Data Analysis Home Assignment 3

Vector Autoregressions

Data

The subject of the analysis is the regression between Mexican GDP and USD-MXN exchange rate.

The daily exchange rate (USD/MXN) was downloaded from website[1] of the central bank of Mexico, Banco de México on February 10, 2016. According to the "Exchange Rate Regimes in Mexico since 1954" paper by Banco de México, different regimes have been used to determine Mexico's exchange rate. This analysis uses exchange rates determined by the free market without the intervention of the authorities (from December 22, 1994).

The quarterly GDP was downloaded from OECD National Accounts data files[2] on February 10, 2016. The GDP is based on output approach given in million Mexican pesos (current prices and volume estimates).

Cleaning and Transformation

The daily exchange rate was transformed to quarterly using the last exchange rate within the quarter.

According to the Phillips-Perron test, the GDP has no unit root but Rate has. In order to test causality both time series are transformed to quarter-on-quarter differences.

		Original Data	Quarter-on-Quarter Difference	Year-on-Year Difference
GDP	Dickey-Fuller	-5.7935	-9.9673	-3.1286
	p-value	0.01	0.01	0.1141
Rate	Dickey-Fuller	-3.3798	-9.0014	-3.9513
	p-value	0.06	0.01	0.0162

[1] http://www.banxico.org.mx/
[2] https://stats.oecd.org/i

Dynamic Lag Analysis

Standard linear regression analysis was executed using the following model:

$$E[\Delta lnGDP_t|\Delta lnRate_t] = \alpha + \sum_{l=0}^{8} \gamma_i \Delta lnRate_{t-i}$$

The table below summarises the coefficients and their Newey-West standard errors. It shows that 4th, 6th, and 8th lags has significant relationship with GDP.

	Coefficients	***Newey-West SE***
(Intercept)	0.0176	0.0020
ΔlnRate	0.0582	0.0645
ΔlnRate (L1)	-0.0353	0.0968
ΔlnRate (L2)	0.0359	0.0601
ΔlnRate (L3)	-0.0202	0.0527
ΔlnRate (L4)	0.1620	0.0495
ΔlnRate (L5)	0.0219	0.0496
ΔlnRate (L6)	0.1397	0.0442
ΔlnRate (L7)	-0.0165	0.0398
ΔlnRate (L8)	0.1870	0.0408

Standard linear regression analysis was executed using the cumulative association model:

$$E[\Delta lnGDP_t|\Delta lnRate_t] = \alpha + \beta \Delta lnRate_{t-N} + \sum_{l=0}^{N-1} \gamma_i \Delta\Delta lnRate_{t-i}$$

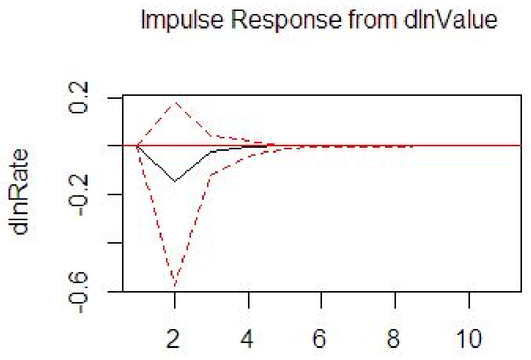
where N is the last lag within the cumulative association. The table belows shows no significant cumulative coefficient up to the lag of 8.

	Lag (1)	***Lag (4)***	***Lag (6)***	***Lag (8)***
Intercept	0.0253	0.0226	0.0206	0.0176
Newey-West SE	0.0028	0.0028	0.0026	0.0020
Cumulative	0.1026	0.1733	0.3017	0.5327
Newey-West SE	0.1721	0.2368	0.2342	0.2831
Contemporaneous	0.0962	0.0612	0.0707	0.0582
Newey-West SE	0.0818	0.0756	0.0721	0.0645

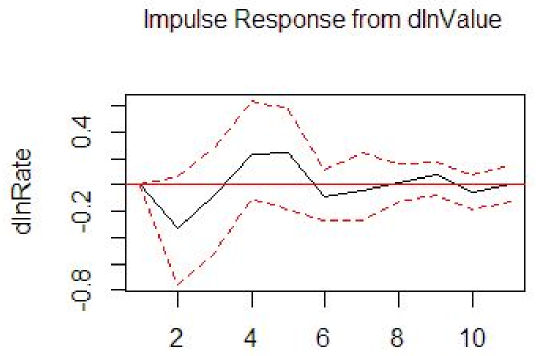
Vector Autoregression

Impulse response functions were calculated both for lag = 1 and lag = 4 cases. However, three methods in dynamic lag analysis shows four lags as optimal approach in our dataset it brings suspicious results:

Lag=1, CI=95%



Lag=4, CI=95%



It seems that that the insufficient number of observations cause less precise model.

