Projekt SAP

Tema 2 - Uloga izvoza i uvoza u gospodarstvu

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Učitavanje podataka i deskriptivna analiza

Na početku učitavamo podatke i analiziramo kako izgledaju podaci.

```
export.data = read.csv("Export_data.csv", fileEncoding="UTF-8-BOM")
# head(export.data)

import.data = read.csv("Import_data.csv", fileEncoding="UTF-8-BOM")
# head(import.data)

gdp.data = read.csv("GDP_data.csv", fileEncoding="UTF-8-BOM")
# head(gdp.data)

gdp.pc.data = read.csv("GDPpercapita_data.csv", fileEncoding="UTF-8-BOM")
# head(gdp.pc.data)
```

Sljedeći blok koda generira dataframe sa brojem upisanih podataka te brojem procjena među upisanim podacima.

```
export.loc.cnt = export.data %>% group_by(LOCATION) %>%
    summarise(exp_n = n(), exp_est = sum(Flag.Codes == 'E')) %>%
    arrange(desc(exp_n), exp_est)
import.loc.cnt = import.data %>% group_by(LOCATION) %>%
    summarise(imp_n = n(), imp_est = sum(Flag.Codes == 'E')) %>%
    arrange(desc(imp_n), imp_est)
gdp.loc.cnt = gdp.data %>% group_by(LOCATION) %>%
    summarise(gdp_n = n(), gdp_est = sum(Flag.Codes == 'E')) %>%
    arrange(desc(gdp_n), gdp_est)
gdp.pc.loc.cnt = gdp.pc.data %>% group_by(LOCATION) %>%
    summarise(gdp_pc_n = n(), gdp_pc_est = sum(Flag.Codes == 'E')) %>%
    arrange(desc(gdp_pc_n), gdp_pc_est)
loc.cnt = merge(merge(export.loc.cnt, import.loc.cnt), merge(gdp.loc.cnt, gdp.pc.loc.cnt))
knitr::kable(
  head(arrange(loc.cnt,
               desc(loc.cnt[,2]), desc(loc.cnt[,4]), desc(loc.cnt[,6]), desc(loc.cnt[,8]),
               loc.cnt[,3], loc.cnt[,5], loc.cnt[,7], loc.cnt[,9]), 20),
  caption = "Broj podataka za pojedinu državu"
)
```

Table 1: Broj podataka za pojedinu državu

LOCATION	exp_n	exp_est	imp_n	imp_est	gdp_n	gdp_est	gdp_pc_n	gdp_pc_est
CAN	41	0	41	0	41	0	41	0

LOCATION	exp_n	exp_est	imp_n	imp_est	gdp_n	gdp_est	gdp_pc_n	gdp_pc_est
DNK	41	0	41	0	41	0	41	0
FRA	41	0	41	0	41	0	41	0
CHE	41	1	41	1	41	1	41	1
FIN	41	1	41	1	41	1	41	1
DEU	41	12	41	12	41	12	41	12
SWE	41	14	41	14	41	14	41	14
GBR	41	16	41	16	41	0	41	0
AUT	41	16	41	16	41	16	41	16
BEL	41	16	41	16	41	16	41	16
ESP	41	16	41	16	41	16	41	16
GRC	41	16	41	16	41	16	41	16
IRL	41	16	41	16	41	16	41	16
ITA	41	16	41	16	41	16	41	16
NLD	41	16	41	16	41	16	41	16
ISL	41	16	41	16	41	16	41	17
PRT	41	17	41	17	41	17	41	17
AUS	40	0	40	0	40	0	40	0
NOR	40	0	40	0	40	0	40	0
USA	40	0	40	0	40	0	40	0

Odabrane drzave

Odabrali smo USA, Njemačku(DEU) i Grčku(GRC) za analizu.

