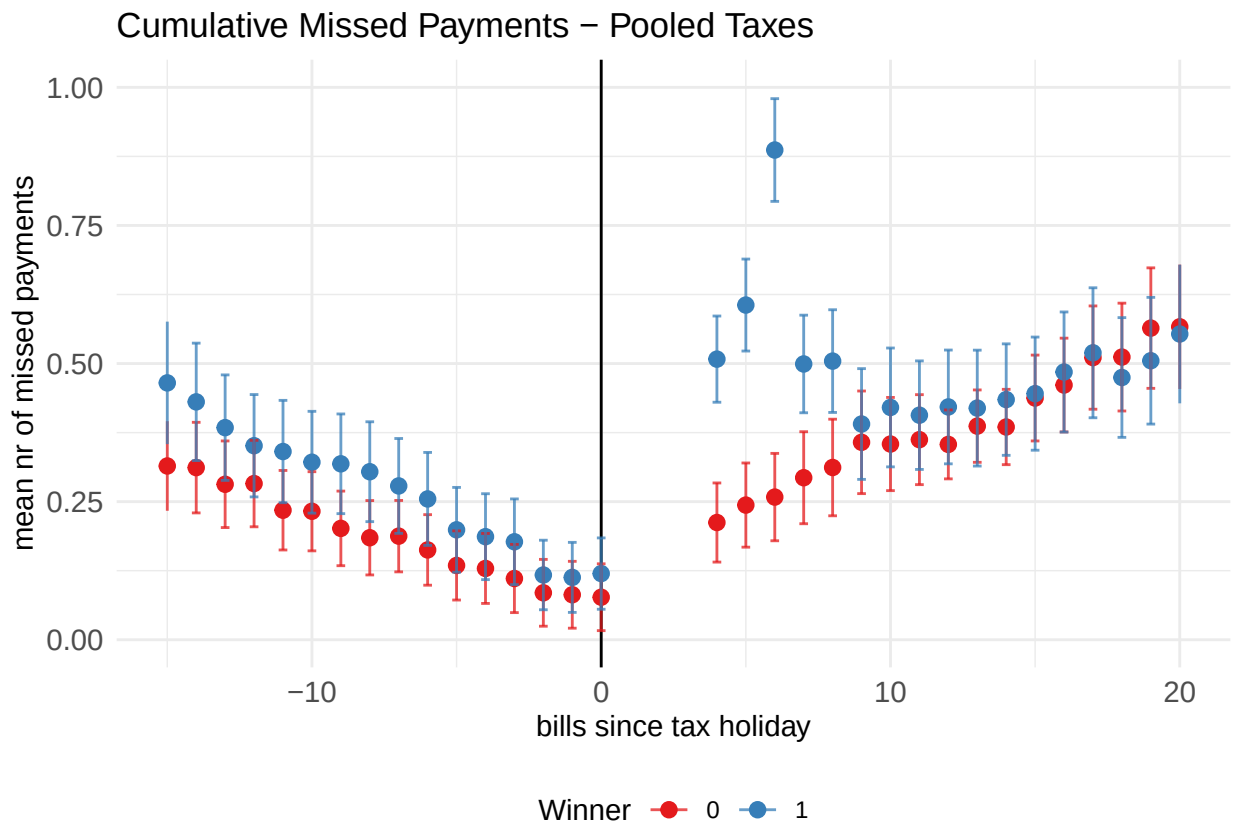
```
        legend.position = "bottom")
```




```
# compliance figure ---
ggplot(plot_data, aes(x=t_st, y=compliance_mean, color=Winner)) +
  geom_vline(aes(xintercept = 0)) +
  geom_point(size=2.4) +
  ylim(0.6, 1) +
  xlim(-15,20) +
  xlab("bills since tax holiday") +
  ylab("mean of compliance") +
  geom_errorbar(aes(ymin=compliance_lower,
                    ymax=compliance_upper), # colour="blue",
                width=.3, alpha=.75) +
  scale_color_brewer(palette="Set1") +
  ggtitle("Compliance - Pooled Taxes") +
  theme_minimal() +
  theme(plot.title = element_text(size = rel(1.2)),
        axis.text = element_text(size = rel(1)),
        axis.title.y = element_text(size = rel(1)),
        axis.title.x = element_text(size = rel(1)),
        strip.text.x = element_text(size = rel(1.2)),
        legend.position = "bottom")
```




```
# nr missed payments figure ---
ggplot(plot_data, aes(x=t_st, y=nr_missed_mean, color=Winner)) +
  geom_vline(aes(xintercept = 0)) +
  geom_point(size=2.4) +
  ylim(0, 1) +
  xlim(-15,20) +
  xlab("bills since tax holiday") +
  ylab("mean nr of missed payments") +
  geom_errorbar(aes(ymin=nr_missed_lower,
                    ymax=nr_missed_upper), # colour="blue",
                width=.3, alpha=.75) +
  scale_color_brewer(palette="Set1") +
  ggtitle("Cumulative Missed Payments - Pooled Taxes") +
  theme_minimal() +
  theme(plot.title = element_text(size = rel(1.2)),
        axis.text = element_text(size = rel(1)),
        axis.title.y = element_text(size = rel(1)),
        axis.title.x = element_text(size = rel(1)),
        strip.text.x = element_text(size = rel(1.2)),
        legend.position = "bottom")
```




```
#####################################################################
## TABLE 1 - NATURAL EXPERIMENT. Effects of the tax holiday
## (difference in differences analysis).
#####################################################################

# rescaling the time variable to account for the taxes that have twice as
# many payments per year
taxes_panel$t_st_2 <- ifelse(taxes_panel$tax=="Sewage" | taxes_panel$tax=="Head",
                             taxes_panel$t_st/2, taxes_panel$t_st)


# 1 year diff in diff setup
dd_data1 <-  rbind.data.frame(taxes_panel %>% filter(ES_BP==1) %>%
                                group_by(CUENTA, tax, TREATMENT) %>% dplyr::summarise(
                                  compliance_mean_DiD_1yr =
                                    mean(compliance[t_st>3 & t_st<=6], na.rm=T) -
                                    mean(compliance[t_st<0 & t_st>=(-3)], na.rm=T),
                                  missed_payment_mean_DiD_1yr =
                                    mean(missed_payment[t_st>3 & t_st<=6], na.rm=T)-
                                    mean(missed_payment[t_st<0 & t_st>=(-3)], na.rm=T),
                                  nr_missed_payments_mean_DiD_1yr =
                                    mean(nr_paymntsowed[t_st> 3 & t_st<=6], na.rm=T)-
                                    mean(nr_paymntsowed[t_st<0 & t_st>=(-3)], na.rm=T),
                                  compliance_mean_DiD_1yr.yr2 =
                                    mean(compliance[t_st>6 & t_st<=9], na.rm=T) -
                                    mean(compliance[t_st<0 & t_st>=(-3)], na.rm=T),
```

```r
                                    missed_payment_mean_DiD_1yr.yr2 =
                                      mean(missed_payment[t_st>6 & t_st<=9], na.rm=T)-
                                      mean(missed_payment[t_st<0 & t_st>=(-3)], na.rm=T),
                                    nr_missed_payments_mean_DiD_1yr.yr2 =
                                      mean(nr_paymntsowed[t_st> 6 & t_st<=9], na.rm=T)-
                                      mean(nr_paymntsowed[t_st<0 & t_st>=(-3)], na.rm=T),
                                    compliance_mean_DiD_1yr.yr3 =
                                      mean(compliance[t_st>9 & t_st<=12], na.rm=T) -
                                      mean(compliance[t_st<0 & t_st>=(-3)], na.rm=T),
                                    missed_payment_mean_DiD_1yr.yr3 =
                                      mean(missed_payment[t_st>9 & t_st<=12], na.rm=T)-
                                      mean(missed_payment[t_st<0 & t_st>=(-3)], na.rm=T),
                                    nr_missed_payments_mean_DiD_1yr.yr3 =
                                      mean(nr_paymntsowed[t_st>9 & t_st<=12], na.rm=T)-
                                      mean(nr_paymntsowed[t_st<0 & t_st>=(-3)], na.rm=T)
                                  )
)
```