According to the findings, after 2 quarters of 1% increase in GDP, the exchange rate is decreased by 0.2% in 1995-2015 period. Practically, no further effect can be detected.

Considering GDP changes, after 2 quarters of 10% increase in exchange rate, GDP is decreased by 0.05% in 1995-2015 period. Practically, no further effect can be detected.

Feedbacks in VAR

Feedback cannot be shown as the exchange rate changes have very low impact on GDP changes. Of course, in economic point of view it is logical to assume that exchange rate has effect on the bilateral trading, but more information should be taken into account to go into deeper analysis (e.g: structure of import-export volumes and values between the two countries).

Granger Causality

There is no evidence for Granger causality. Granger causality tests show that null hypothesis of logdiff GDP does not cause logdiff Exchange rate, or logdiff Exchange rate does not cause logdiff GDP cannot be rejected.

Granger causality H0: *dlnValue* do not Granger-cause *dlnRate*
data: VAR object var1
F-Test = 0.55864, df1 = 1, df2 = 156, p-value = 0.4559

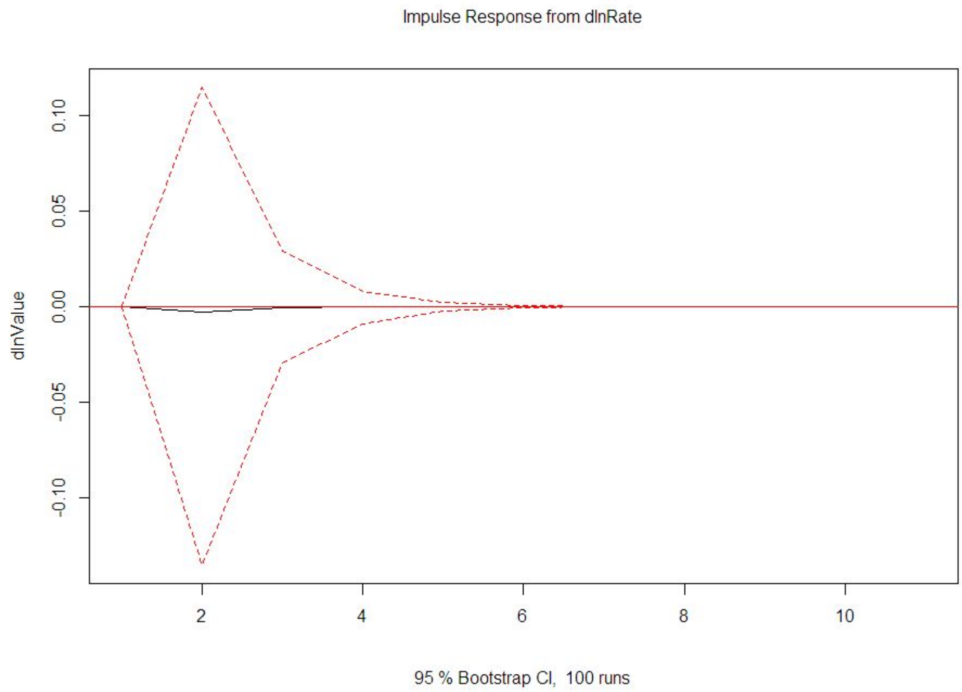
Granger causality H0: *dlnRate* do not Granger-cause *dlnValue*

