Assignment 4
Professor Yukai Yang
Time Series Econometrics

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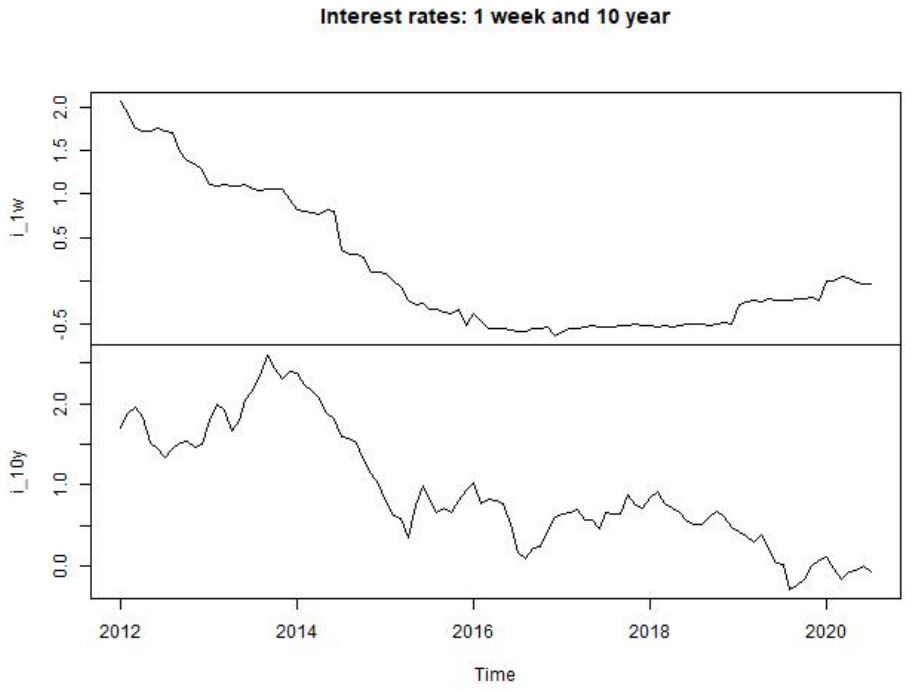
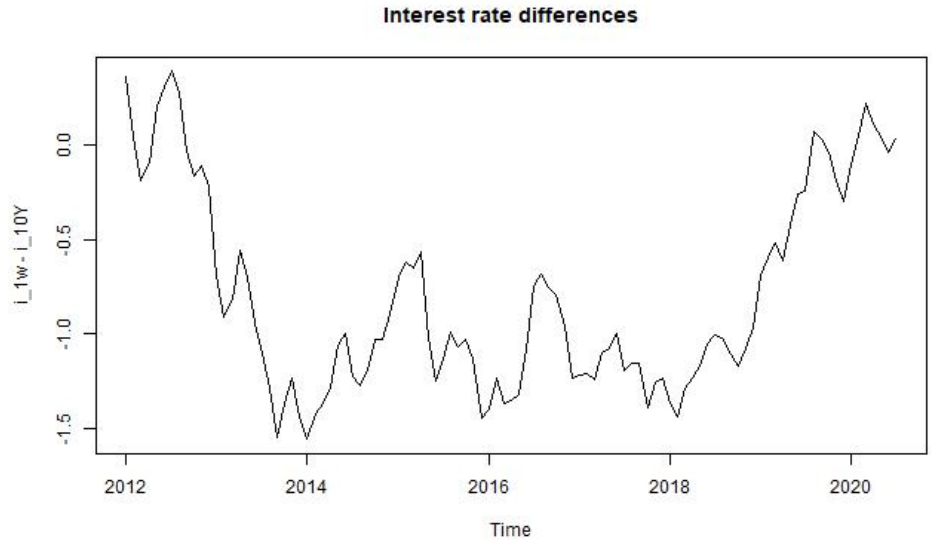
Problem 1.

Q1.1. Since the interest rates are non-stationary, and have similar trends, they could be cointegrated.



But since the plot of $i_t^{1w} - i_t^{10Y}$ below show the spread is non-stationary, they may not be cointegrated as cointegration requires that there exists $a \in \mathbb{R}$ where $i_t^{1w} - a \cdot i_t^{10Y} \sim I(0)$.



Q1.2. Based on AIC, the lag order of the VAR process is $k = 2$. The results of Johansen's procedure test with $p = 2$ are as follows:

Values of teststatistic and critical values of test				
	test	10pct	5pct	1pct
r $\leq$ 1	3.98	6.50	8.18	11.65
r = 0	15.64	15.66	17.95	23.52

Neither $r = 0$ nor $r \geq 1$ are statistically significant at the 10% level, thus we cannot reject either hypothesis. Therefore the co-integration rank may be 0 or 1.