Deskriptivna statistika

```
time = 1979:2018
usa = data.frame(year = 1979:2018,
                 export.mln_usd = export.data$Value[export.data$LOCATION == "USA"],
                 import.mln_usd = import.data$Value[import.data$LOCATION == "USA"],
                 gdp.mln_usd = gdp.data$Value[gdp.data$LOCATION == "USA"],
                 gdp.pc.usd_cap = gdp.pc.data$Value[gdp.pc.data$LOCATION == "USA"])
usa$net.trade = usa$export.mln_usd - usa$import.mln_usd
deu = data.frame(year = 1979:2019,
                 export.mln_usd = export.data$Value[export.data$LOCATION == "DEU"],
                 import.mln_usd = import.data$Value[import.data$LOCATION == "DEU"],
                 gdp.mln_usd = gdp.data$Value[gdp.data$LOCATION == "DEU"],
                 gdp.pc.usd_cap = gdp.pc.data$Value[gdp.pc.data$LOCATION == "DEU"])
deu$net.trade = deu$export.mln_usd - deu$import.mln_usd
grc = data.frame(year = 1979:2019,
                 export.mln_usd = export.data$Value[export.data$LOCATION == "GRC"],
                 import.mln_usd = import.data$Value[import.data$LOCATION == "GRC"],
                 gdp.mln_usd = gdp.data$Value[gdp.data$LOCATION == "GRC"],
                 gdp.pc.usd_cap = gdp.pc.data$Value[gdp.pc.data$LOCATION == "GRC"])
grc$net.trade = grc$export.mln_usd - grc$import.mln_usd
```

```
usa = usa %>% mutate(import.mln_usd,
                     import.growth = import.mln_usd - lag(import.mln_usd),
                     import.growth.p = import.growth / lag(import.mln_usd) * 100)
deu = deu %>% mutate(import.mln_usd,
```

```
                      import.growth = import.mln_usd - lag(import.mln_usd),
                      import.growth.p = import.growth / lag(import.mln_usd) * 100)
grc = grc %>% mutate(import.mln_usd,
                      import.growth = import.mln_usd - lag(import.mln_usd),
                      import.growth.p = import.growth / lag(import.mln_usd) * 100)
usa = usa %>% mutate(export.mln_usd,
                      export.growth = export.mln_usd - lag(export.mln_usd),
                      export.growth.p = export.growth / lag(export.mln_usd) * 100)
deu = deu %>% mutate(export.mln_usd,
                      export.growth = export.mln_usd - lag(export.mln_usd),
                      export.growth.p = export.growth / lag(export.mln_usd) * 100)
grc = grc %>% mutate(export.mln_usd,
                      export.growth = export.mln_usd - lag(export.mln_usd),
                      export.growth.p = export.growth / lag(export.mln_usd) * 100)
usa = usa %>% mutate(gdp.mln_usd,
                      gdp.growth = gdp.mln_usd - lag(gdp.mln_usd),
                      gdp.growth.p = gdp.growth / lag(gdp.mln_usd) * 100)
deu = deu %>% mutate(gdp.mln_usd,
                      gdp.growth = gdp.mln_usd - lag(gdp.mln_usd),
                      gdp.growth.p = gdp.growth / lag(gdp.mln_usd) * 100)
grc = grc %>% mutate(gdp.mln_usd,
                      gdp.growth = gdp.mln_usd - lag(gdp.mln_usd),
                      gdp.growth.p = gdp.growth / lag(gdp.mln_usd) * 100)
usa = usa %>% mutate(gdp.pc.usd_cap,
                      gdp.pc.growth = gdp.pc.usd_cap - lag(gdp.pc.usd_cap),
                      gdp.pc.growth.p = gdp.pc.growth / lag(gdp.pc.usd_cap) * 100)
deu = deu %>% mutate(gdp.pc.usd_cap,
                      gdp.pc.growth = gdp.pc.usd_cap - lag(gdp.pc.usd_cap),
                      gdp.pc.growth.p = gdp.pc.growth / lag(gdp.pc.usd_cap) * 100)
grc = grc %>% mutate(gdp.pc.usd_cap,
                      gdp.pc.growth = gdp.pc.usd_cap - lag(gdp.pc.usd_cap),
                      gdp.pc.growth.p = gdp.pc.growth / lag(gdp.pc.usd_cap) * 100)
# brisemo zadnju opservaciju za deu i grc jer usa nema podatke za 2019.g.
deu = deu[-nrow(deu),]
grc = grc[-nrow(grc),]
```

```
data.all = bind_rows(lapply(c("USA", "DEU", "GRC"), function (x) {
  data.frame(country=x, get(tolower(x)))
}))
data.all$country = factor(data.all$country, levels = c("USA", "DEU", "GRC"))
```

```
summary(usa)
```

```
##       year      export.mln_usd    import.mln_usd     gdp.mln_usd
##  Min.   :1979   Min.   : 347872   Min.   : 366207   Min.   : 2627334
##  1st Qu.:1989   1st Qu.: 591516   1st Qu.: 682910   1st Qu.: 5540294
##  Median :1998   Median :1185694   Median :1459992   Median : 9346740
##  Mean   :1998   Mean   :1206334   Mean   :1503298   Mean   :10103023
##  3rd Qu.:2008   3rd Qu.:1762818   3rd Qu.:2323213   3rd Qu.:14517106
##  Max.   :2018   Max.   :2416053   Max.   :3105836   Max.   :20580223
##
##  gdp.pc.usd_cap    net.trade       import.growth     import.growth.p
##  Min.   :11672   Min.   :-722881   Min.   :-304448   Min.   :-13.084
##  1st Qu.:22445   1st Qu.:-497748   1st Qu.:  31413   1st Qu.:  2.659
```

```
##  Median :33648   Median :-274298   Median :  65420   Median :  5.288
##  Mean   :34815   Mean   :-296964   Mean   :  69577   Mean   :  5.637
##  3rd Qu.:48004   3rd Qu.: -77556   3rd Qu.: 131694   3rd Qu.:  8.672
##  Max.   :62853   Max.   :  19122   Max.   : 265511   Max.   : 24.343
##                                    NA's   :1         NA's   :1
##  export.growth     export.growth.p    gdp.growth       gdp.growth.p
##  Min.   :-154210   Min.   :-8.397   Min.   :-263913   Min.   :-1.794
##  1st Qu.:  25540   1st Qu.: 2.676   1st Qu.: 325520   1st Qu.: 4.095
##  Median :  57629   Median : 6.614   Median : 428677   Median : 5.546
##  Mean   :  53030   Mean   : 5.239   Mean   : 460330   Mean   : 5.447
##  3rd Qu.:  89140   3rd Qu.: 8.829   3rd Qu.: 604764   3rd Qu.: 6.360
##  Max.   : 204211   Max.   :16.212   Max.   :1060799   Max.   :12.240
##  NA's   :1         NA's   :1        NA's   :1         NA's   :1
##  gdp.pc.growth     gdp.pc.growth.p
##  Min.   :-1283.1   Min.   :-2.656
##  1st Qu.:  984.6   1st Qu.: 3.252
##  Median : 1374.7   Median : 4.448
##  Mean   : 1312.3   Mean   : 4.438
##  3rd Qu.: 1665.6   3rd Qu.: 5.186
##  Max.   : 2868.6   Max.   :11.126
##  NA's   :1         NA's   :1
```

```
summary(deu)
```

```
##       year      export.mln_usd    import.mln_usd     gdp.mln_usd
##  Min.   :1979   Min.   : 277599   Min.   : 303002   Min.   : 736116
##  1st Qu.:1989   1st Qu.: 429192   1st Qu.: 413063   1st Qu.:1387158
##  Median :1998   Median : 769614   Median : 748374   Median :2118984
##  Mean   :1998   Mean   : 935370   Mean   : 828751   Mean   :2287035
##  3rd Qu.:2008   3rd Qu.:1466327   3rd Qu.:1216519   3rd Qu.:3039642
##  Max.   :2018   Max.   :2001818   Max.   :1740059   Max.   :4514794
##
##  gdp.pc.usd_cap    net.trade      import.growth     import.growth.p
##  Min.   : 9425   Min.   :-27681   Min.   :-119972   Min.   :-9.695
##  1st Qu.:17661   1st Qu.: 12404   1st Qu.:  12114   1st Qu.: 2.857
##  Median :26021   Median : 35989   Median :  37491   Median : 5.185
##  Mean   :28294   Mean   :106619   Mean   :  36789   Mean   : 4.674
##  3rd Qu.:37734   3rd Qu.:214854   3rd Qu.:  62588   3rd Qu.: 8.020
##  Max.   :54457   Max.   :294551   Max.   : 143844   Max.   :12.871
##                                   NA's   :1         NA's   :1
##  export.growth     export.growth.p     gdp.growth      gdp.growth.p
##  Min.   :-213503   Min.   :-14.280   Min.   :-85755   Min.   :-2.763
##  1st Qu.:  19873   1st Qu.:  2.271   1st Qu.: 59055   1st Qu.: 3.114
##  Median :  40328   Median :  5.661   Median : 79063   Median : 4.481
##  Mean   :  44211   Mean   :  5.343   Mean   : 96889   Mean   : 4.792
##  3rd Qu.:  75638   3rd Qu.:  8.610   3rd Qu.:131475   3rd Qu.: 6.318
##  Max.   : 184671   Max.   : 14.410   Max.   :268773   Max.   :10.569
##  NA's   :1         NA's   :1         NA's   :1        NA's   :1
##  gdp.pc.growth    gdp.pc.growth.p
##  Min.   :-931.3   Min.   :-2.423
##  1st Qu.: 719.1   1st Qu.: 3.090
##  Median : 951.0   Median : 4.379
##  Mean   :1154.7   Mean   : 4.630
##  3rd Qu.:1502.7   3rd Qu.: 6.190
##  Max.   :2880.5   Max.   :10.288
```

```
##  NA's   :1        NA's   :1
```

```
summary(grc)
```

