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

Ordinary linear regression analysis was executed using the following model with the N equals to 1, 4, 6, and 8.

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

	Lag (1)	Lag (4)	Lag (6)	Lag (8)
(Intercept)	0.0253	0.0226	0.0206	0.0176
Newey-West s.e	0.0028	0.0028	0.0026	0.0020
ΔlnRate	0.0962	0.0612	0.0707	0.0582
Newey-West s.e	*0.0818*	*0.0756*	*0.0721*	*0.0645*
ΔlnRate (L1)	0.0065	-0.0481	-0.0387	-0.0353
Newey-West s.e	*0.1043*	*0.1031*	*0.0945*	*0.0968*
ΔlnRate (L2)	NA	0.0266	0.0123	0.0359
Newey-West s.e	*NA*	*0.0599*	*0.0575*	*0.0601*
ΔlnRate (L3)	NA	-0.0034	-0.0191	-0.0202
Newey-West s.e	*NA*	*0.0422*	*0.0458*	*0.0527*
ΔlnRate (L4)	NA	0.1369	0.1699	0.1620
Newey-West s.e	*NA*	*0.0636*	*0.0423*	*0.0496*
ΔlnRate (L6)	NA	NA	0.0647	0.1397
Newey-West s.e	*NA*	*NA*	*0.0518*	*0.0398*
ΔlnRate (L2)	NA	NA	NA	0.1870
Newey-West s.e	*NA*	*NA*	*NA*	*0.0408*

Ordinary linear regression analysis was executed using the cumulative association model with the N equals to 1, 4, 6, and 8.

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

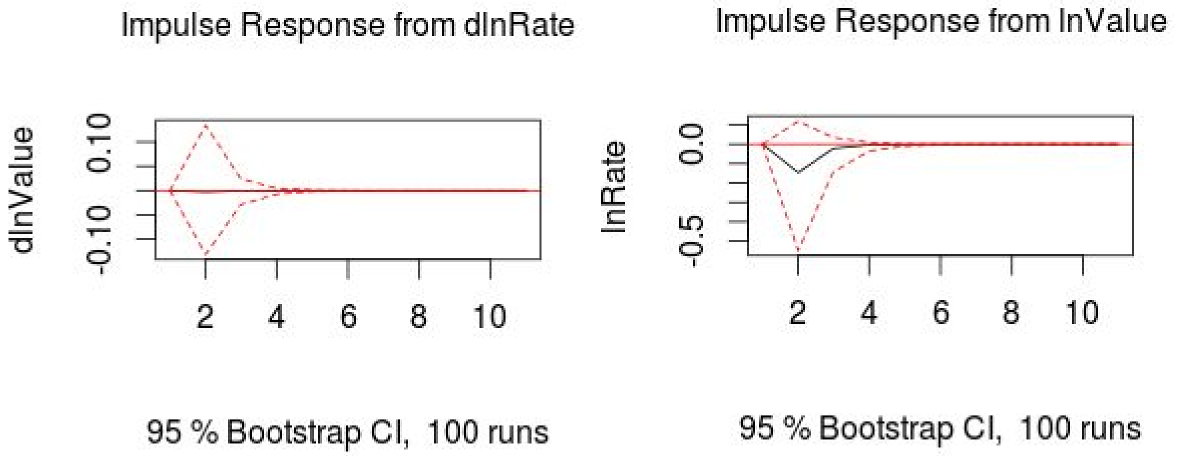
	Lag (1)	Lag (4)	Lag (6)	Lag (8)
Intercept	0.0253	0.0226	0.0206	0.0176
Newey-West s.e	*0.0028*	*0.0028*	*0.0026*	*0.0020*
Cumulative	0.1026	0.1733	0.3017	0.5327
Newey-West s.e	*0.1721*	*0.2368*	*0.2342*	*0.2831*

Although the first model shows some significant coefficients towards GDP (i.e. model (8) at lags 4, 6, and 8), it most probably due to seasonality, because the cumulative association model does indicate any relationship between exchange rate and currency up to using 8 lags. The result is correspondent with the Impulse response functions shown within the next chapter.