data: VAR object var1
F-Test = 0.0023171, df1 = 1, df2 = 156, p-value = 0.9617

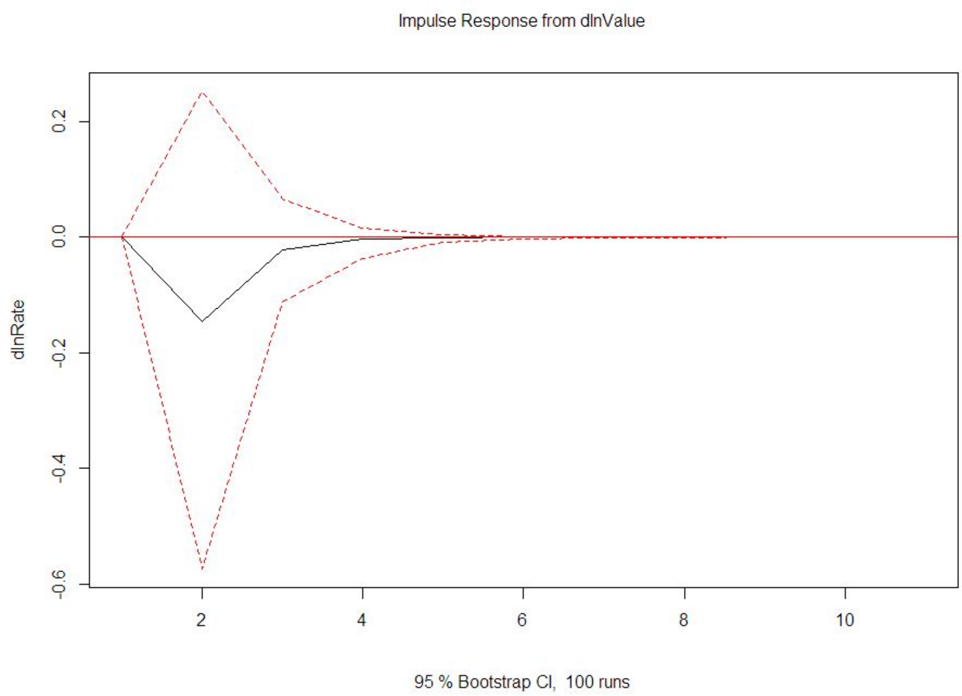
Appendix

Impulse Response Functions

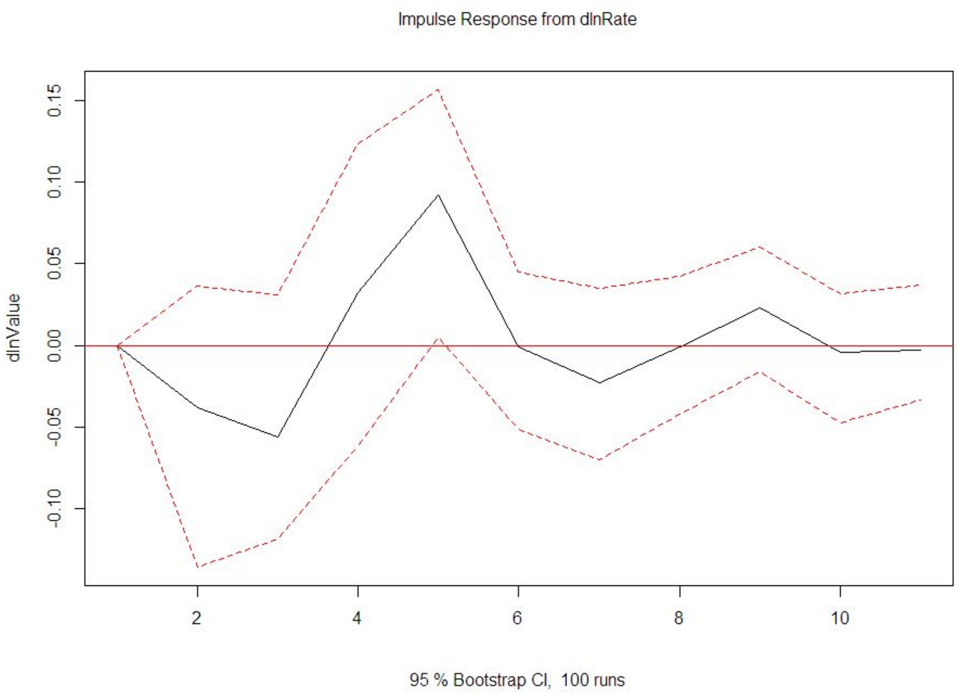
Value on Rate with VAR(1)