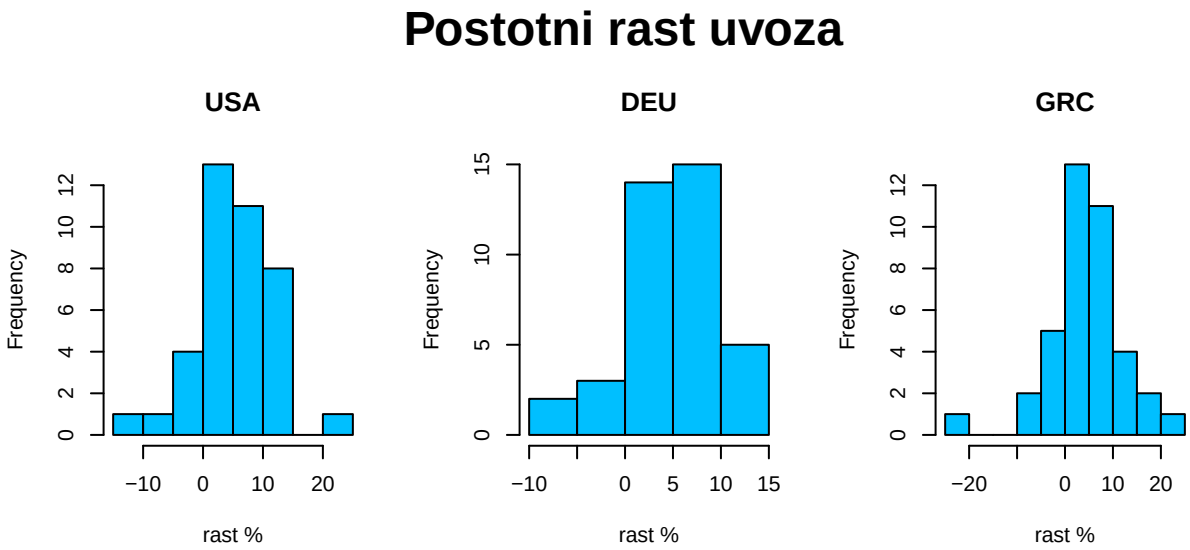
```
##       year      export.mln_usd   import.mln_usd    gdp.mln_usd
##  Min.   :1979   Min.   : 20482   Min.   : 22900   Min.   : 76529
##  1st Qu.:1989   1st Qu.: 28444   1st Qu.: 36651   1st Qu.:128217
##  Median :1998   Median : 51170   Median : 73155   Median :196020
##  Mean   :1998   Mean   : 55043   Mean   : 69218   Mean   :207226
##  3rd Qu.:2008   3rd Qu.: 80753   3rd Qu.: 96276   3rd Qu.:290500
##  Max.   :2018   Max.   :104650   Max.   :137267   Max.   :341818
##
##  gdp.pc.usd_cap    net.trade      import.growth      import.growth.p
##  Min.   : 7933   Min.   :-44429   Min.   :-27939.2   Min.   :-20.3539
##  1st Qu.:12593   1st Qu.:-24665   1st Qu.:   321.2   1st Qu.:  0.5161
##  Median :18249   Median :-12461   Median :  1789.3   Median :  4.4176
##  Mean   :19320   Mean   :-14175   Mean   :  2041.9   Mean   :  4.2218
##  3rd Qu.:26315   3rd Qu.: -3260   3rd Qu.:  4417.3   3rd Qu.:  8.6914
##  Max.   :30856   Max.   :  2114   Max.   : 18180.4   Max.   : 20.1801
##                                   NA's   :1          NA's   :1
##  export.growth      export.growth.p       gdp.growth      gdp.growth.p
##  Min.   :-17447.1   Min.   :-18.51934   Min.   :-24242   Min.   :-7.337
##  1st Qu.:    52.6   1st Qu.:  0.07368   1st Qu.:  3550   1st Qu.: 2.507
##  Median :  1969.5   Median :  4.08448   Median :  6619   Median : 4.241
##  Mean   :  2128.8   Mean   :  4.51601   Mean   :  6391   Mean   : 3.864
##  3rd Qu.:  3815.2   3rd Qu.:  8.54993   3rd Qu.: 11152   3rd Qu.: 6.377
##  Max.   : 12587.3   Max.   : 24.44487   Max.   : 33214   Max.   :11.819
##  NA's   :1          NA's   :1           NA's   :1        NA's   :1
##  gdp.pc.growth     gdp.pc.growth.p
##  Min.   :-2219.0   Min.   :-7.302
##  1st Qu.:  276.5   1st Qu.: 2.225
##  Median :  689.4   Median : 4.321
##  Mean   :  574.9   Mean   : 3.573
##  3rd Qu.:  975.0   3rd Qu.: 5.713
##  Max.   : 2937.2   Max.   :11.483
##  NA's   :1         NA's   :1
```

Uvoz

Uvozi u mil. USD razlikuju se jako čak i na logaritamskoj skali. Veličine su razmjerne površini države te broju stanovnika. Za distribucije ukupnog uvoza ne možemo pretpostaviti normalnost, pa nema smisla raditi parametarske testove.

Distribucije postotnog rasta izgledaju normalnije pa ćemo njih uzeti za analizu. Dalje ćemo za postotni rast govoriti samo rast.

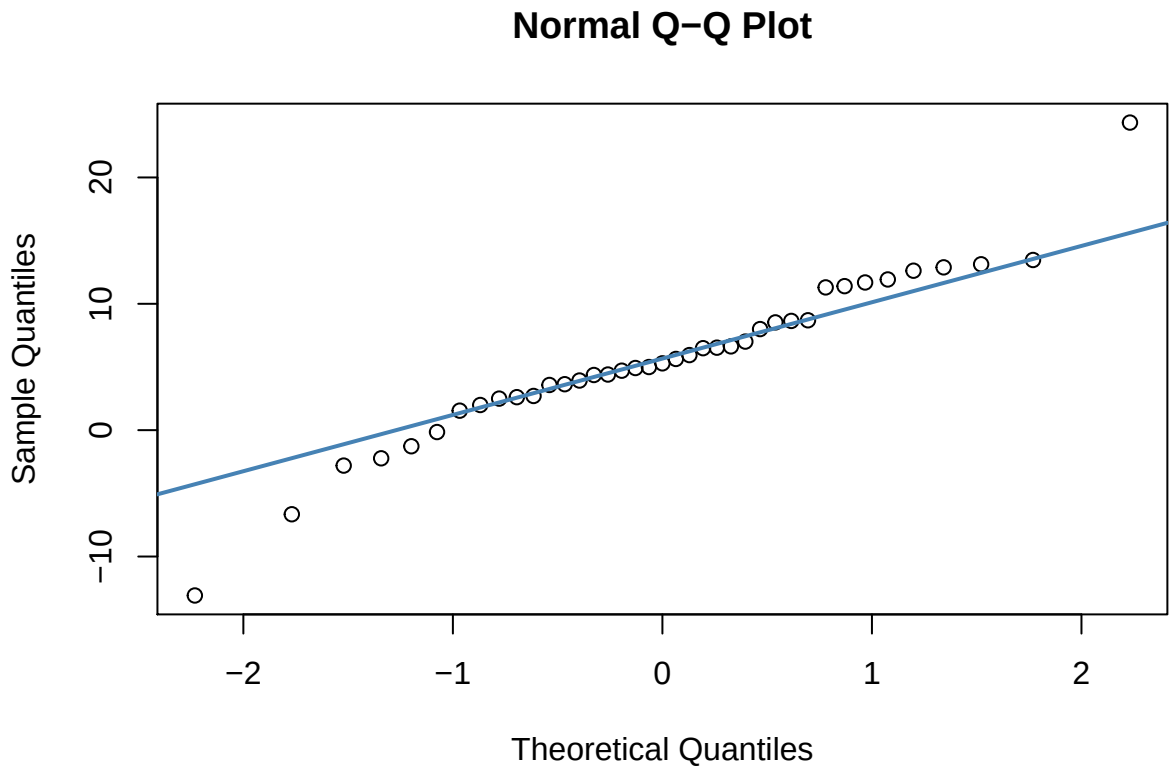
```
par(mfrow = c(1, 3), oma = c(0, 0, 2, 0))
hist(usa$import.growth.p, main="USA", xlab="rast %", col="deepskyblue")
hist(deu$import.growth.p, main="DEU", xlab="rast %", col="deepskyblue")
hist(grc$import.growth.p, main="GRC", xlab="rast %", col="deepskyblue")
mtext("Postotni rast uvoza", outer = T, cex = 1.5, font = 2)
```