```
## `summarise()` has grouped output by 'CUENTA', 'tax'. You can override using the
## `.groups` argument.
```

```r
# 1 year diff in diff all taxes:
# compliance, missed payments & number of missed payments

difference_in_means(compliance_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1)
```

```
## Design:  Standard
##           Estimate Std. Error t value
## TREATMENT   -0.199    0.00935   -21.3
##
## TREATMENT 0.00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
##           CI Lower CI Upper   DF
## TREATMENT   -0.218   -0.181 4611
```

```r
difference_in_means(missed_payment_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1)
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0202     0.0065    3.11  0.00191  0.00745    0.033 5307
```

```r
difference_in_means(nr_missed_payments_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1)
```

```
## Design:  Standard
##           Estimate Std. Error t value                Pr(>|t|) CI Lower CI Upper
## TREATMENT    0.349     0.0389    8.98 0.0000000000000000000391    0.273    0.425
##             DF
## TREATMENT 4410
```

```r
# 1 year diff in diff by type of tax
# (compliance, missed payments & number of missed payments)

# Property
difference_in_means(compliance_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Property",])
```

```
## Design:  Standard
##           Estimate Std. Error t value
## TREATMENT    -0.46     0.0155   -29.6
##
## TREATMENT 0.000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
##           CI Lower CI Upper   DF
## TREATMENT    -0.49   -0.429 1699
```

```r
difference_in_means(missed_payment_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Property",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0273    0.00866    3.16  0.00163   0.0103   0.0443 2147
```

```r
difference_in_means(nr_missed_payments_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Property",])
```

```
## Design:  Standard
##           Estimate Std. Error t value
## TREATMENT    0.866     0.0419    20.6
##                                                                                                Pr(>|t|
## TREATMENT 0.0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000374
##           CI Lower CI Upper   DF
## TREATMENT    0.784    0.948 2336
```

```r
# Sewage
difference_in_means(compliance_mean_DiD_1yr ~ TREATMENT,
                  data = dd_data1[dd_data1$tax=="Sewage",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT  -0.0333     0.0205   -1.63    0.104  -0.0735  0.00688 748
```

```r
difference_in_means(missed_payment_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Sewage",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT   0.0398     0.0143    2.78  0.00553   0.0117   0.0678 712
```

```
difference_in_means(nr_missed_payments_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Sewage",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT    0.249      0.166     1.5    0.134  -0.0769    0.574 676
```

```
# Head
difference_in_means(compliance_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Head",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT  -0.0363     0.0116   -3.14  0.00171   -0.059  -0.0136 1821
```

```
difference_in_means(missed_payment_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Head",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0323     0.0111    2.92  0.00352   0.0106    0.054 1739
```

```
difference_in_means(nr_missed_payments_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Head",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT  -0.0354     0.0399  -0.885    0.376   -0.114    0.043 1596
```

```
# Vehicle
difference_in_means(compliance_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Vehicle",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT   0.0459      0.024    1.91   0.0559 -0.00116   0.0931 702
```

```
difference_in_means(missed_payment_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Vehicle",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT  -0.0556     0.0273   -2.03   0.0425   -0.109 -0.00189 668
```

```
difference_in_means(nr_missed_payments_mean_DiD_1yr ~ TREATMENT,
                    data = dd_data1[dd_data1$tax=="Vehicle",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT   -0.256      0.166   -1.54    0.124   -0.583   0.0707 411
```

```r
# 3 year diff in diff setup
dd_data <-  rbind.data.frame(taxes_panel %>% filter(ES_BP==1) %>%
                               group_by(CUENTA, tax, TREATMENT) %>% dplyr::summarise(

                                 compliance_mean_DiD_3yr =
                                   mean(compliance[t_st>3 & t_st<=12], na.rm=T)-
                                   mean(compliance[t_st<0 & t_st>=(-9)], na.rm=T),
                                 missed_payment_mean_DiD_3yr =
                                   mean(missed_payment[t_st>3 & t_st<=12], na.rm=T)-
                                   mean(missed_payment[t_st<0 & t_st>=(-9)], na.rm=T),
                                 nr_missed_payments_mean_DiD_3yr =
                                   mean(nr_paymntsowed[t_st> 3 & t_st<=12], na.rm=T)-
                                   mean(nr_paymntsowed[t_st<0 & t_st>=(-9)], na.rm=T)
                               )
)
```

```
## `summarise()` has grouped output by 'CUENTA', 'tax'. You can override using the
## `.groups` argument.
```

```r
# 3 year diff in diff all taxes:
# compliance, missed payments & number of missed payments
difference_in_means(compliance_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data)
```

```
## Design:  Standard
##           Estimate Std. Error t value
## TREATMENT   -0.116    0.00751   -15.5
##                                                                      Pr(>|t|) CI Lower
## TREATMENT 0.000000000000000000000000000000000000000000000000000584   -0.131
##           CI Upper   DF
## TREATMENT   -0.102 5322
```

```r
difference_in_means(missed_payment_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data)
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0145    0.00576    2.52   0.0118  0.00321   0.0258 5451
```

```r
difference_in_means(nr_missed_payments_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data)
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT    0.136     0.0448    3.04  0.00234   0.0485    0.224 4666
```

```r
# 3 year diff in diff by type of tax
# (compliance, missed payments & number of missed payments)

# Property
difference_in_means(compliance_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Property",])
```

```
## Design:  Standard
##           Estimate Std. Error t value
## TREATMENT   -0.281     0.0125   -22.5
##
## TREATMENT 0.0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
##           CI Lower CI Upper   DF
## TREATMENT   -0.306   -0.257 2029
```

```
difference_in_means(missed_payment_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Property",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0224     0.0083     2.7  0.00702  0.00612   0.0387 2208
```

```
difference_in_means(nr_missed_payments_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Property",])
```

```
## Design:  Standard
##           Estimate Std. Error t value                 Pr(>|t|) CI Lower
## TREATMENT    0.424     0.0461     9.2 0.000000000000000000801    0.334
##           CI Upper   DF
## TREATMENT    0.515 2336
```

```
# Sewage
difference_in_means(compliance_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Sewage",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT  -0.0103     0.0169   -0.61    0.542  -0.0435   0.0229 745
```

```
difference_in_means(missed_payment_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Sewage",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT   0.0234     0.0118    1.99   0.0468 0.000328   0.0466 732
```

```
difference_in_means(nr_missed_payments_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Sewage",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT    0.152        0.2   0.757    0.449   -0.242    0.545 598
```

```
# Head
difference_in_means(compliance_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Head",])
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT  -0.0038     0.0104  -0.364    0.716  -0.0243   0.0167 1829
```

```
difference_in_means(missed_payment_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Head",])
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT  0.00956    0.00931    1.03    0.305 -0.00871   0.0278 1748
```

```
difference_in_means(nr_missed_payments_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Head",])
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   -0.114     0.0528   -2.16   0.0307   -0.218  -0.0106 1770
```

```
# Vehicle
difference_in_means(compliance_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Vehicle",])
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT   0.0165     0.0212   0.776    0.438  -0.0252   0.0581 719
```

```
difference_in_means(missed_payment_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Vehicle",])
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT  -0.0127     0.0232  -0.548    0.584  -0.0582   0.0328 700
```

```
difference_in_means(nr_missed_payments_mean_DiD_3yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Vehicle",])
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT   -0.208      0.183   -1.14    0.255   -0.567    0.151 534
```

```
#################################################################
## TABLE 2 - NATURAL EXPERIMENT. Effect of the tax holiday (T-test)
## Comparing winners to non-winners, difference of means test
# for the total debt as of October, 2014.
#################################################################

difference_in_means(debt_amount ~ won_lottery,
                    data = naturalex_debt_gtp)
```

```
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## won_lottery      184        297   0.619    0.536     -398      765 4948
```

```
#################################################################
## TABLE 3 - NATURAL EXPERIMENT. Effects of the tax holiday
## (difference in differences analysis), 5 year window
#################################################################


# 5 year diff in diff setup
dd_data <-  rbind.data.frame(taxes_panel %>% filter(ES_BP==1) %>%
                               group_by(CUENTA, tax, TREATMENT) %>% dplyr::summarise(
                                 compliance_mean_DiD_5yr =
                                   mean(compliance[t_st>3 & t_st<=18], na.rm=T)-
                                   mean(compliance[t_st<0 & t_st>=(-15)], na.rm=T),
                                 missed_payment_mean_DiD_5yr =
                                   mean(missed_payment[t_st>3 & t_st<=18], na.rm=T)-
                                   mean(missed_payment[t_st<0 & t_st>=(-15)], na.rm=T),
                                 nr_missed_payments_mean_DiD_5yr =
                                   mean(nr_paymntsowed[t_st> 3 & t_st<=18], na.rm=T)-
                                   mean(nr_paymntsowed[t_st<0 & t_st>=(-15)], na.rm=T)
                               )
)
```