Q1.3. The value of the likelihood ratio test statistic is 7.63 distributed as chi square with 1 df. The p-value of the test statistic is 0.01. Under this test, $i_t^{1W} - i_t^{10Y}$ is likely a cointegrating relation.

Q1.4. Using a augmented Dickey-Fuller test with no constant (case 1), constant (case 2), and constant with trend (case 4), the p-values are respectively 0.3495, 0.5274, and 0.783. Based on the unit root tests, there is no evidence to reject the null of the unit root. Thus the spread $i_t^{1W} - i_t^{10Y}$ is likely non-stationary and not a cointegrating relation.

Appendix: R Code

```
library(rio)
library(dplyr)
library(vars)
library(urca)
library(fUnitRoots)
library(tseries)


### Load and clean data


# Search interest & exchange rates
url <- "https://www.riksbank.se/en-gb/statistics/search-interest--exchange-rates/?c=cAverage&f=Month

raw <- rio::import(url)

# 1-week STIBOR
i_1w <- raw[raw$Series == "STIBOR 1W", 4] %>%
  gsub(",", ".", .) %>%
  as.numeric() %>%
  ts(start=2012, frequency = 12)

# 10-year Swedish government bonds
i_10y <- raw[raw$Series == "SE GVB 10Y", 4] %>%
  gsub(",", ".", .) %>%
  as.numeric() %>%
  ts(start=2012, frequency = 12)

data <- ts.union(i_1w, i_10y) %>%
  window(start=c(2012, 1), end=c(2020, 7))

# 1. Plot data ####

# Plot data
jpeg("HW3-data.jpg", width = 650, height = 500)
plot.ts(data, plot.type = "multiple",
        main = 'Interest rates: 1 week and 10 year'
        )
dev.off()

# Differences is not stationary
jpeg("HW3-int-diff.jpg", width = 650, height = 400)
plot.ts(data[,1]-data[,2],
        main = 'Interest rate differences',
        ylab = 'i_1w - i_10Y')
dev.off()

# Test stationarity of interest rates
adfTest(i_1w, lags = 8, type = "ct")  # Case 4
adfTest(i_1w, lags = 8, type = "c")   # Case 2

adfTest(i_10y, lags = 8, type = "ct") # Case 4
adfTest(i_10y, lags = 8, type = "c")  # Case 2


# 2. Estimate cointegrating rank ####
```

```
# All are non-stationary
adfTest(data[,1], lags = 8, type = "ct")   # Case 4
adfTest(data[,1], lags = 8, type = "c")    # Case 2

adfTest(data[,2], lags = 8, type = "ct")   # Case 4
adfTest(data[,2], lags = 8, type = "c")    # Case 2


# Estimate var order
var <- VAR(data, type='const', lag.max=8)
var$p

# Johansen's procedure
jo <- ca.jo(data, type = "trace", K = var$p, spec = "transitory", ecdet = "none")
summary(jo)


# 3. Test i_1w - i_10Y is a cointegrating relation ####
B <- matrix(c(1, -1), nrow = 2)
test <- blrtest(z = jo, H=B, r=1)
summary(test)


# 4. Unit root test ####
y <- data[,1]-data[,2]
adfTest(y, type = "nc",lags=var$p)
adfTest(y, type = "c", lags=var$p)
adfTest(y, type = "ct", lags=var$p)
```

Time Series Econometrics: Home work assignment 5

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Abstract

Please write your report in LaTeX. The report should be clearly written such that it is easy to understand what is done and why. Please attach any computer code in an appendix.

1 Problem 1

Assume the model

$$\Delta \mathbf{y}_t = \boldsymbol{\zeta}_0 \mathbf{y}_{t-1} + \boldsymbol{\epsilon}_t$$

where

$$\mathbf{y}_t = \begin{pmatrix} i_t^{1W} \\ i_t^{10Y} \end{pmatrix},$$

i.e. a 2×1 vector with one-week and ten-year interest rates. The error terms $\boldsymbol{\epsilon}_t$ are iid $N(\mathbf{0}, \boldsymbol{\Omega})$, $t = 1, 2, \ldots, T$. The data to be used can be obtained at `https://www.riksbank.se/en-gb/` under *Search interest & exchange rates*. Download the STIBOR one-week interest rate and the 10 year rate for Swedish government bonds (in Swedish Market (based) rates). Use monthly data and as long a sample as possible.

1. Plot the series. Could these potentially be cointegrated?
2. Estimate the cointegrating rank of the system by a sequence of tests.

3. Assume that the cointegrating rank is 1 and, using Johansen's approach, test that $i_t^{1W} - i_t^{10Y}$ is a cointegrating relation, i.e. that the spread between the two interest rates is stationary.

4. Test the same null hypothesis using a simple unit root test.