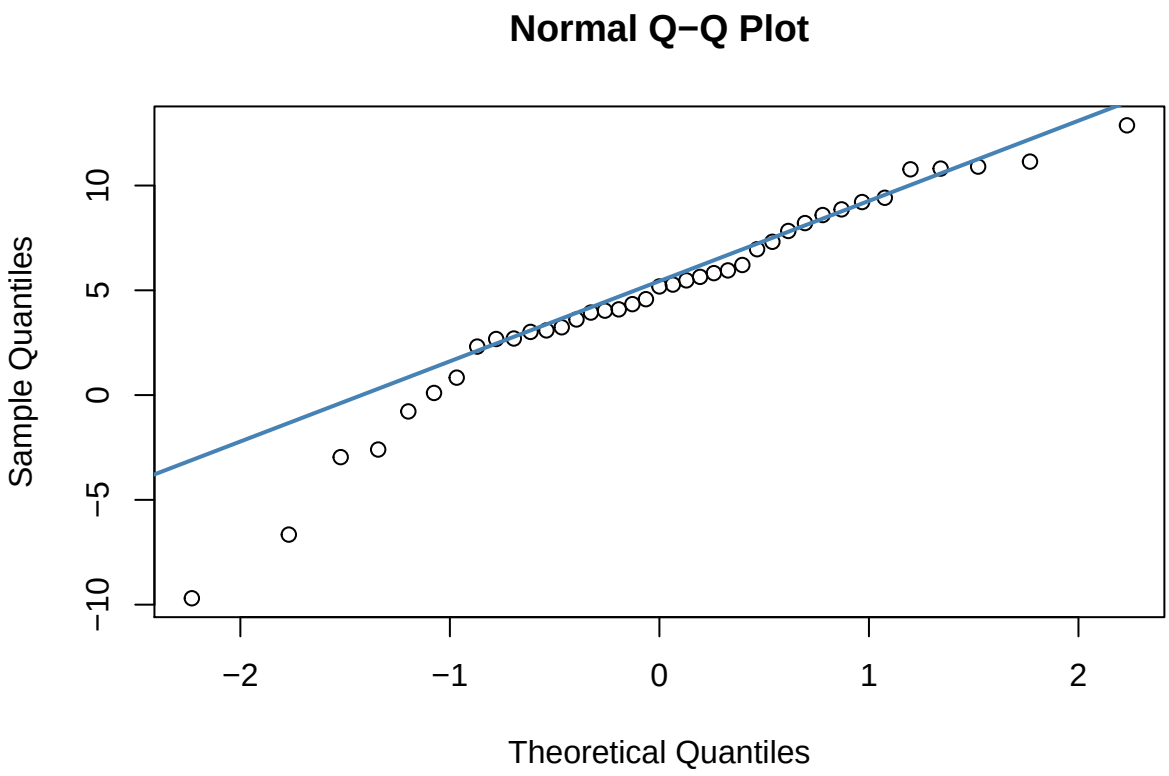
Distribucije nisu previše zakrivljene i imamo dovoljno podataka da možemo pretpostaviti normalnost distribucije.

Taj zaključak potvrđuju i qq plotovi.

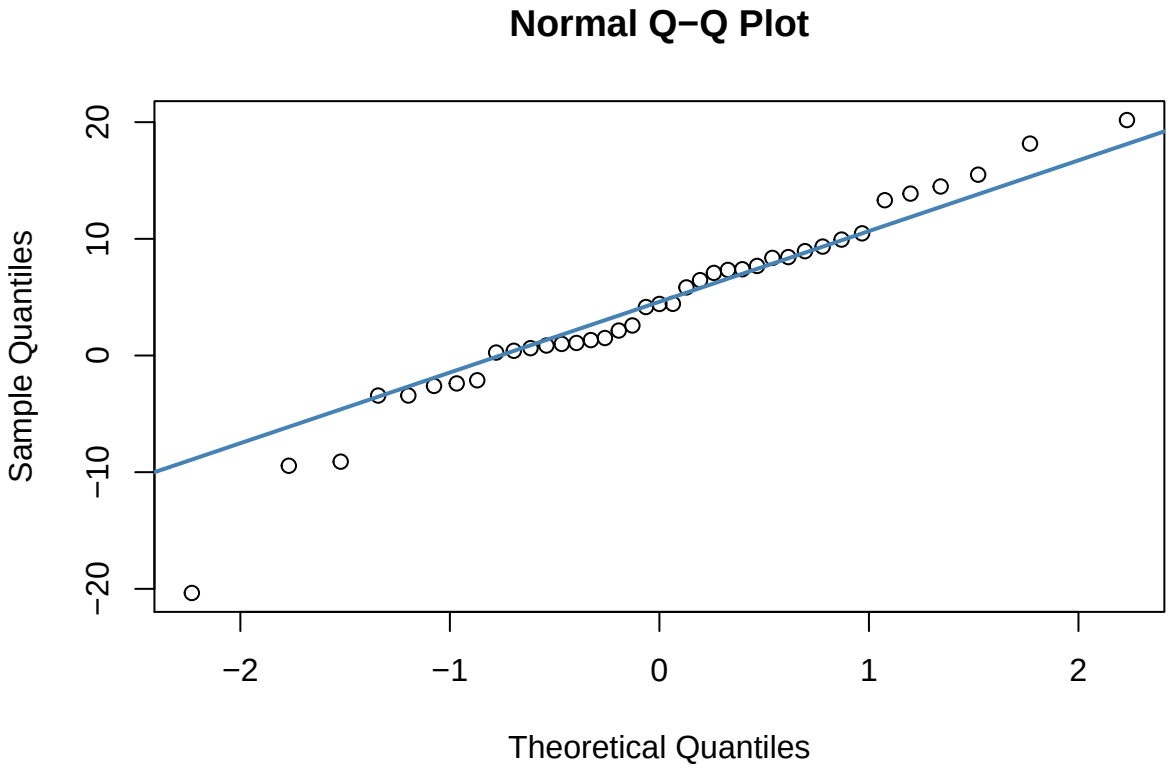
```
qqnorm(usa$import.growth.p)
qqline(usa$import.growth.p, col = "steelblue", lwd = 2)
```




```
qqnorm(deu$import.growth.p)
qqline(deu$import.growth.p, col = "steelblue", lwd = 2)
```