```
## `summarise()` has grouped output by 'CUENTA', 'tax'. You can override using the
## `.groups` argument.
```

```
# 5 year diff in diff all taxes:
# compliance, missed payments & number of missed payments
difference_in_means(compliance_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data)
```

```
## Design:  Standard
##            Estimate Std. Error t value                                  Pr(>|t|)
## TREATMENT   -0.089    0.00724   -12.3 0.00000000000000000000000000000000000272
##            CI Lower CI Upper   DF
## TREATMENT   -0.103  -0.0748 5446
```

```
difference_in_means(missed_payment_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data)
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT     0.012    0.00581    2.06    0.039 0.000606   0.0234 5453
```

```
difference_in_means(nr_missed_payments_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data)
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0795     0.0482    1.65   0.0991   -0.015    0.174 5268
```

```r
# 5 year diff in diff by type of tax
# (compliance, missed payments & number of missed payments)

# Property
difference_in_means(compliance_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Property",])
```

```
## Design:  Standard
##           Estimate Std. Error t value
## TREATMENT   -0.216     0.0122   -17.7
##                                                                 Pr(>|t|)
## TREATMENT 0.0000000000000000000000000000000000000000000000000000000000000343
##           CI Lower CI Upper   DF
## TREATMENT    -0.24   -0.192 2116
```

```r
difference_in_means(missed_payment_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Property",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0195     0.0085     2.3   0.0215  0.00288   0.0362 2241
```

```r
difference_in_means(nr_missed_payments_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Property",])
```

```
## Design:  Standard
##           Estimate Std. Error t value       Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT    0.321     0.0514    6.25 0.000000000484     0.22    0.422 2345
```

```r
# Sewage
difference_in_means(compliance_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Sewage",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT 0.000237     0.0149  0.0159    0.987   -0.029   0.0295 763
```

```r
difference_in_means(missed_payment_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Sewage",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT   0.0134     0.0109    1.23     0.22 -0.00804   0.0349 731
```

```r
difference_in_means(nr_missed_payments_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Sewage",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT   0.0837      0.176   0.476    0.635   -0.262     0.43 593
```

```r
# Head
difference_in_means(compliance_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Head",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT -0.00388     0.0106  -0.365    0.715  -0.0247   0.0169 1829
```

```r
difference_in_means(missed_payment_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Head",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT  0.00911    0.00922   0.988    0.323 -0.00897   0.0272 1750
```

```r
difference_in_means(nr_missed_payments_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Head",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   -0.111     0.0778   -1.42    0.156   -0.263   0.0421 1822
```

```r
# Vehicle
difference_in_means(compliance_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Vehicle",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT  0.00897     0.0215   0.417    0.677  -0.0333   0.0512 720
```

```r
difference_in_means(missed_payment_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Vehicle",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT  -0.0116     0.0234  -0.498    0.619  -0.0575   0.0342 700
```

```r
difference_in_means(nr_missed_payments_mean_DiD_5yr ~ TREATMENT,
                    data = dd_data[dd_data$tax=="Vehicle",])
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## TREATMENT   -0.255      0.195    -1.3    0.193   -0.638    0.129 610
```

```r
#################################################################
## TABLE 4 - FIELD EXPERIMENT. Informational mechanism.
# Good and bad taxpayers, comparison of treatments 1, 2 and
# 4 (pooled) vs. the placebo control group (treatment 0).
# First differences use the value of the dependent variable
```

```r
# for the pre-treatment period (March 2014).
#################################################################

### Creating first differences outcomes for the field experiment
fieldex$missed_payment_DiD <- fieldex$JUL_2014_ontime - fieldex$MAR_2014_ontime # missed payment
fieldex$web_bill_DiD <- fieldex$july_web_access - fieldex$march_web_access # web access
fieldex$payments_owed_DiD <- fieldex$july_nrbills_owed - fieldex$adeudadas_2014_MAR # nr bills owed

# compliance
fieldex$compliance_march <- ifelse(fieldex$march_ontime==1 & fieldex$adeudadas_2014_MAR==0, 1, 0)
fieldex$compliance_july <- ifelse(fieldex$JUL_2014_ontime==1 & fieldex$july_nrbills_owed==0, 1, 0)
fieldex$compliance_DiD <- fieldex$compliance_july - fieldex$compliance_march

# results
difference_in_means(missed_payment_DiD ~ pooled_124_0, data = fieldex)
```

```
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0 -0.000745    0.00868 -0.0858    0.932  -0.0178   0.0163 7227
```

```r
difference_in_means(payments_owed_DiD ~ pooled_124_0, data = fieldex)
```

```
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0   0.0131      0.023   0.568     0.57   -0.032   0.0582 7787
```

```r
difference_in_means(compliance_DiD ~ pooled_124_0, data = fieldex)
```

```
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0 0.0000208    0.00837 0.00249    0.998  -0.0164   0.0164 7298
```

```r
difference_in_means(web_bill_DiD ~ pooled_124_0, data = fieldex)
```

```
## Design:  Standard
##              Estimate Std. Error t value   Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0  -0.0458    0.00798   -5.74 0.00000001  -0.0614  -0.0301 6601
```

```r
#################################################################
## TABLE 6 - FIELD EXPERIMENT: Comparison of effects for good
# and bad taxpayers: difference of the difference of means for
# the comparison of treatments 1, 2 and 4 (pooled) vs. the
# placebo control group (treatment 0).
#################################################################

# Function to test the difference of the differences
comp.eff <- function(dm1, dm2){

  print("Difference in Means 1")
  print(dm1)
```

```
  print("Difference in Means 2")
  print(dm2)

  print("#####. Difference in Effects")

  diff <- dm1$coefficients - dm2$coefficients
  se.diff <- sqrt((dm1$std.error^2)+(dm2$std.error^2))
  t.val.diff <- diff/se.diff
  df <- dm1$nobs + dm2$nobs -2
  # Calculate the p-value
  p_val <- 2 * (1 - pt(abs(t.val.diff), df=df))

  res <- c(diff,se.diff,t.val.diff, p_val)
  names(res) <- c("Diff in effects", "SE", "t", "p-value")
  print(res)
  return(res)
}

message("difference of the differences")
```

```
## difference of the differences
```

```
comp.eff(difference_in_means(missed_payment_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "good taxpayer")),
         difference_in_means(missed_payment_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "bad taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0 0.000155     0.0076  0.0204    0.984  -0.0147   0.0151 3036
## [1] "Difference in Means 2"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0 -0.00208     0.0138  -0.151     0.88  -0.0291   0.0249 4138
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         0.00223         0.01573         0.14189         0.88717

## Diff in effects              SE               t         p-value
##         0.00223         0.01573         0.14189         0.88717
```

```
comp.eff(difference_in_means(web_bill_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "good taxpayer")),
         difference_in_means(web_bill_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "bad taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##              Estimate Std. Error t value   Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0  -0.0623     0.0128   -4.86 0.00000127  -0.0874  -0.0371 2683
```

```
## [1] "Difference in Means 2"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0  -0.0336     0.0101   -3.33 0.000889  -0.0533  -0.0138 3955
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         -0.0287          0.0163         -1.7594          0.0785

## Diff in effects              SE               t         p-value
##         -0.0287          0.0163         -1.7594          0.0785
```

```
#################################################################
## TABLE 7-  NATURAL EXPERIMENT. Income effects. Comparison
# of winners vs. non-winners: heterogeneous effects of winning
# the lottery by tax bracket.
#################################################################

# Coding tax brackets
a <- 418958
b <- 1047393
c <- 2094784
d <- 41895699

taxes_panel$tax_bracket <- "D"
taxes_panel$tax_bracket[taxes_panel$VALOR_CATASTRALACTUAL<d] <- "C"
taxes_panel$tax_bracket[taxes_panel$VALOR_CATASTRALACTUAL<c] <- "B"
taxes_panel$tax_bracket[taxes_panel$VALOR_CATASTRALACTUAL<b] <- "A"
taxes_panel$tax_bracket[is.na(taxes_panel$VALOR_CATASTRALACTUAL)] <- NA

by_tax_bracket <- taxes_panel %>% dplyr::filter(!is.na(tax_bracket) & t_st==4) %>%
  group_by(tax_bracket) %>%
  dplyr::summarize(
    N_treat = sum(TREATMENT==1),
    N_control = sum(TREATMENT==0),
    missed_treat = mean(missed_payment[TREATMENT==1], na.rm=T),
    missed_control = mean(missed_payment[TREATMENT==0], na.rm=T)
  )

by_tax_bracket
```

```
## # A tibble: 1 x 5
##   tax_bracket N_treat N_control missed_treat missed_control
##   <chr>         <int>     <int>        <dbl>          <dbl>
## 1 D              8334      8372        0.340          0.330
```

```
chisq.test(by_tax_bracket[,c(4,5)])
```

```
##
##  Chi-squared test for given probabilities
##
## data:  by_tax_bracket[, c(4, 5)]
## X-squared = 0.0001, df = 1, p-value = 1
```

```r
# HTEs by Valor Catastral

# 1 year diff in diff setup
dd_data_vc <-  rbind.data.frame(taxes_panel %>% filter(ES_BP==1 & tax=="Property") %>%
                                  group_by(CUENTA, TREATMENT, VALOR_CAT2004) %>% dplyr::summarise(
                                    compliance_mean_DiD_1yr =
                                      mean(compliance[t_st>3 & t_st<=6], na.rm=T) -
                                      mean(compliance[t_st<0 & t_st>=(-3)], na.rm=T),
                                    missed_payment_mean_DiD_1yr =
                                      mean(missed_payment[t_st>3 & t_st<=6], na.rm=T)-
                                      mean(missed_payment[t_st<0 & t_st>=(-3)], na.rm=T),
                                    nr_missed_payments_mean_DiD_1yr =
                                      mean(nr_paymntsowed[t_st> 3 & t_st<=6], na.rm=T)-
                                      mean(nr_paymntsowed[t_st<0 & t_st>=(-3)], na.rm=T)
                                  )
)
```