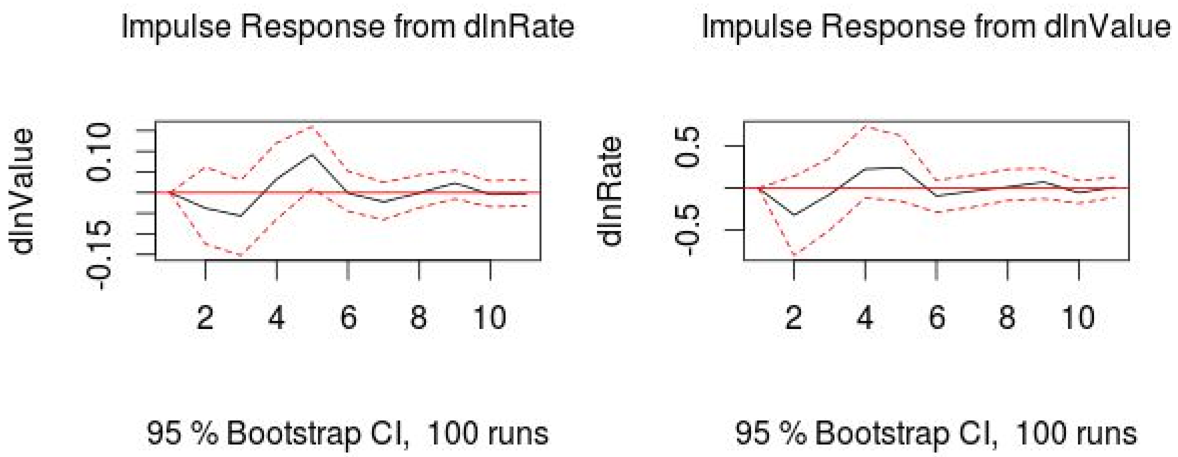
Vector Autoregression

Impulse response functions were calculated both for 1 lags and 4 lags. Because one automated dynamic lag analysis method (SC) suggested 1 lag, but three others (AIC, HQ, FPE) suggested to use 4 lags.

VAR(1)



VAR(4)



Feedbacks in VAR

Feedback cannot be shown as the exchange rate changes have very low (practically none) 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). The result is correspondent with dynamic lag analysis within the previous chapter, and with the Granger causality test within the next chapter.

Granger Causality

There is no evidence for Granger causality. Granger causality tests show that null hypothesis of difference in GDP (%) does not cause difference in exchange rate (%), or vica-versa.

Hypothesis: Difference in exchange rate (%) does not Granger-cause difference in GDP (%)
Result: F-Test = 1.9967, df1 = 4, df2 = 138, p-value = 0.0984

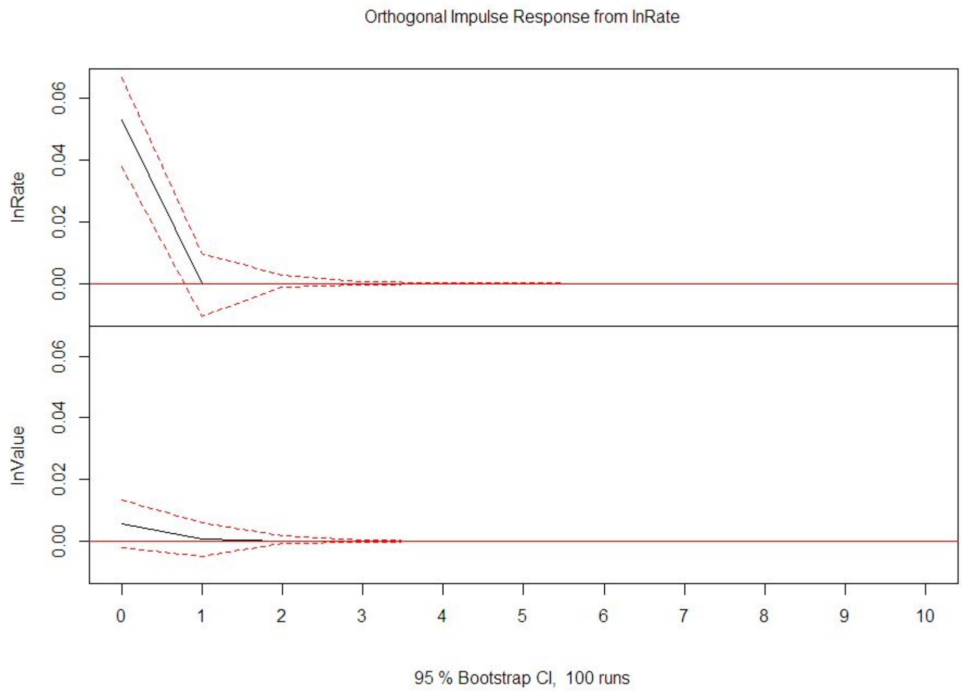
Summary

According to the findings there is a very low level connection between USD-MXN exchange rate changes and the Mexican GDP changes. After GDP increase decrease of the exchange rate is expected. There is no clue of causality, neither feedback.