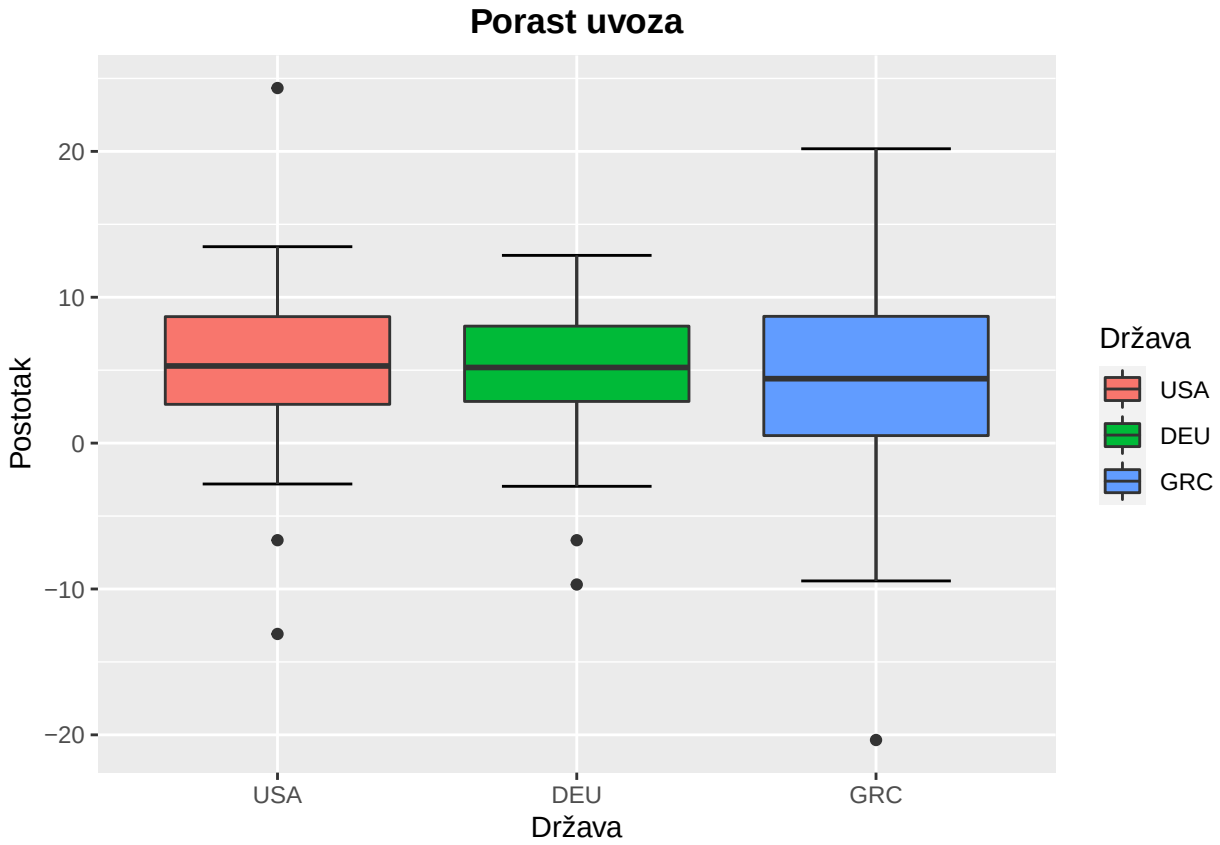



```
qqnorm(grc$import.growth.p)
qqline(grc$import.growth.p, col = "steelblue", lwd = 2)
```



Odstupanja na krajevima qq plota nam sugeriraju da bi distribucije mogle imati teške repove.

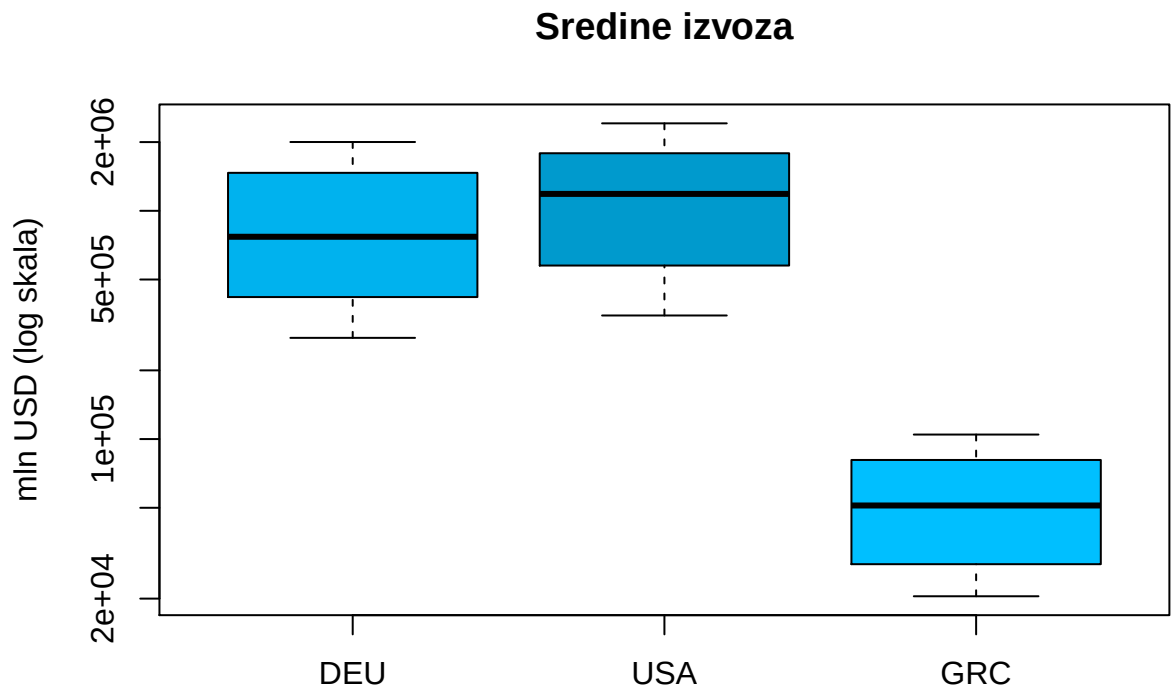
```r
ggplot(na.omit(data.all), aes(x=country, y=import.growth.p)) +
  stat_boxplot(geom = "errorbar", width = 0.5) +
  geom_boxplot(aes(fill=country)) +
  labs(title = "Porast uvoza", x = "Država", y = "Postotak", fill = "Država") +
  theme(plot.title = element_text(hjust = 0.5, face = "bold"))
```



Ovaj plot pokazuje da bi varijable USA i DEU mogle imati istu sredinu.