```
## `summarise()` has grouped output by 'CUENTA', 'TREATMENT'. You can override
## using the `.groups` argument.
```

```r
dd_data_vc$high_propvalue <- ifelse(dd_data_vc$VALOR_CAT2004 >
                                      median(dd_data_vc$VALOR_CAT2004, na.rm=T),
                                    1, 0)

income_missed <- comp.eff(difference_in_means(missed_payment_mean_DiD_1yr ~ TREATMENT,
                                              data = filter(dd_data_vc, high_propvalue == 1)),
                          difference_in_means(missed_payment_mean_DiD_1yr ~ TREATMENT,
                                              data = filter(dd_data_vc, high_propvalue == 0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0347      0.011    3.15  0.00166   0.0131   0.0563 1032
## [1] "Difference in Means 2"
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0188     0.0134    1.41     0.16 -0.00743   0.0451 1069
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##          0.0159          0.0173          0.9157          0.3599
```

```r
income_missed
```

```
## Diff in effects              SE               t         p-value
##          0.0159          0.0173          0.9157          0.3599
```

```r
income_nrmissed <- comp.eff(difference_in_means(nr_missed_payments_mean_DiD_1yr ~ TREATMENT,
                                                data = filter(dd_data_vc, high_propvalue == 1)),
                            difference_in_means(nr_missed_payments_mean_DiD_1yr ~ TREATMENT,
                                                data = filter(dd_data_vc, high_propvalue == 0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value
## TREATMENT       0.94      0.048    19.6
##                                                                             Pr(>|t|)
## TREATMENT 0.0000000000000000000000000000000000000000000000000000000000000000000644
##             CI Lower CI Upper  DF
## TREATMENT      0.846     1.03 725
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value                            Pr(>|t|)
## TREATMENT      0.812     0.0667    12.2 0.00000000000000000000000000000000442
##             CI Lower CI Upper   DF
## TREATMENT      0.681    0.943 1133
## [1] "#####. Difference in Effects"
## Diff in effects              SE                t          p-value
##          0.1287          0.0822           1.5661           0.1175
```

```
income_nrmissed
```

```
## Diff in effects              SE                t          p-value
##          0.1287          0.0822           1.5661           0.1175
```

```
income_compliance <- comp.eff(difference_in_means(compliance_mean_DiD_1yr ~ TREATMENT,
                                                  data = filter(dd_data_vc, high_propvalue == 1)),
                              difference_in_means(compliance_mean_DiD_1yr ~ TREATMENT,
                                                  data = filter(dd_data_vc, high_propvalue == 0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value
## TREATMENT     -0.505     0.0219   -23.1
##                                                                                       Pr(
## TREATMENT 0.0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
##             CI Lower CI Upper  DF
## TREATMENT     -0.548   -0.462 821
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value
## TREATMENT     -0.418      0.022     -19
##                                                                           Pr(>|t|)
## TREATMENT 0.0000000000000000000000000000000000000000000000000000000000000000000184
##             CI Lower CI Upper  DF
## TREATMENT     -0.462   -0.375 856
## [1] "#####. Difference in Effects"
## Diff in effects              SE                t          p-value
##        -0.08671         0.03103         -2.79414          0.00525
```

```
income_compliance
```

```
## Diff in effects              SE                t          p-value
##        -0.08671         0.03103         -2.79414          0.00525
```

```
#################################################################
## TABLE 8. NATURAL EXPERIMENT. Habit effects. Winners vs.
# non-winners: heterogeneous treatment effects by time since
# winning (heterogeneous effects; 1, 2 and 3 years).
#################################################################

# Yr 1 vs 2
comp.eff(difference_in_means(missed_payment_mean_DiD_1yr ~ TREATMENT,
                             data = dd_data1),
         difference_in_means(missed_payment_mean_DiD_1yr.yr2 ~ TREATMENT,
                             data = dd_data1))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0202     0.0065    3.11  0.00191  0.00745    0.033 5307
## [1] "Difference in Means 2"
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|)  CI Lower CI Upper   DF
## TREATMENT   0.0125    0.00688    1.82   0.0688 -0.000964    0.026 4985
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         0.00767         0.00947         0.80971         0.41812

## Diff in effects              SE               t         p-value
##         0.00767         0.00947         0.80971         0.41812
```

```
comp.eff(difference_in_means(nr_missed_payments_mean_DiD_1yr ~ TREATMENT,
                             data = dd_data1),
         difference_in_means(nr_missed_payments_mean_DiD_1yr.yr2 ~ TREATMENT,
                             data = dd_data1))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##           Estimate Std. Error t value                Pr(>|t|) CI Lower CI Upper
## TREATMENT    0.349     0.0389    8.98 0.00000000000000000391    0.273    0.425
##             DF
## TREATMENT 4410
## [1] "Difference in Means 2"
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT    0.105     0.0404    2.61  0.00913   0.0261    0.184 4931
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##       0.2438890       0.0560550       4.3508898       0.0000137

## Diff in effects              SE               t         p-value
##       0.2438890       0.0560550       4.3508898       0.0000137
```

```
comp.eff(difference_in_means(compliance_mean_DiD_1yr ~ TREATMENT,
                             data = dd_data1),
         difference_in_means(compliance_mean_DiD_1yr.yr2 ~ TREATMENT,
                             data = dd_data1))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##           Estimate Std. Error t value
## TREATMENT   -0.199    0.00935   -21.3
##
## TREATMENT 0.0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
##           CI Lower CI Upper   DF
## TREATMENT   -0.218   -0.181 4611
## [1] "Difference in Means 2"
## Design:  Standard
##           Estimate Std. Error t value
## TREATMENT   -0.116    0.00876   -13.2
##                                            Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT 0.00000000000000000000000000000000000432   -0.133  -0.0984 4944
## [1] "#####. Difference in Effects"
##  Diff in effects               SE                t          p-value
## -0.0837187274593  0.0128110676674 -6.5348751277177  0.0000000000665

##  Diff in effects               SE                t          p-value
## -0.0837187274593  0.0128110676674 -6.5348751277177  0.0000000000665
```

```
# Yr 2 vs 3
comp.eff(difference_in_means(missed_payment_mean_DiD_1yr.yr2 ~ TREATMENT,
                             data = dd_data1),
         difference_in_means(missed_payment_mean_DiD_1yr.yr3 ~ TREATMENT,
                             data = dd_data1))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|)  CI Lower CI Upper   DF
## TREATMENT   0.0125    0.00688    1.82   0.0688 -0.000964    0.026 4985
## [1] "Difference in Means 2"
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0042    0.00762   0.551    0.581  -0.0107   0.0191 4555
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         0.00833         0.01027         0.81101         0.41738

## Diff in effects              SE               t         p-value
##         0.00833         0.01027         0.81101         0.41738
```

```
comp.eff(difference_in_means(nr_missed_payments_mean_DiD_1yr.yr2 ~ TREATMENT,
                             data = dd_data1),
         difference_in_means(nr_missed_payments_mean_DiD_1yr.yr3 ~ TREATMENT,
                             data = dd_data1))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT    0.105     0.0404    2.61  0.00913   0.0261    0.184 4931
## [1] "Difference in Means 2"
```

```
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT   0.0126     0.0524    0.24     0.81  -0.0901    0.115 4849
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##          0.0927          0.0661          1.4023          0.1608

## Diff in effects              SE               t         p-value
##          0.0927          0.0661          1.4023          0.1608
```

```
comp.eff(difference_in_means(compliance_mean_DiD_1yr.yr2 ~ TREATMENT,
                             data = dd_data1),
         difference_in_means(compliance_mean_DiD_1yr.yr3 ~ TREATMENT,
                             data = dd_data1))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##           Estimate Std. Error t value
## TREATMENT   -0.116    0.00876   -13.2
##                                                 Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT 0.00000000000000000000000000000000000000000432   -0.133  -0.0984 4944
## [1] "Difference in Means 2"
## Design:  Standard
##           Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## TREATMENT  0.00212    0.00857   0.247    0.805  -0.0147   0.0189 4844
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         -0.1177          0.0123         -9.6029          0.0000

## Diff in effects              SE               t         p-value
##         -0.1177          0.0123         -9.6029          0.0000
```