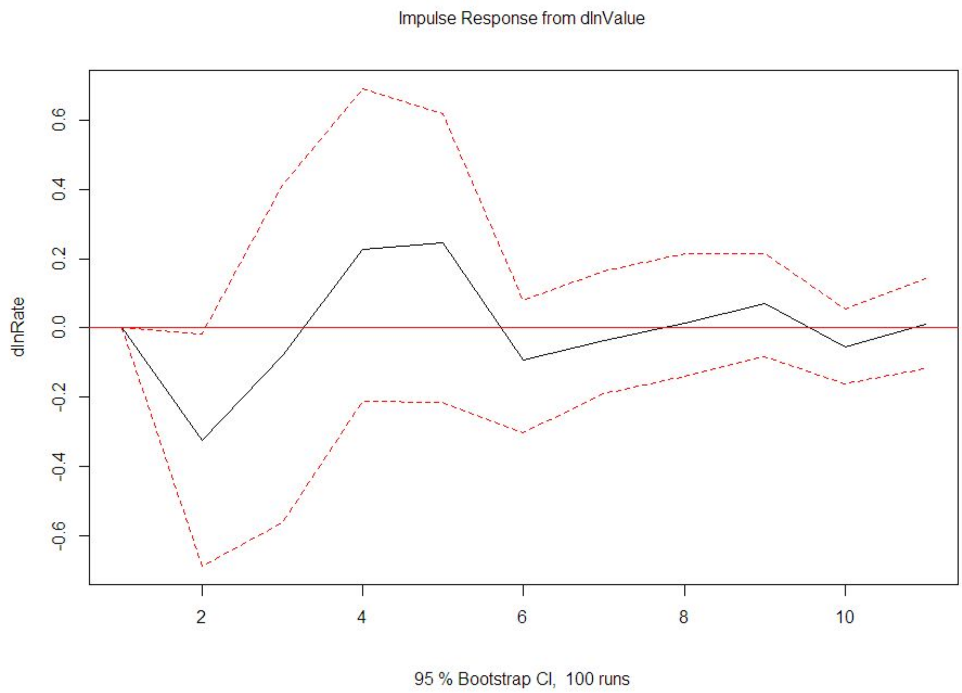
Rate on Value with VAR(1)



Value on Rate with VAR(4)



Rate on Value with VAR(4)