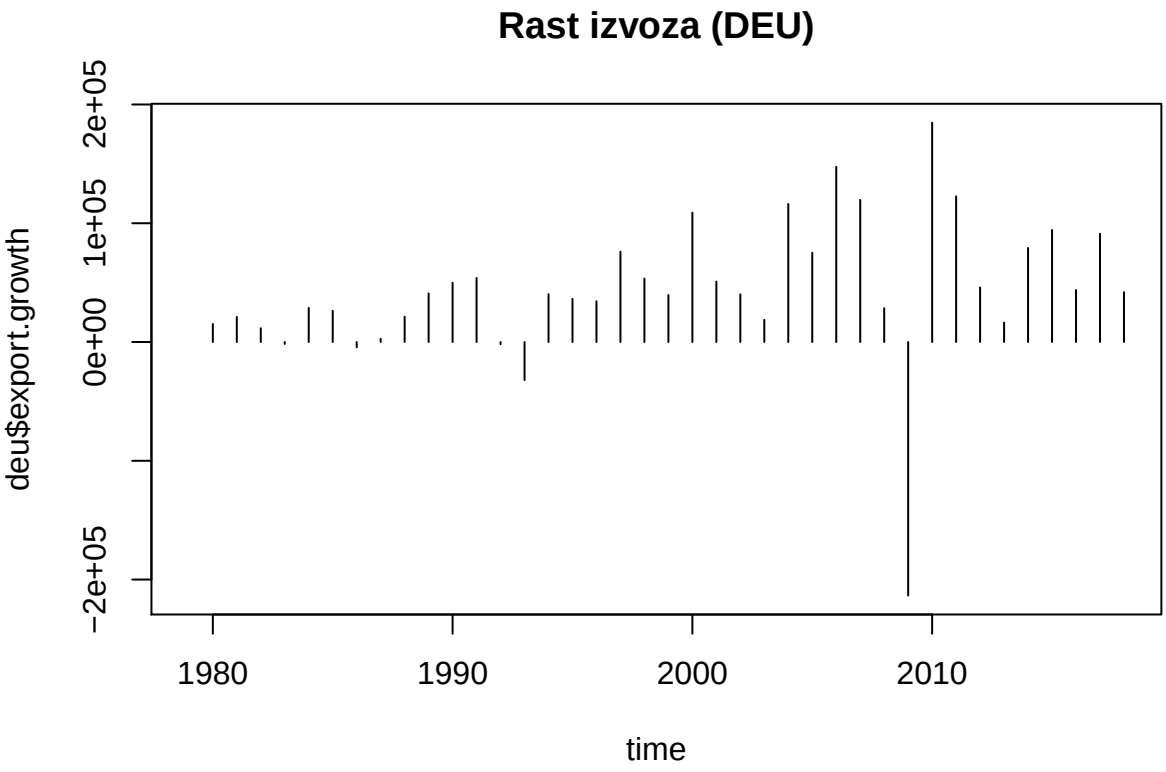
Izvoz

```r
boxplot(deu$export.mln_usd,
        usa$export.mln_usd,
        grc$export.mln_usd,
        names = c("DEU", "USA", "GRC"), main = "Sredine izvoza",
        col = c("deepskyblue2", "deepskyblue3", "deepskyblue"),
        ylab = "mln USD (log skala)",
        log = "y")
```



Podaci su slični kao i kod uvoza, SAD prednjači i u izvozu u odnosu na Njemačku i Grčku.

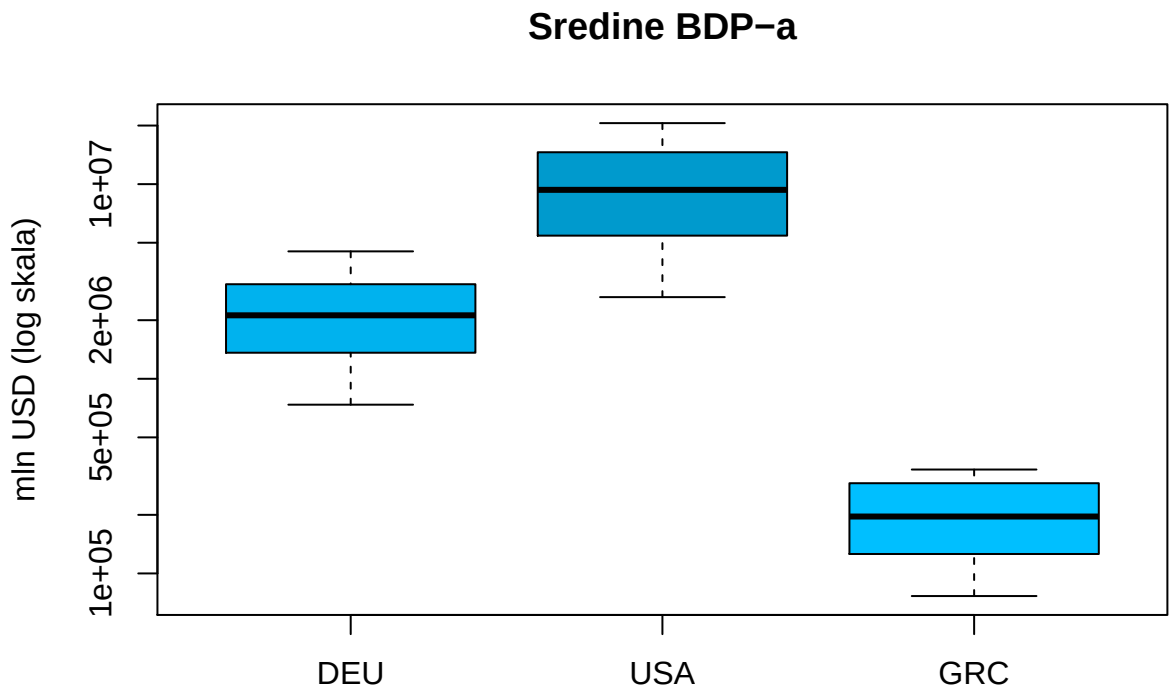
```
plot(time, deu$export.growth, type = "h", main = "Rast izvoza (DEU)")
```