```
#####################################################################
## TABLE 9. FIELD EXPERIMENT. Priming knowledge of punishment.
# Good and bad taxpayers, comparison of treatments 3 and 5
# (pooled) vs. the placebo control group (treatment 0).
#####################################################################

difference_in_means(missed_payment_DiD ~ pooled_35_0, data = fieldex)
```

```
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0093    0.00869   -1.07    0.285  -0.0263  0.00774 7252
```

```
difference_in_means(payments_owed_DiD ~ pooled_35_0, data = fieldex)
```

```
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  0.00877     0.0227   0.386    0.699  -0.0357   0.0533 7531
```

```
difference_in_means(web_bill_DiD ~ pooled_35_0, data = fieldex)
```

```
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0193    0.00818   -2.36   0.0184  -0.0353 -0.00325 7066
```

```
difference_in_means(compliance_DiD ~ pooled_35_0, data = fieldex)
```

```
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0106    0.00839   -1.26    0.207   -0.027  0.00586 7348
```

```
#################################################################
# TABLE 10. FIELD EXPERIMENT: Comparison of effects for good
# and bad taxpayers: difference of the difference in means for
# the comparison of treatments 3 and 5 (priming knowledge of
# sanctions, pooled) vs. the placebo control group (treatment 0).
#################################################################

comp.eff(difference_in_means(missed_payment_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "good taxpayer")),
         difference_in_means(missed_payment_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "bad taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0 -0.00862    0.00776   -1.11    0.266  -0.0238  0.00658 3188
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0131     0.0137  -0.955    0.339  -0.0399   0.0138 4083
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         0.00446         0.01574         0.28355         0.77676

## Diff in effects              SE               t         p-value
##         0.00446         0.01574         0.28355         0.77676
```

```
comp.eff(difference_in_means(web_bill_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "good taxpayer")),
         difference_in_means(web_bill_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "bad taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0258     0.0133   -1.93   0.0533   -0.052 0.000372 3004
## [1] "Difference in Means 2"
## Design:  Standard
```

```
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0134     0.0102   -1.31    0.189  -0.0334   0.0066 4079
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         -0.0124          0.0168         -0.7388          0.4600

## Diff in effects              SE               t         p-value
##         -0.0124          0.0168         -0.7388          0.4600
```

```
#################################################################
# TABLE 11. FIELD EXPERIMENT. Positive vs negative incentives.
# Good and bad taxpayers, comparison of treatments 1, 2 and 4
# (positive incentives, pooled) vs 3 and 5 (negative incentives, pooled).
# Test using compliance conditional on significant effects for missed payment,
# number of payments owed or total debt.
#################################################################

difference_in_means(missed_payment_DiD ~ pooled_124_35, data = fieldex)
```

```
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper    DF
## pooled_124_35  0.00855    0.00716    1.19    0.232 -0.00548   0.0226 14260
```

```
difference_in_means(payments_owed_DiD ~ pooled_124_35, data = fieldex)
```

```
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper    DF
## pooled_124_35  0.00429     0.0195    0.22    0.826  -0.0339   0.0425 14356
```

```
difference_in_means(web_bill_DiD ~ pooled_124_35, data = fieldex)
```

```
## Design:  Standard
##               Estimate Std. Error t value  Pr(>|t|) CI Lower CI Upper    DF
## pooled_124_35  -0.0265    0.00633   -4.19 0.0000278  -0.0389  -0.0141 14290
```

```
#################################################################
# TABLE 12. FIELD EXPERIMENT. Comparison of effects of positive
# vs negative incentives for good and bad taxpayers: difference
# of the difference in means for the comparison of treatments
# 1, 2 and 4 (pooled) and 3 and 5 (pooled).
#################################################################

comp.eff(difference_in_means(missed_payment_DiD ~ pooled_124_35,
                             data = filter(fieldex, type == "good taxpayer")),
         difference_in_means(missed_payment_DiD ~ pooled_124_35,
                             data = filter(fieldex, type == "bad taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_35  0.00878    0.00636    1.38    0.168 -0.00369   0.0213 5972
```

```
## [1] "Difference in Means 2"
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_35    0.011     0.0113   0.978    0.328   -0.011   0.0331 8252
## [1] "#####. Difference in Effects"
## Diff in effects              SE              t         p-value
##        -0.00223         0.01293        -0.17255         0.86301

## Diff in effects              SE              t         p-value
##        -0.00223         0.01293        -0.17255         0.86301
```

```
comp.eff(difference_in_means(payments_owed_DiD ~ pooled_124_35,
                             data = filter(fieldex, type == "good taxpayer")),
         difference_in_means(payments_owed_DiD ~ pooled_124_35,
                             data = filter(fieldex, type == "bad taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower  CI Upper   DF
## pooled_124_35  -0.0082    0.00404   -2.03   0.0427  -0.0161 -0.000271 5818
## [1] "Difference in Means 2"
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_35   0.0172     0.0332   0.519    0.603  -0.0478   0.0823 8335
## [1] "#####. Difference in Effects"
## Diff in effects              SE              t         p-value
##         -0.0254          0.0334         -0.7609          0.4467

## Diff in effects              SE              t         p-value
##         -0.0254          0.0334         -0.7609          0.4467
```

```
comp.eff(difference_in_means(web_bill_DiD ~ pooled_124_35,
                             data = filter(fieldex, type == "good taxpayer")),
         difference_in_means(web_bill_DiD ~ pooled_124_35,
                             data = filter(fieldex, type == "bad taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_35  -0.0365     0.0101   -3.61 0.000313  -0.0563  -0.0166 5884
## [1] "Difference in Means 2"
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_35  -0.0202    0.00806    -2.5   0.0124   -0.036 -0.00436 8363
## [1] "#####. Difference in Effects"
## Diff in effects              SE              t         p-value
##         -0.0163          0.0129         -1.2603          0.2076

## Diff in effects              SE              t         p-value
##         -0.0163          0.0129         -1.2603          0.2076
```

```
#################################################################
# TABLE 13. FIELD EXPERIMENT. Marginal taxpayers. Good taxpayers.
# Heterogeneous effects, taxpayers at risk. Comparison of
# treatment effect of 1, 2 and 4 (pooled) vs control
# (A-Information about the tax lottery), on one test and 3
# and 5 (pooled) vs control on another (B-Information about sanctions).
#################################################################

# Identifying good taxpayers with history of debt
# Ever owed a bill since March 2009?
names(fieldex)[grepl("adeudadas", names(fieldex))]
```

```
##  [1] "adeudadas_2014_MAR" "adeudadas_2009_MAR" "adeudadas_2009_JUL"
##  [4] "adeudadas_2009_NOV" "adeudadas_2010_MAR" "adeudadas_2010_JUL"
##  [7] "adeudadas_2010_NOV" "adeudadas_2011_MAR" "adeudadas_2011_JUL"
## [10] "adeudadas_2011_NOV" "adeudadas_2012_MAR" "adeudadas_2012_JUL"
## [13] "adeudadas_2012_NOV" "adeudadas_2013_MAR" "adeudadas_2013_JUL"
## [16] "adeudadas_2013_NOV"
```

```
sum_bills_owed <- apply(fieldex[,grepl("adeudadas", names(fieldex))], 1, sum)
fieldex$goodtp_at_risk <- ifelse(sum_bills_owed>0, 1, 0)
table(fieldex$goodtp_at_risk[fieldex$type=="good taxpayer"])
```

```
##
##     0     1
## 10665  4119
```

```
### A. Information on the lottery - Heterogeneous effects for taxpayers at risk
comp.eff(difference_in_means(missed_payment_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "good taxpayer" & goodtp_at_risk==1)),
         difference_in_means(missed_payment_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "good taxpayer" & goodtp_at_risk==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## pooled_124_0  0.00963     0.0194   0.496     0.62  -0.0284   0.0477 771
## [1] "Difference in Means 2"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0 -0.00331    0.00764  -0.433    0.665  -0.0183   0.0117 2287
## [1] "#####. Difference in Effects"
## Diff in effects              SE              t         p-value
##          0.0129          0.0208          0.6205          0.5350

## Diff in effects              SE              t         p-value
##          0.0129          0.0208          0.6205          0.5350
```

```
comp.eff(difference_in_means(web_bill_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "good taxpayer" & goodtp_at_risk==1)),
         difference_in_means(web_bill_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "good taxpayer" & goodtp_at_risk==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## pooled_124_0  -0.0571     0.0248    -2.3   0.0218   -0.106 -0.00836 712
## [1] "Difference in Means 2"
## Design:  Standard
##              Estimate Std. Error t value  Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0   -0.064      0.015   -4.28 0.0000197  -0.0934  -0.0347 1971
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         0.00691         0.02901         0.23817         0.81176

## Diff in effects              SE               t         p-value
##         0.00691         0.02901         0.23817         0.81176
```

```
### B. Information on sanctions - Heterogeneous effects for taxpayers at risk
comp.eff(difference_in_means(missed_payment_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "good taxpayer" & goodtp_at_risk==1)),
         difference_in_means(missed_payment_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "good taxpayer" & goodtp_at_risk==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## pooled_35_0    0.023     0.0192     1.2     0.23  -0.0146   0.0607 745
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0    -0.02    0.00801   -2.49   0.0128  -0.0357 -0.00425 2556
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##          0.0430          0.0208          2.0674          0.0388

## Diff in effects              SE               t         p-value
##          0.0430          0.0208          2.0674          0.0388
```

```
comp.eff(difference_in_means(web_bill_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "good taxpayer" & goodtp_at_risk==1)),
         difference_in_means(web_bill_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "good taxpayer" & goodtp_at_risk==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## pooled_35_0  -0.0392     0.0255   -1.54    0.124  -0.0892   0.0108 759
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0216     0.0156   -1.38    0.168  -0.0523  0.00909 2238
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         -0.0176          0.0299         -0.5903          0.5550
```

```
## Diff in effects              SE               t         p-value
##         -0.0176          0.0299         -0.5903          0.5550
```