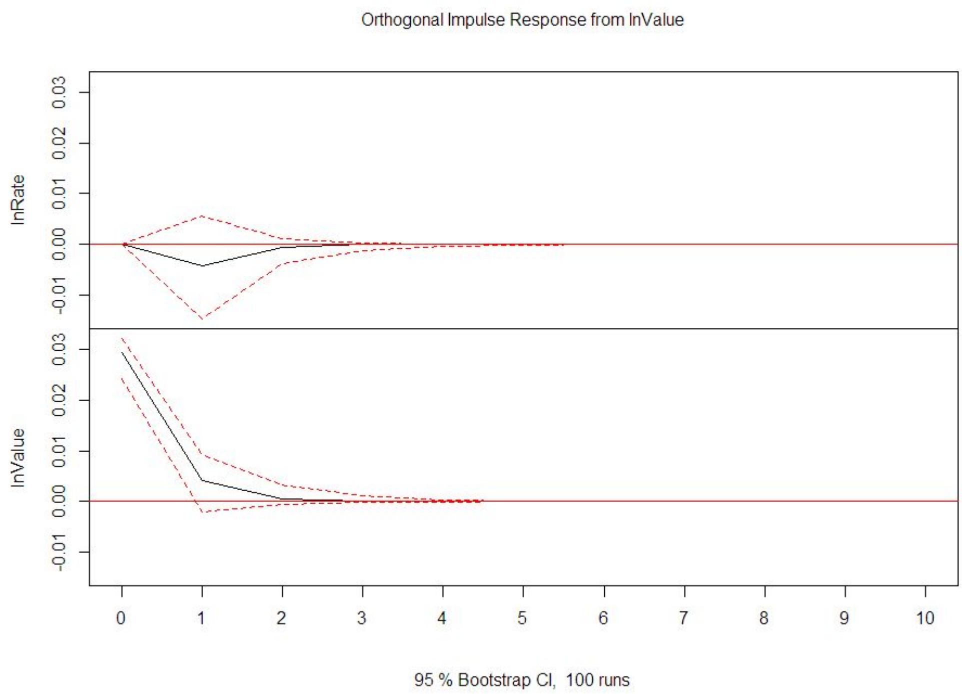
Appendix

Impulse Response Functions

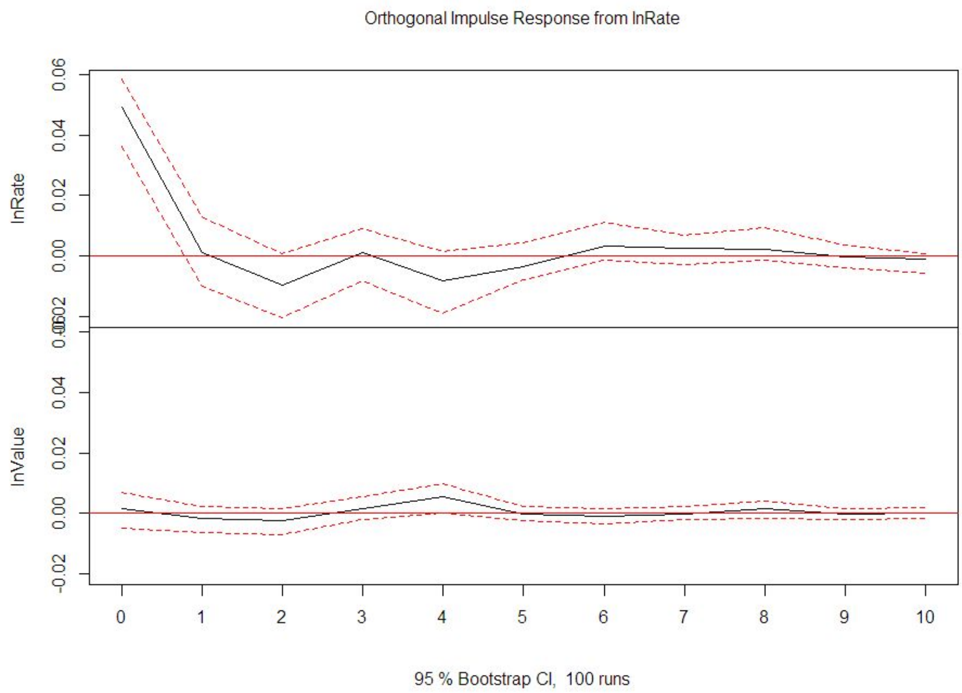
Value on Rate with VAR(1)