Za razliku od uvoza koji linearno raste, izvoz više "osjeća" promjene na tržištu (veće fluktuacije), npr. značajan pad izvoza 2009. godine zbog tadašnje svjetske gospodarske krize.

```
boxplot(deu$gdp.mln_usd,
        usa$gdp.mln_usd,
```

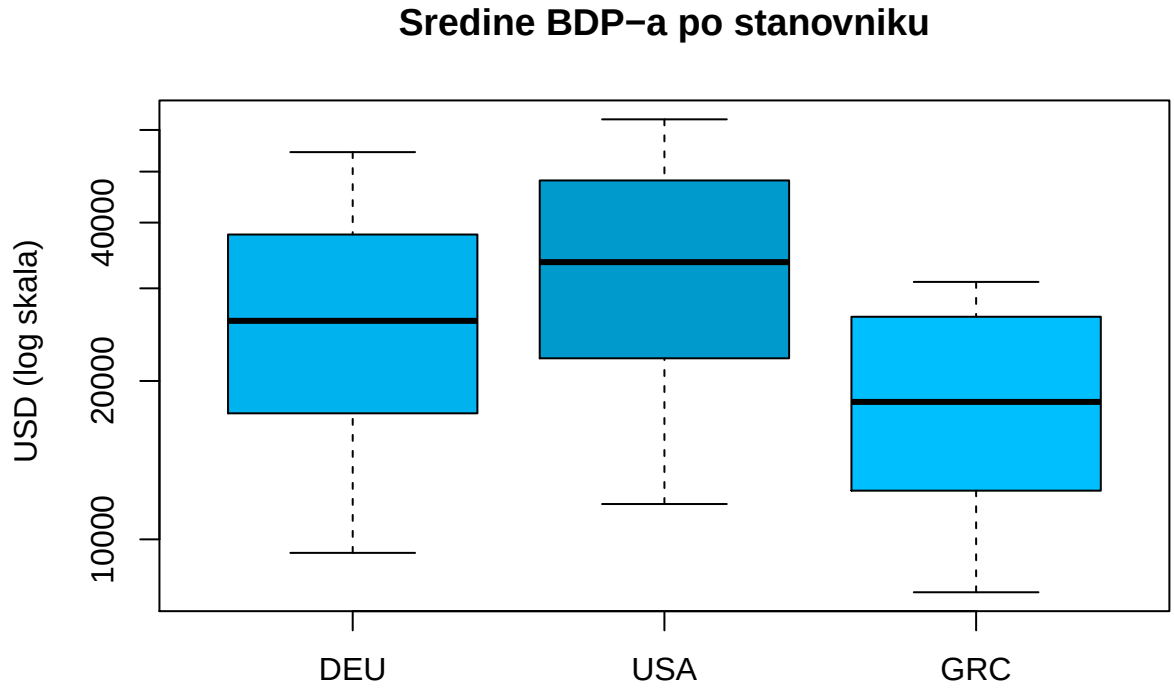
```
        grc$gdp.mln_usd,
        names = c("DEU", "USA", "GRC"), main = "Sredine BDP-a",
        col = c("deepskyblue2", "deepskyblue3", "deepskyblue"),
        ylab = "mln USD (log skala)",
        log = "y")
```



BDP

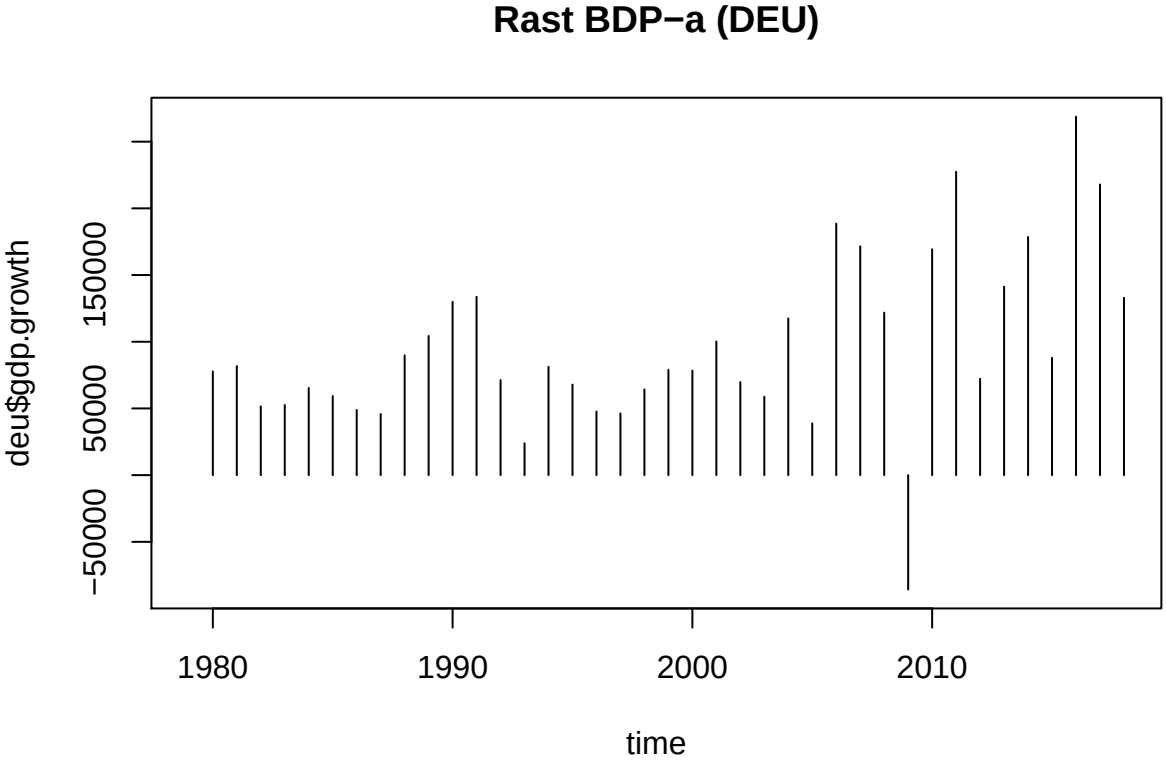
Kao i kod uvoza i izvoza, po čistom BDP-u SAD značajno prednjači, dok je razlika između Njemačke i Grčke veća od one između SAD-a i Njemačke. No, ovaj prikaz možda nije mjerodavan što se tiče razvijenosti. Treba pogledati BDP po stanovniku:

```
boxplot(deu$gdp.pc.usd_cap,
        usa$gdp.pc.usd_cap,
        grc$gdp.pc.usd_cap,
        names = c("DEU", "USA", "GRC"), main = "Sredine BDP-a po stanovniku",
        col = c("deepskyblue2", "deepskyblue3", "deepskyblue"),
        ylab = " USD (log skala)",
        log = "y")
```



