Problem Set 2

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```
dt <- data.table(haven::read_dta("data/ps2.dta"))
fwrite(dt, "data/ps2.csv")
```

```
dt <- fread("data/ps2.csv")
```

1.

Investigate bank balance-sheet data and show whether IRB- banks use internal models to reduce capital holdings. You should use both statistical and graphical tools.

To make things clearer we reformat the date variable `date_q`:

```
library(zoo)
dt[,date_q:=zoo::as.yearqtr(2000 + (date_q-min(date_q))/4)]
```

The table below shows a summary of the distribution of bank's total assets. Figure 1 provides a visual summary. The left panel shows the log-distribution, while the right panel shows levels in millions of assets. Light-blue bins indicate IRB-labelled banks.

```
library(xtable)
options(xtable.comment = FALSE)
xtab = data.frame(c(summary(dt[date_q=="2007 Q1"]$bsize_)))
colnames(xtab) = "Total assets (logs)"
xtable(xtab, label = "Distribution of banks' total assets as of 2017 Q1.")
```

	Total assets (logs)
Min.	16.09
1st Qu.	17.43
Median	18.10
Mean	18.17
3rd Qu.	18.99
Max.	20.63

```
library(ggplot2)
theme_set(theme_bw())
dt[,total_assets_mn:=exp(bsize_)/1e6]
# Assign indicator:
dt_sub <- unique(dt[date_q=="2007 Q1", .(bankid, bsize_)])[,type:=ifelse(bsize_>quantile(bsize_, 0.75),'
dt_sub[,bsize_:=NULL]
setkey(dt, bankid)
setkey(dt_sub, bankid)
dt <- dt_sub[dt]
```

```
# Prepare plot:
dt_plot <- melt(dt[date_q=="2007 Q1"], id.vars = c("firmid", "bankid", "date_q", "type"), measure.vars =
levels(dt_plot$variable) <- c("Logs", "Levels (millions)")
p <- ggplot(data=dt_plot, aes(x=value, fill=type)) +
  geom_histogram(colour="blue") +
  scale_fill_manual(
    name="Risk-weighting:",
    values=c("lightblue", "white")
  ) +
  labs(
    x = "Total assets",
    y = "Count"
  ) +
  facet_wrap(
    ~ variable,
    scales = "free"
  )
p
```

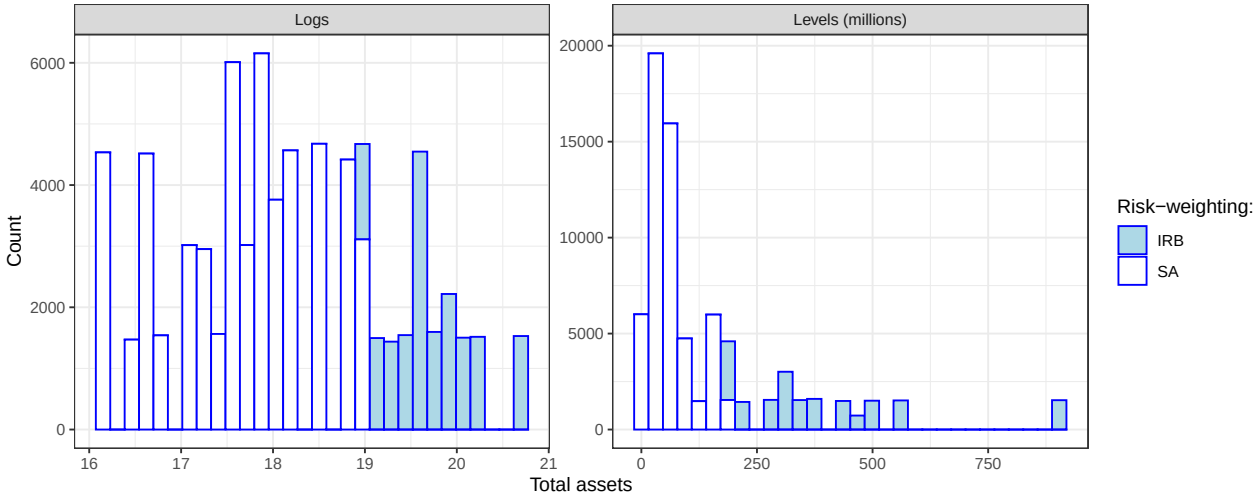

Figure 1: Histograms for banks' total assets as of 2017 Q1. The left panel shows the log-distribution, while the right panel shows levels in millions of assets. Light-blue bins indicate IRB-labelled banks.

The Basel III leverage ratio can be computed form the available data as $\ell_{\text{Basel}} = \frac{\ell_{\text{Tier-1}} A_{\text{risk-weighted}}}{A}$ where $\ell_{\text{Tier-1}}$ denotes the Tier-1 Capital Ratio, $A_{\text{risk-weighted}}$ denotes risk-weighted capital and A denotes banks' total assets. Since assets (`bcet1_`,`bsize_`) are provided in log-terms we need to make a small adjustment for that and take exponentials (although not accounting for only leads to a relatively error):

```
dt[,basel_lev:=(bcet1_*exp(bsizerw_))/exp(bsize_)] # compute leverage ratio
```

Then the following code generates Figure 2. The top panel shows time series of the different leverage ratios differentiated by bank type. The black vertical stalk indicates 2007 Q1. The bottom panel shows the difference in leverage ratios between IRB- and SA-labelled banks indexed to 2007 Q1. Upon visual inspection the difference in Basel III leverage ratios increased following the regulatory change in 2007 Q1. In the annex you may find a table of average leverage ratios pre- and post-treatment (over the period of analysis goes from 2006 Q1 to 2008 Q2).