Code

```
library(XML)
library(data.table)
library(xts)
library(vars)
library(forecast)

diff(shift(1:10, type = "lag"))

#### Functions
explore.ts <- function(ts, lag = 0, difference = 0, title) {
  if (lag > 0) {
    ts <- diff(x = ts, lag = lag, differences = difference)
  }
  print(PP.test(ts))
  fit <- stl(usd_mxn_quarter, t.window=4, s.window="periodic", robust=TRUE)
  plot(fit,  main = title)
  plot(usd_mxn_quarter, col="gray", main = title)
  lines(fit$time.series[,2],col="red", ylab="Trend", main = title)
  monthplot(fit$time.series[,"seasonal"], main="", ylab=title)
  plot(forecast(fit, method="naive"), main = title)
  Acf(ts, main = title)
  Pacf(ts, main = title)
}

#### Data ####
#### USD/MXN Exchnage Rate ####
usd_mxn <- read.csv("usdmxn.csv", stringsAsFactors = FALSE, strip.white=TRUE)
setDT(usd_mxn)
str(usd_mxn)
summary(usd_mxn)
# Cleaning and transformation
usd_mxn[, Date := as.Date(usd_mxn$Date, "%m/%d/%Y")]
usd_mxn <- usd_mxn[Date >= as.Date("1995-01-01") & Date < as.Date("2015-09-01")]
usd_mxn[, lnRate := log(Rate)]
usd_mxn[, Year := as.numeric(format(usd_mxn$Date,'%Y'))]
usd_mxn[, Quarter := as.yearqtr(Date)]
usd_mxn[, Year_Close_Date := max(Date), by = Year]
usd_mxn[, Quarter_Close_Date := max(Date), by = Quarter]
usd_mxn[, Year_Close := Date == Year_Close_Date]
usd_mxn[, Quarter_Close := Date == Quarter_Close_Date]
summary(usd_mxn)

# Time series
usd_mxn_quarter <- ts(usd_mxn[Quarter_Close == TRUE]$lnRate, start = c(1995, 1), frequency
= 4)
for (lag in c(0, 1, 2, 4)) {
  title <- paste("% Exchange Rate of USD/MXN (Δ on ", lag ,")", sep = "")
  print(title)
  explore.ts(usd_mxn_quarter, lag = lag, difference = 1, title = title)
}

#### GDP (Quarterly) ####
oecd <- read.csv("oecd_mexico.csv", stringsAsFactors = FALSE, strip.white=TRUE)
setDT(oecd)
str(oecd)
summary(oecd)
oecd <- oecd[LOCATION == "MEX" & SUBJECT == "B1_GA" & MEASURE == "CQR" & FREQUENCY == "Q",
.(TIME, Unit, Unit.Code,  PowerCode, PowerCode.Code, Value)]
oecd[, TIME := as.yearqtr(TIME, format = "%Y-Q%q")]
```

```
oecd[, lnValue := log(Value)]
oecd <- oecd[as.Date(TIME) >= as.Date("1995-01-01")]
str(oecd)
summary(oecd)
# Time series
oecd_quarter <- ts(oecd$lnValue, start = c(1995, 1), frequency = 4)
for (lag in c(0, 1, 2, 4)) {
  title <- paste("% GDP (Δ on ", lag ,")", sep = "")
  print(title)
  explore.ts(oecd_quarter, lag = lag, difference = 1, title = title)
}

#### Dynamic Lag Analysis ####
data <- merge(usd_mxn[Quarter_Close == TRUE, .(Quarter, lnRate)], oecd[, .(TIME, lnValue)],
by.x = "Quarter", by.y = "TIME")
data[, lnRate.Diff := lnRate - shift(lnRate, n=1, fill=NA, type="lag")]
data[, lnValue.Diff := lnValue - shift(lnValue, n=1, fill=NA, type="lag")]
data[, lnRate.Diff.Diff := lnRate.Diff - shift(lnRate.Diff, n=1, fill=NA, type="lag")]
data[, lnValue.Diff.Diff := lnValue.Diff - shift(lnValue.Diff, n=1, fill=NA, type="lag")]


lag.max <- 8
# Standard
summary <- data.table(i = 1:(lag.max + 2))
formula <- "lnValue.Diff ~ lnRate.Diff"
for (lag in 1:lag.max) {
  formula <- paste(formula, " + shift(lnRate.Diff, n = ", lag, ", fill=NA, type='lag')",
sep = "")
}
fit <- lm(as.formula(formula), data = data)
Coefficients <- data.table(i = 1:(lag + 2), Coefficients =
data.frame(summary(fit)["coefficients"])[,1])
NeweyWest.SE <- data.table(i = 1:(lag + 2), NeweyWest.SE = sqrt(diag(NeweyWest(fit, lag =
lag))))
s <- merge(Coefficients, NeweyWest.SE, by = "i")
colnames(s) <- c("i", paste("Coefficients (", lag, ")", sep = ""), paste("NeweyWest SE (",
lag, ")", sep = ""))
summary <- merge(summary, s, by = "i", all.y  = TRUE)
rownames(summary) <- rownames(data.frame(summary(fit)["coefficients"]))
summary
write.csv(summary, "lags.csv")

# Commulative
summary <- data.table(i = 1:(lag.max + 2))
for (lag in 1:lag.max) {
  formula <- paste(" lnValue.Diff ~  shift(lnRate.Diff, n = ", lag, ", fill=NA,
type='lag')", sep = "")
  for (l in 0:(lag - 1)) {
    formula <- paste(formula, " + shift(lnRate.Diff.Diff, n = ", l, ", fill=NA,
type='lag')", sep = "")
  }
  print(formula)
  fit <- lm(as.formula(formula), data = data)
  s <- cbind(i = 1:(lag + 2), Coefficients = data.frame(summary(fit)["coefficients"])[,1],
NeweyWest.SE = sqrt(diag(NeweyWest(fit, lag = lag))))
  colnames(s) <- c("i", paste("Coefficients (", lag, ")", sep = ""), paste("NeweyWest SE
(", lag, ")", sep = ""))
  summary <- merge(summary, s, by = "i", all.y  = TRUE)
}
rownames(summary)[1:3] <- c("Intercept", "Cumulative", "Contemporaneous")
summary
write.csv(summary, "dynamic.lags.csv")
```

```
#### Vector Autoregression ####
data <- merge(usd_mxn[Quarter_Close == TRUE, .(Quarter, lnRate)], oecd[, .(TIME, lnValue)],
by.x = "Quarter", by.y = "TIME")
timeseries <- ts(data[, .(lnRate, lnValue)], start = c(1995, 1), frequency = 4)
plot(timeseries)
plot(diff(timeseries))
VARselect(diff(timeseries), lag.max=16, type="const")$selection
var <- VAR(diff(timeseries), p=1, type="const")
serial.test(var, lags.pt=1, type="PT.asymptotic")
summary(var)
fcst <- forecast(var)
plot(fcst, xlab="Year")

#### IRF ####
plot(irf(var, impulse = 'lnRate', response = 'lnValue', ortho = FALSE))
plot(irf(var, impulse = 'lnValue', response = 'lnRate', ortho = FALSE))
gdp_var_rate <- data[, .(dlnRate = diff(lnRate), dlnValue = diff(lnValue))]

# lag1
var1 <- VAR(gdp_var_rate, p = 1)
plot(irf(var1, impulse = 'dlnRate', response = 'dlnValue', ortho = FALSE))
plot(irf(var1, impulse = 'dlnValue', response = 'dlnRate', ortho = FALSE))

#lag4
var4 <- VAR(gdp_var_rate, p = 4)
plot(irf(var4, impulse = 'dlnRate', response = 'dlnValue', ortho = FALSE))
plot(irf(var4, impulse = 'dlnValue', response = 'dlnRate', ortho = FALSE))

causality(var1, cause = "dlnRate")
```