Na prikazu BDP-a po stanovniku podaci su normaliziralni brojem stanovnika, razlike nisu toliko značajne, no SAD i dalje prednjači.

```
plot(time, deu$gdp.growth, type = "h", main = "Rast BDP-a (DEU)")
```

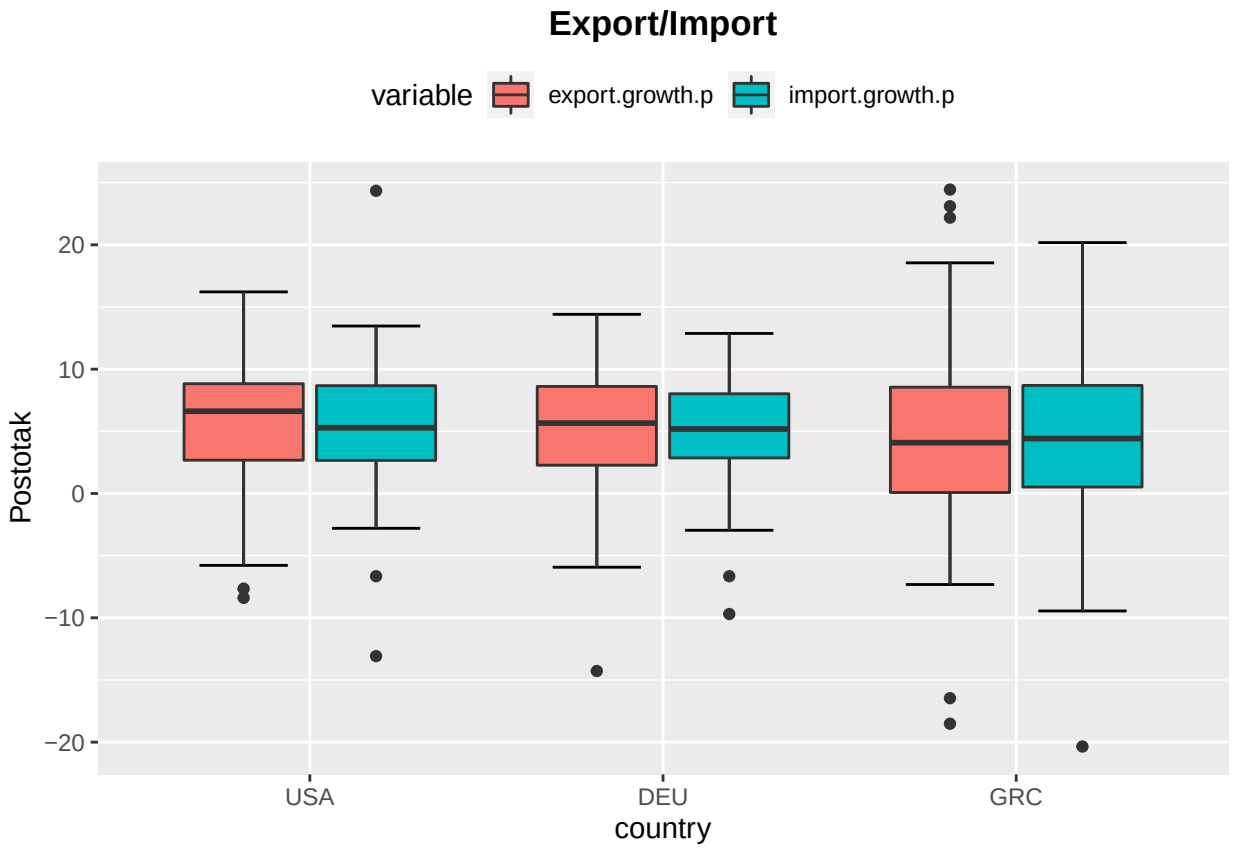


BDP Njemačke je u stalnom porastu uz fluktuacije, a jedini pad BDP-a koji primjećujemo vezan je uz gospodarsku krizu 2009. godine, kada primjećujemo i značajne padove u uvozu i izvozu. Rast BDP-a po stanovniku bit će proporcionalan.

Testiranje hipoteza

Pretpostavka: Rast izvoza značajno je veći od rasta uvoza za neku državu

```
exp.imp = melt(data.all, id.vars = "country",
               measure.vars = c("export.growth.p", "import.growth.p"), na.rm = T)
ggplot(exp.imp, aes(x = country, y = value, fill = variable)) +
  stat_boxplot(geom = "errorbar", width = 0.5, position = position_dodge(0.75)) +
  geom_boxplot() +
  labs(title = "Export/Import", y="Postotak") +
  theme(plot.title = element_text(hjust = 0.5, face = "bold"), legend.position = "top")
```



Pogledom na gornji boxplot čini se da se uvoz i izvoz za neku državu ne razlikuju previše. Jedinu značajniju razliku vidimo za USA. Provjerit ćemo je li to statistički značajno pomoću t-testa.

Prvo ćemo provjeriti jednakost varijanci, ako su jednake moći ćemo koristiti inačicu t-testa sa većom snagom. Jednakost varijanci provjeravamo F-testom uz razinu značajnosti $\alpha = 0.05$. Za F-test postavljamo sljedeće hipoteze:

$$H_0 : \text{Omjer varijanci} = 1$$
$$H_1 : \text{Omjer varijanci} \neq 1$$

```
var.test(usa$export.growth.p, usa$import.growth.p, alternative = "two.sided",
         na.action = na.omit)
```

```
##
```

```
##  F test to compare two variances
##
## data:  usa$export.growth.p and usa$import.growth.p
## F = 0.74877, num df = 38, denom df = 38, p-value = 0.3765
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3926431 1.4279106
## sample estimates:
## ratio of variances
##          0.7487718
```

P vrijednost testa jednakosti varijanci je veća od razine značajnosti, te pokazuje da se podaci više priklanjaju hipotezi H_0, koju ne odbacujemo.

Uz pretpostavku jednakosti varijanci postavit ćemo hipoteze za t-test jednakosti sredina:

$$H_0 : \mu_{izvoz} = \mu_{uvoz}$$
$$H_1 : \mu_{izvoz} > \mu_{uvoz}$$

Razina značajnosti $\alpha = 0.05$.

```
t.test(usa$export.growth.p, usa$import.growth.p, alternative = "greater", var.equal = TRUE,
       na.action = na.omit)
```

```
##
##  Two Sample t-test
##
## data:  usa$export.growth.p and usa$import.growth.p
## t = -0.29578, df = 76, p-value = 0.6159
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
##  -2.640559       Inf
## sample estimates:
## mean of x mean of y
##  5.238851  5.637139
```

Dobivena p vrijednost testa je veća od razine značajnosti, te ne možemo odbaciti H_0.

Zaključak: Uz dane podatke pretpostavka nije ispunjena, tj. ne možemo pokazati da se rast izvoza neke države značajno razlikuje od rasta uvoza.