```
dt_plot <- unique(melt(dt, id.vars = c("bankid", "date_q", "type"), measure.vars = c("bcet1_", "basel_l
dt_plot <- dt_plot[,.(value=mean(value)),by=.(date_q, type, variable)][order(date_q, type, variable)] #
```

```
levels(dt_plot$variable) <- c("Tier-1", "Basel III")
p1 <- ggplot(data=dt_plot, aes(x=date_q, y=value, colour=type, linetype=variable)) +
  geom_line() +
  scale_color_discrete(name="Risk-weighting:") +
  scale_linetype_discrete(name="Ratio:") +
  labs(
    x="",
    y="Ratio"
  ) +
  geom_vline(xintercept = zoo::as.yearqtr("2007 Q1")) +
  theme(
    legend.position="top",
    axis.title.x = element_blank(),
    axis.text.x = element_blank(),
    axis.ticks.x = element_blank()
  )
dt_tab <- copy(dt_plot[date_q %between% c("2006 Q1", "2008 Q2")]) # save for table in annex

dt_plot <- dt_plot[,.(value=value[type=="SA"] - value[type=="IRB"]), by=.(date_q, variable)]
dt_plot <- dt_plot[,.(date_q=date_q,value=value),by=variable]
p2 <- ggplot(dt_plot, aes(x=date_q, y=value, linetype=variable)) +
  geom_col(position = "dodge", fill="white", colour="black") +
  labs(
    x="Time",
    y="IBR minus SA"
  ) +
  scale_linetype_discrete(name="Ratio:") +
  theme(legend.position="none") +
  scale_x_yearqtr(
    format = "%YQ%q"
  )

library(gridExtra)
grid.arrange(p1,p2, heights=c(2,1), ncol=1)
```

2.

Diff-in-diff

Since the exercise clearly states that the period of analysis goes from 2006 Q1 to 2008 Q2, we restrict the sample for this exercise:

```
dt_full <- copy(dt) # keep copy of full sample
dt <- dt[date_q %between% c("2006 Q1", "2008 Q2")]
```

Below we first run a simple pooled difference-in-difference (DiD) model.

```
library(stargazer)
dt[,post:=ifelse(date_q<="2007 Q1",0,1)] # define structural break indicator
dt[,D:=ifelse(type=="IRB",1,0)] # define treatment dummy
mod_pooled <- lm(lncredit ~ post * D, data = dt)
mod_pooled_X_macro <- lm(lncredit ~ post * D + mpshock + mprate + gdp + infl, data = dt)
mod_pooled_X_entity <- lm(lncredit ~ post * D + basel_lev + bsizerw_ + bsize_ + rating + empl + fsize,
```

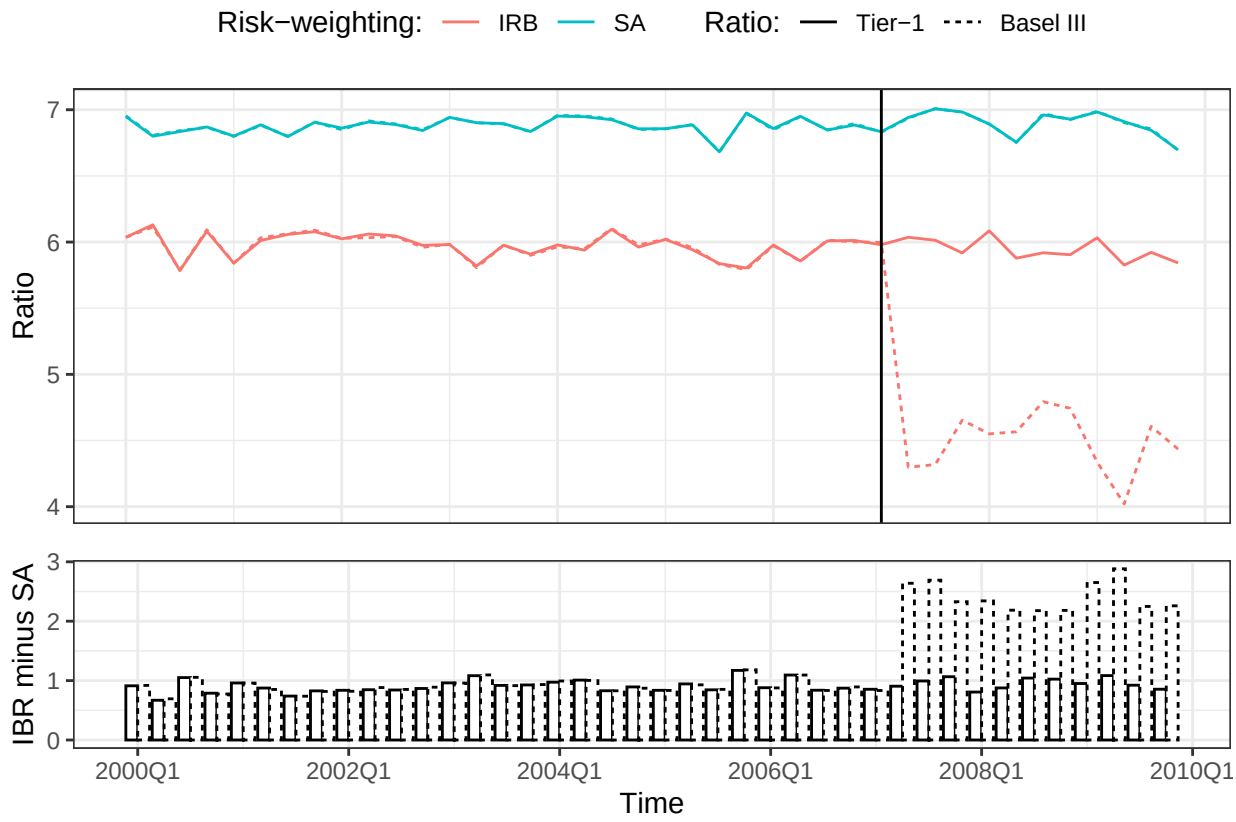

Figure 2: Evolution of leverage ratio over time. The top panel shows time series of the different leverage ratios diffentiated by bank type. The black vertical stalk indicates 2007 Q1. The bottom panel shows the difference in leverage ratios between IRB- and SA-labelled banks indexed to 2007 Q1.