```
#################################################################
# TABLE 14. FIELD EXPERIMENT. Marginal taxpayers. Bad taxpayers.
# Heterogeneous effects, salvageable taxpayers. Comparison of treatment
# effect of 1, 2 and 4 (pooled) vs control (A-Information about the
# tax lottery), on one test and 3 and 5 (pooled) vs control on
# another (B-Information about sanctions). Test using compliance
# conditional on significant effects for missed payment, number
# of payments owed or total debt.
#################################################################

# Identifying bad taxpayers not too in debt
# Ever owed a bill since March 2009?
fieldex$salvageable_btp <- ifelse(fieldex$adeudadas_2014_MAR>3, 0, 1)

### A. Information on the lottery - Heterogeneous effects for taxpayers at risk

# Missed payments
comp.eff(difference_in_means(missed_payment_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==1)),
         difference_in_means(missed_payment_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0  0.00433     0.0174   0.248    0.804  -0.0299   0.0385 3119
## [1] "Difference in Means 2"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## pooled_124_0  -0.0248     0.0151   -1.64    0.101  -0.0544   0.0048 986
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##          0.0291          0.0231          1.2624          0.2068

## Diff in effects              SE               t         p-value
##          0.0291          0.0231          1.2624          0.2068
```

```
# Web access
comp.eff(difference_in_means(web_bill_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==1)),
         difference_in_means(web_bill_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0  -0.0398     0.0128   -3.11  0.00188  -0.0649  -0.0147 2999
## [1] "Difference in Means 2"
## Design:  Standard
```

```
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## pooled_124_0  -0.0148      0.011   -1.34     0.18  -0.0364  0.00686 926
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         -0.0250          0.0169         -1.4803          0.1388

## Diff in effects              SE               t         p-value
##         -0.0250          0.0169         -1.4803          0.1388
```

```
# Nr of payments owed
comp.eff(difference_in_means(payments_owed_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==1)),
         difference_in_means(payments_owed_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0   0.0334     0.0249    1.34     0.18  -0.0154   0.0821 4118
## [1] "Difference in Means 2"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0   0.0112      0.144  0.0781    0.938   -0.271    0.293 1026
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##          0.0222          0.1458          0.1520          0.8792

## Diff in effects              SE               t         p-value
##          0.0222          0.1458          0.1520          0.8792
```

```
# Compliance
comp.eff(difference_in_means(compliance_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==1)),
         difference_in_means(compliance_DiD ~ pooled_124_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##               Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_124_0 -0.000557     0.0171 -0.0326    0.974  -0.0341    0.033 3185
## [1] "Difference in Means 2"
## Design:  Standard
##              Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## pooled_124_0 -0.00379    0.00611   -0.62    0.535  -0.0158   0.0082 884
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         0.00323         0.01817         0.17782         0.85887

## Diff in effects              SE               t         p-value
##         0.00323         0.01817         0.17782         0.85887
```

```
### B. Information on sanctions - Heterogeneous effects for taxpayers at risk

# Missed payments
comp.eff(difference_in_means(missed_payment_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==1)),
         difference_in_means(missed_payment_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0143     0.0173  -0.826    0.409  -0.0481   0.0196 3045
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0154     0.0152   -1.01    0.311  -0.0452   0.0144 1000
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         0.00113         0.02299         0.04900         0.96092

## Diff in effects              SE               t         p-value
##         0.00113         0.02299         0.04900         0.96092
```

```
# Web access
comp.eff(difference_in_means(web_bill_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==1)),
         difference_in_means(web_bill_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0224     0.0128   -1.74   0.0813  -0.0475  0.00278 3035
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0   0.0118     0.0117    1.01    0.311  -0.0111   0.0347 1069
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         -0.0342         0.0173         -1.9722          0.0486

## Diff in effects              SE               t         p-value
##         -0.0342         0.0173         -1.9722          0.0486
```

```
# Nr of payments owed
comp.eff(difference_in_means(payments_owed_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==1)),
         difference_in_means(payments_owed_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==0)))
```

```
## [1] "Difference in Means 1"
```

```
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  0.00328     0.0272   0.121    0.904    -0.05   0.0566 4610
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## pooled_35_0   0.0533      0.137   0.389    0.697   -0.216    0.322 897
## [1] "#####. Difference in Effects"
## Diff in effects              SE              t         p-value
##          -0.050           0.140          -0.358           0.720

## Diff in effects              SE              t         p-value
##          -0.050           0.140          -0.358           0.720
```

```
# Compliance
comp.eff(difference_in_means(compliance_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==1)),
         difference_in_means(compliance_DiD ~ pooled_35_0,
                             data = filter(fieldex, type == "bad taxpayer" & salvageable_btp==0)))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_35_0  -0.0217     0.0169   -1.28    0.201  -0.0549   0.0115 3110
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## pooled_35_0 -0.00122    0.00636  -0.191    0.848  -0.0137   0.0113 987
## [1] "#####. Difference in Effects"
## Diff in effects              SE              t         p-value
##         -0.0204          0.0181         -1.1301          0.2585

## Diff in effects              SE              t         p-value
##         -0.0204          0.0181         -1.1301          0.2585
```

```
#################################################################
# TABLE 15. FIELD EXPERIMENT. Good and bad taxpayers. Social
# vs individual rewards. Comparison of treatments 1, 2 (pooled) vs 4.
# Test using compliance conditional on significant effects for
# missed payment, number of payments owed or total debt.
#################################################################

# Missed payments
difference_in_means(missed_payment_DiD ~ pooled_12_4, data = fieldex)
```

```
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_12_4  -0.0312     0.0101   -3.09  0.00201   -0.051  -0.0114 7128
```

```
# Web access
difference_in_means(web_bill_DiD ~ pooled_12_4, data = fieldex)
```

```
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_12_4 -0.00308    0.00859  -0.358     0.72  -0.0199   0.0138 7185
```

```
# Nr of payments owed
difference_in_means(payments_owed_DiD ~ pooled_12_4, data = fieldex)
```

```
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_12_4  -0.0507      0.028   -1.81   0.0707   -0.106  0.00428 6480
```

```
# Compliance
difference_in_means(compliance_DiD ~ pooled_12_4, data = fieldex)
```

```
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_12_4  -0.0318    0.00975   -3.26   0.0011  -0.0509  -0.0127 7169
```

```
#################################################################
# TABLE 16. FIELD EXPERIMENT. Social (4) vs individual rewards
# (1 and 2, pooled), comparison of effect between good and bad taxpayers.
#################################################################

# Missed payments
comp.eff(difference_in_means(missed_payment_DiD ~ pooled_12_4,
                             data = filter(fieldex, type == "bad taxpayer")),
         difference_in_means(missed_payment_DiD ~ pooled_12_4,
                             data = filter(fieldex, type == "good taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_12_4   -0.044      0.016   -2.74  0.00612  -0.0754  -0.0125 4088
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_12_4  -0.0158    0.00873   -1.81   0.0701  -0.0329   0.0013 2990
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         -0.0282          0.0183         -1.5433          0.1228

## Diff in effects              SE               t         p-value
##         -0.0282          0.0183         -1.5433          0.1228
```

```
# Web access
comp.eff(difference_in_means(web_bill_DiD ~ pooled_12_4,
                             data = filter(fieldex, type == "bad taxpayer")),
         difference_in_means(web_bill_DiD ~ pooled_12_4,
                             data = filter(fieldex, type == "good taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_12_4 -0.00168     0.0112   -0.15    0.881  -0.0237   0.0203 4134
## [1] "Difference in Means 2"
## Design:  Standard
##             Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_12_4 -0.00456     0.0133  -0.342    0.732  -0.0307   0.0215 3024
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         0.00287         0.01741         0.16503         0.86893

## Diff in effects              SE               t         p-value
##         0.00287         0.01741         0.16503         0.86893
```