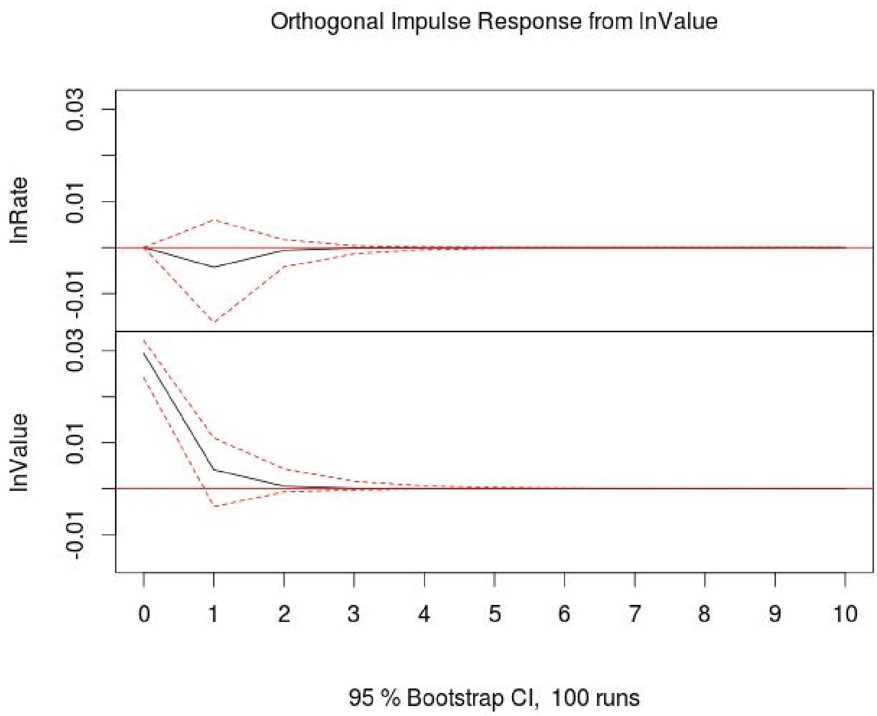
Rate on Value with VAR(1)



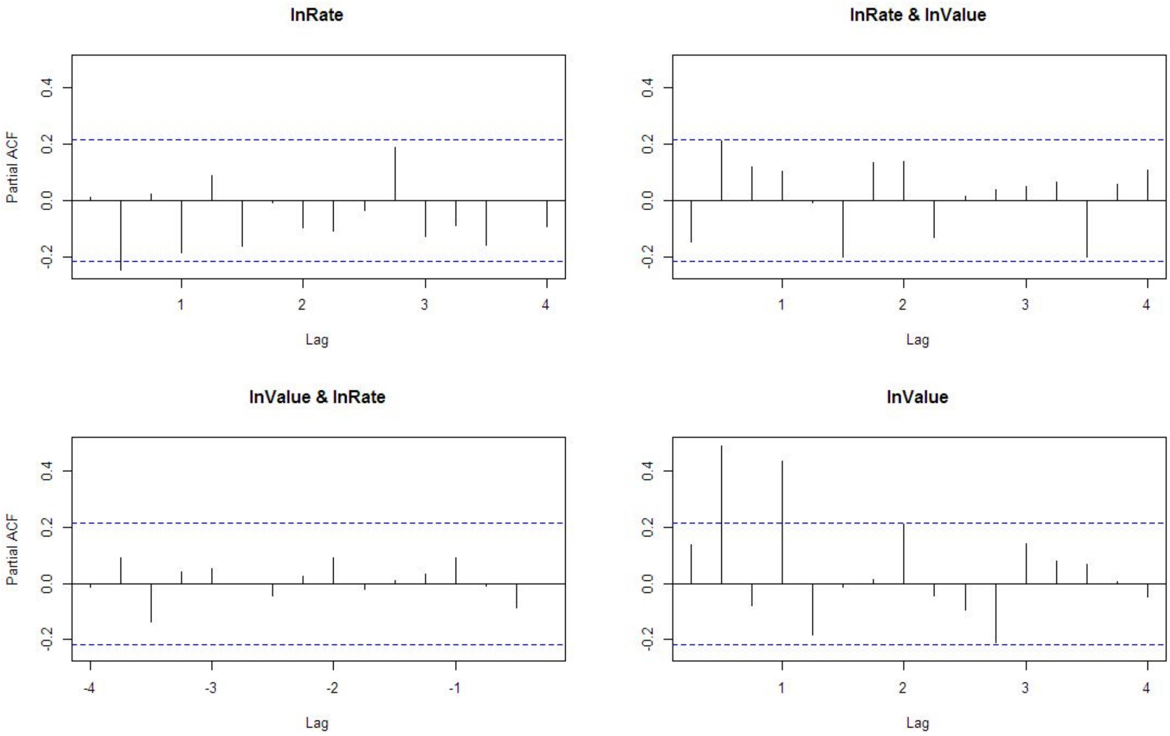
Value on Rate with VAR(4)



Rate on Value with VAR(4)



ACF and PACF


lnRate
lnRate & lnValue
lnValue & lnRate
lnValue
Partial ACF
Lag
0.4
0.2
0.0
-0.2
1
2
3
4
-4
-3
-2
-1

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 (i in 1:lag.max){
  for (lag in 1:i){
    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"]))
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 = "")
  }
  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")
```

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

#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(var4, cause = "dlnRate")
```