```r
mod_pooled_X_all <- lm(lncredit ~ post * D + mpshock + mprate + gdp + infl + basel_lev + bsizerw_ + bsi
mods <- list(
  mod_pooled,
  mod_pooled_X_entity,
  mod_pooled_X_macro,
  mod_pooled_X_all
)
names(mods) <- c(
  "Simple",
  "Entity controls",
  "Macro controls",
  "Full controls"
)
stargazer(
  mods,
  header = FALSE,
  column.labels = names(mods),
  column.sep.width = "-5pt",
  font.size = "footnotesize"
)
```

Table 1:

	Dependent variable:			
	lncredit			
	Simple	Entity controls	Macro controls	Full controls
	(1)	(2)	(3)	(4)
post	−0.0001	−0.001	−0.0003	−0.001
	(0.008)	(0.008)	(0.016)	(0.016)
D	0.017	0.010	0.017	0.010
	(0.011)	(0.011)	(0.011)	(0.011)
basel_lev		−0.003*		−0.003*
		(0.001)		(0.001)
bsizerw_		−0.009		−0.009
		(0.080)		(0.080)
bsize_		0.017		0.017
		(0.080)		(0.080)
rating		−0.008**		−0.008**
		(0.003)		(0.003)
empl		0.0003*		0.0003*
		(0.0002)		(0.0002)
fsize		0.049***		0.049***
		(0.010)		(0.010)
mpshock			−0.0004	−0.0001
			(0.031)	(0.031)
mprate			0.001	−0.0003
			(0.044)	(0.044)
gdp			0.00000	0.0005
			(0.006)	(0.006)
infl			0.0001	0.0001
			(0.005)	(0.005)
post:D	0.011	0.006	0.011	0.005
	(0.016)	(0.028)	(0.016)	(0.028)
Constant	4.391***	3.954***	4.388***	3.953***
	(0.006)	(0.086)	(0.197)	(0.214)
Observations	742,590	742,590	742,590	742,590
R^2	0.00001	0.0001	0.00001	0.0001
Adjusted R^2	0.00001	0.0001	0.00000	0.0001
Residual Std. Error	2.973 (df = 742586)	2.973 (df = 742580)	2.973 (df = 742582)	2.973 (df = 742576)
F Statistic	2.977** (df = 3; 742586)	5.740*** (df = 9; 742580)	1.276 (df = 7; 742582)	3.975*** (df = 13; 742576)
Note:				*p<0.1; **p<0.05; ***p<0.01

Parallel trend

Annex

```
dt_tab[,post:=ifelse(date_q<="2007 Q1",0,1)]
dt_tab <- dt_tab[,.(value=mean(value)),by=.(type,variable,post)]
dt_tab <- dcast(dt_tab, type + variable ~ post, value.var = "value")
setnames(dt_tab,colnames(dt_tab),c("Bank type", "Leverage ratio", "Pre-treatment", "Post-treatment"))
xtable(dt_tab)
```

	Bank type	Leverage ratio	Pre-treatment	Post-treatment
1	IRB	Tier-1	5.97	5.99
2	IRB	Basel III	5.97	4.48
3	SA	Tier-1	6.87	6.92
4	SA	Basel III	6.87	6.91