```
#################################################################
# TABLE 17. FIELD EXPERIMENT. Good and bad taxpayers. Social vs
# individual sanctions. Comparison of treatments 3 vs 5. Test
# using compliance conditional on significant effects for missed
# payment, number of payments owed or total debt.
#################################################################

# Missed payments
difference_in_means(missed_payment_DiD ~ pooled_3_5, data = fieldex)
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_3_5  0.00949     0.0101   0.935     0.35  -0.0104   0.0294 7123
```

```
# Web access
difference_in_means(web_bill_DiD ~ pooled_3_5, data = fieldex)
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_3_5   0.0211    0.00929    2.27   0.0234  0.00286   0.0393 7171
```

```
# Nr of payments owed
difference_in_means(payments_owed_DiD ~ pooled_3_5, data = fieldex)
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_3_5  0.00205     0.0271  0.0755     0.94  -0.0512   0.0553 5162
```

```
# Compliance
difference_in_means(compliance_DiD ~ pooled_3_5, data = fieldex)
```

```
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_3_5  0.00888    0.00983   0.903    0.366  -0.0104   0.0282 7165
```

```
#################################################################
# TABLE 18. FIELD EXPERIMENT. Social vs individual sanctions.
# Comparison of effects for good and bad taxpayers.
# Comparison of treatments 3 vs 5. Test using compliance conditional
# on significant effects for missed payment, number of payments owed or total debt.
#################################################################

# Missed payments
comp.eff(difference_in_means(missed_payment_DiD ~ pooled_3_5,
                             data = filter(fieldex, type == "bad taxpayer")),
         difference_in_means(missed_payment_DiD ~ pooled_3_5,
                             data = filter(fieldex, type == "good taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_3_5  0.00983     0.0158   0.623    0.533  -0.0211   0.0408 4160
## [1] "Difference in Means 2"
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_3_5  0.00623    0.00925   0.673    0.501  -0.0119   0.0244 2965
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         0.00361         0.01829         0.19711         0.84375

## Diff in effects              SE               t         p-value
##         0.00361         0.01829         0.19711         0.84375
```

```
# Web access
comp.eff(difference_in_means(web_bill_DiD ~ pooled_3_5,
                             data = filter(fieldex, type == "bad taxpayer")),
         difference_in_means(web_bill_DiD ~ pooled_3_5,
                             data = filter(fieldex, type == "good taxpayer")))
```

```
## [1] "Difference in Means 1"
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_3_5   0.0143     0.0116    1.23    0.218 -0.00845    0.037 4205
## [1] "Difference in Means 2"
## Design:  Standard
##            Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## pooled_3_5   0.0316     0.0152    2.08   0.0378  0.00178   0.0615 2963
## [1] "#####. Difference in Effects"
## Diff in effects              SE               t         p-value
##         -0.0174          0.0191         -0.9073          0.3643

## Diff in effects              SE               t         p-value
##         -0.0174          0.0191         -0.9073          0.3643
```

```
#################################################################################
# PAP 2 - SURVEY EXPERIMENT

message("load data")
```

```
## load data

load("survey_data.Rda")
#################################################################

#################################################################
# Social vs Individual Benefit
#################################################################

# Pooling the individual benefits treatments (questionaire versions 2 and 3)
# and recoding as treatment=1.
survey_data$social_individual <- ifelse((survey_data$treatment==2|
                                         survey_data$treatment==3),1,NA)
# Recoding the social benefits treatment as 0.
survey_data$social_individual <- ifelse((survey_data$treatment==1),0,
                                        survey_data$social_individual)


# Outcome: "Policies that reward good taxpayers are a waste of money"
# totally disagree (0) - totally agree (10)
ben1 <- difference_in_means(S1p1 ~ social_individual, data = survey_data)

# Outcome: "It is worth it to be up to date with ones taxes"
# totally disagree (0) - totally agree (10)
ben2 <- difference_in_means(S1p3 ~ social_individual, data = survey_data)

social_individual <- rbind.data.frame(ben1, ben2)
rownames(social_individual) <- c("Rewards are waste of money",
                                 "Worth it to be up to date")

# Adding p-value adjustments
social_individual <- social_individual[order(social_individual[,6], decreasing=F),]
# Ordering p-values in decreasing order
ordered.ps <- social_individual[, 6]
# Building reference vector to compare to ordered p-values
FDR_reference <- .05*(1:length(ordered.ps)/length(ordered.ps))
# Comparing p-values to referece vector
FDR <- as.data.frame(cbind(ordered.ps, FDR_reference, ordered.ps<=FDR_reference))
FDR[,3] <- as.numeric(FDR[,3])
if (sum(FDR[,3])>0){
  fdr <- which(FDR[,1]==max(FDR[,1][FDR[,3]==1]))
  FDR[,4] <- c(rep("reject null", fdr), rep("do not reject", nrow(FDR)-fdr))}

if (sum(FDR[,3])==0){
  FDR[,4] <- rep("do not reject", nrow(FDR))}

Bonferroni_reference <- rep(.05/nrow(FDR), nrow(FDR))
Bonferroni_reject <- ifelse(ordered.ps<=Bonferroni_reference,
                            "reject null", "do not reject")

social_individual <- cbind(social_individual, FDR[,c(2,4)],
                           Bonferroni_reference,
                           Bonferroni_reject)
```

```r
names(social_individual)[17] <- "FDR_reject"
social_individual
```

```
##                            coefficients std.error   df nobs statistic p.value
## Worth it to be up to date       -0.3061     0.142 1247 1685    -2.161  0.0309
## Rewards are waste of money      -0.0343     0.188 1152 1664    -0.183  0.8552
##                            conf.low conf.high alpha              term outcome
## Worth it to be up to date    -0.584   -0.0282  0.05 social_individual    S1p3
## Rewards are waste of money   -0.403    0.3345  0.05 social_individual    S1p1
##                            condition2 condition1   vcov   design FDR_reference
## Worth it to be up to date           1          0 0.0201 Standard         0.025
## Rewards are waste of money          1          0 0.0353 Standard         0.050
##                              FDR_reject Bonferroni_reference Bonferroni_reject
## Worth it to be up to date  do not reject                0.025     do not reject
## Rewards are waste of money do not reject                0.025     do not reject
```

```r
#################################################################
# Discretionary vs lottery allocation of benefits
#################################################################

# Generating discretionary benefits dummy where surveys with the discretionary version
# of the survey are 1.
survey_data$treat_discretion <- ifelse((survey_data$treatment==4),1,0)

# Outcome: "In Montevideo, rewards for good taxpayers go to the same people as always"
# totally disagree (0) - totally agree (10)
discretion1 <- difference_in_means(S1p4 ~ treat_discretion,
                                   data = survey_data)
discretion1
```

```
## Design:  Standard
##                  Estimate Std. Error t value   Pr(>|t|) CI Lower CI Upper  DF
## treat_discretion     1.05      0.219    4.81 0.00000184    0.623     1.48 691
```

```r
# Outcome: "Policies that reward good taxpayers are a waste of money"
# totally disagree (0) - totally agree (10)
discretion2 <- difference_in_means(S1p1 ~ treat_discretion,
                                   data = survey_data)
discretion2
```

```
## Design:  Standard
##                  Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## treat_discretion  -0.0219      0.177  -0.124    0.901   -0.369    0.325 979
```

```r
# Outcome: "It is worth it to be up to date with ones taxes"
# totally disagree (0) - totally agree (10)
discretion3 <- difference_in_means(S1p3 ~ treat_discretion,
                                   data = survey_data)
discretion3
```

```
## Design:  Standard
##                  Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper  DF
## treat_discretion   -0.477      0.151   -3.16  0.00164   -0.774   -0.181 902
```

```r
# Outcome: "In general, the municipal government does a good job"
# totally disagree (0) - totally agree (10)
discretion4 <- difference_in_means(S1p2 ~ treat_discretion,
                                   data = survey_data)
discretion4
```

```
## Design:  Standard
##                  Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## treat_discretion   -0.168      0.141   -1.19    0.234   -0.445    0.109 1038
```

```r
# Outcome: "How would you classify the taxes that the municipal
# government charges in gene
# very just (1) - not just at all (4)
discretion5 <- difference_in_means(S1p5 ~ treat_discretion,
                                   data = survey_data)
discretion5
```

```
## Design:  Standard
##                  Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper   DF
## treat_discretion   0.0354     0.0352    1.01    0.314  -0.0336    0.105 1022
```

```r
discretion <- rbind.data.frame(discretion1, discretion2, discretion3, discretion4, discretion5)
rownames(discretion) <- c("Rewards go to the same people as always",
                          "Rewards are waste of money",
                          "Worth it to be up to date",
                          "Mun.gov. does a good job",
                          "Mun. taxes are just")


# Adding p-value adjustments
discretion <- discretion[order(discretion[,6], decreasing=F),]
# Ordering p-values in decreasing order
ordered.ps <- discretion[,6]
# Building reference vector to compare to ordered p-values
FDR_reference <- .05*(1:length(ordered.ps)/length(ordered.ps))
# Comparing p-values to referece vector
FDR <- as.data.frame(cbind(ordered.ps, FDR_reference, ordered.ps<=FDR_reference))
FDR[,3] <- as.numeric(FDR[,3])
if (sum(FDR[,3])>0){
  fdr <- which(FDR[,1]==max(FDR[,1][FDR[,3]==1]))
  FDR[,4] <- c(rep("reject null", fdr), rep("do not reject", nrow(FDR)-fdr))}

if (sum(FDR[,3])==0){
  FDR[,4] <- rep("do not reject", nrow(FDR))}

Bonferroni_reference <- rep(.05/nrow(FDR), nrow(FDR))
Bonferroni_reject <- ifelse(ordered.ps<=Bonferroni_reference,"reject null", "do not reject")

discretion <- cbind(discretion, FDR[,c(2,4)],
                    Bonferroni_reference,
                    Bonferroni_reject)
```

```r
names(discretion)[17] <- "FDR_reject"
discretion
```

```
##                                       coefficients std.error   df nobs
## Rewards go to the same people as always       1.0521    0.2187  691 1542
## Worth it to be up to date                    -0.4775    0.1512  902 2266
## Mun.gov. does a good job                     -0.1682    0.1412 1038 2313
## Mun. taxes are just                           0.0354    0.0352 1022 2291
## Rewards are waste of money                   -0.0219    0.1770  979 2234
##                                       statistic    p.value conf.low conf.high
## Rewards go to the same people as always     4.812 0.00000184   0.6228     1.481
## Worth it to be up to date                  -3.158 0.00164060  -0.7742    -0.181
## Mun.gov. does a good job                   -1.191 0.23379546  -0.4453     0.109
## Mun. taxes are just                         1.007 0.31401306  -0.0336     0.105
## Rewards are waste of money                 -0.124 0.90147452  -0.3692     0.325
##                                       alpha             term outcome
## Rewards go to the same people as always  0.05 treat_discretion    S1p4
## Worth it to be up to date                0.05 treat_discretion    S1p3
## Mun.gov. does a good job                 0.05 treat_discretion    S1p2
## Mun. taxes are just                      0.05 treat_discretion    S1p5
## Rewards are waste of money               0.05 treat_discretion    S1p1
##                                       condition2 condition1    vcov   design
## Rewards go to the same people as always          1          0 0.04782 Standard
## Worth it to be up to date                        1          0 0.02286 Standard
## Mun.gov. does a good job                         1          0 0.01994 Standard
## Mun. taxes are just                              1          0 0.00124 Standard
## Rewards are waste of money                       1          0 0.03133 Standard
##                                       FDR_reference    FDR_reject
## Rewards go to the same people as always          0.01   reject null
## Worth it to be up to date                        0.02   reject null
## Mun.gov. does a good job                         0.03 do not reject
## Mun. taxes are just                              0.04 do not reject
## Rewards are waste of money                       0.05 do not reject
##                                       Bonferroni_reference Bonferroni_reject
## Rewards go to the same people as always                 0.01       reject null
## Worth it to be up to date                               0.01       reject null
## Mun.gov. does a good job                                0.01     do not reject
## Mun. taxes are just                                     0.01     do not reject
## Rewards are waste of money                              0.01     do not reject
```

```r
#################################################################
# Fines and charges vs. benefits of tax holidays
#################################################################

# Creating dataframe with relevant treatments and outcomes.
# Keeping outcomes we want for benefits
ben <- survey_data[(survey_data$treatment!=4),names(survey_data) %in%
                     c("treatment", "S1p2", "S1p3","S1p5" )]
names(ben)
```

```
## [1] "S1p2"      "S1p3"      "S1p5"      "treatment"
```

```r
# Benefits pooled (S1p2) (A, B and C)
ben$benefits_punishments <- 1

# versus fines and charges pooled (M1p3)  (A, B , C and D)
fin <- survey_data[,names(survey_data) %in% c("treatment", "M1p2", "M1p3","M1p6")]
names(fin)
```

```
## [1] "treatment" "M1p2"      "M1p3"      "M1p6"
```

```r
# Pooling punishments
fin$benefits_punishments <- 0

# For three questions the outcomes are the same in the punishments and benefits conditions
# but have different survey question numbers. Here we rename the variables so
# that we can bind the datasets into one.
names(ben)
```

```
## [1] "S1p2"                "S1p3"                "S1p5"
## [4] "treatment"           "benefits_punishments"
```

```r
names(ben)[1:3] <- c("M1p3", "M1p2", "M1p6")
pooled <- rbind(ben,fin)


# Outcome: "In general, the municipal government does a good job"
# totally disagree (0) - totally agree (10)
benefits_punishments1 <- difference_in_means(M1p3 ~ benefits_punishments, data = pooled)
benefits_punishments1
```

```
## Design:  Standard
##                       Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper
## benefits_punishments     -0.1     0.0958   -1.04    0.296   -0.288   0.0877
##                         DF
## benefits_punishments 3727
```

```r
# Outcome: "In Montevideo, it is worth it to be up to date on ones taxes"
# totally disagree (0) - totally agree (10)
benefits_punishments2 <- difference_in_means(M1p2 ~ benefits_punishments, data = pooled)
benefits_punishments2
```

```
## Design:  Standard
##                       Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper
## benefits_punishments   -0.211     0.0905   -2.33   0.0199   -0.388  -0.0334
##                         DF
## benefits_punishments 3606
```

```r
# Outcome: "How would you classify the taxes that the municipal government charges?"
# very just (1) - not just at all (4)
benefits_punishments3 <- difference_in_means(M1p6 ~ benefits_punishments, data = pooled)
benefits_punishments3
```

```
## Design:  Standard
##                       Estimate Std. Error t value Pr(>|t|) CI Lower CI Upper
## benefits_punishments  0.00835     0.0236   0.354    0.724  -0.0379   0.0546
##                         DF
## benefits_punishments 3676
```

```
benefits_punishments <- rbind.data.frame(benefits_punishments1,
                                         benefits_punishments2,
                                         benefits_punishments3)
rownames(benefits_punishments) <- c("Mun. gov. does a good job",
                                    "Worth it to be up to date",
                                    "Mun. taxes are just")

# Adding p-value adjustments
benefits_punishments <- benefits_punishments[order(benefits_punishments[,6], decreasing=F),]
# Ordering p-values in decreasing order
ordered.ps <- benefits_punishments[,6]
# Building reference vector to compare to ordered p-values
FDR_reference <- .05*(1:length(ordered.ps)/length(ordered.ps))
# Comparing p-values to referece vector
FDR <- as.data.frame(cbind(ordered.ps, FDR_reference, ordered.ps<=FDR_reference))
FDR[,3] <- as.numeric(FDR[,3])
if (sum(FDR[,3])>0){
  fdr <- which(FDR[,1]==max(FDR[,1][FDR[,3]==1]))
  FDR[,4] <- c(rep("reject null", fdr), rep("do not reject", nrow(FDR)-fdr))}

if (sum(FDR[,3])==0){
  FDR[,4] <- rep("do not reject", nrow(FDR))}

Bonferroni_reference <- rep(.05/nrow(FDR), nrow(FDR))
Bonferroni_reject <- ifelse(ordered.ps<=Bonferroni_reference,"reject null", "do not reject")

benefits_punishments <- cbind(benefits_punishments, FDR[,c(2,4)],
                              Bonferroni_reference,
                              Bonferroni_reject)

names(benefits_punishments)[17] <- "FDR_reject"
benefits_punishments
```

```
##                           coefficients std.error   df nobs statistic p.value
## Worth it to be up to date     -0.21077    0.0905 3606 3958    -2.329  0.0199
## Mun. gov. does a good job     -0.10004    0.0958 3727 4008    -1.045  0.2963
## Mun. taxes are just            0.00835    0.0236 3676 3993     0.354  0.7235
##                           conf.low conf.high alpha                term outcome
## Worth it to be up to date  -0.3882   -0.0334  0.05 benefits_punishments    M1p2
## Mun. gov. does a good job  -0.2878    0.0877  0.05 benefits_punishments    M1p3
## Mun. taxes are just        -0.0379    0.0546  0.05 benefits_punishments    M1p6
##                           condition2 condition1     vcov   design FDR_reference
## Worth it to be up to date          1          0 0.008187 Standard        0.0167
## Mun. gov. does a good job          1          0 0.009173 Standard        0.0333
## Mun. taxes are just                1          0 0.000557 Standard        0.0500
##                              FDR_reject Bonferroni_reference Bonferroni_reject
## Worth it to be up to date do not reject               0.0167     do not reject
## Mun. gov. does a good job do not reject               0.0167     do not reject
```

```
## Mun. taxes are just       do not reject              0.0167     do not reject
```