Econometrics 3

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Assignment 4

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Question 1

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Question 1.a

Test for unit roots in all series using the Phillips and Perron test. What do you conclude?

Table 1:

Variable	t-test	p-value
Broadm	1.6993	0.99
FFR	-14.06	0.313
R10Y	-5.17	0.8188
LGDP	-12.299	0.4133

First, we use the Phillips and Perron test to identify if the serie has unit root or it is stationary. The null hypothesis of the test is that the series has a unit root and the alternate hypothesis says that the serie is stationary. From the test statistic and the p-values from the table 1, for the four graphs we can not reject the null hypothesis therefore we conclude that the series has unit roots.

Question 1.b

Test for cointegration among all series using Johansen's trace test. Explain what is the null and alternative for each test in this series, and what you conclude.

Table 2:

	test	10pct	5pct	1pct
$r \leq 3$	5.15	7.52	9.24	12.97
$r \leq 2$	23.96	17.85	19.96	24.60
$r \leq 1$	56.75	32.00	34.91	41.07
$r \leq 0$	115.33	49.65	53.12	60.16

The Johansen trace test is a sequential test that estimates the rank of the representation matrix and it indicates us the number of cointegration relationship. As it is sequential, it starts with the null that there is no cointegration relationships (r= 0) against the alternate hypothesis that there more than 0 cointegration relationships. As we can see from the Table 2, we do not reject the null hypothesis for r = 0, 1 and 2. That means that there are 3 co-integral as we choose the rank for which we can reject the null hypothesis at 5%. So when r = 3 we can reject the null and hence we conclude that there are 3 cointegrated vectors.

Question 1.c

Redo b) with Johansen's max. eigenvalue test and discuss these results in comparison to b)

Table 3:

	test	10pct	5pct	1pct
$r \leq 3$	5.15	7.52	9.24	12.97
$r \leq 2$	18.81	13.75	15.67	20.20
$r \leq 1$	32.79	19.77	22.00	26.81
$r \leq 0$	58.58	25.56	28.14	33.24

From the two tests, trace test and eigenvalue test which are based on pure unit root assumption, we can conclude that the series has a co-integration relationship of 3 at 5% of significance because we are unable to reject the null hyphotesis until the rank below two. As we choose the rank for which we can reject the null we choose the third one.

Question 1.d

d) Write down the linear combination(s) from c) that is (are) stationary. Explain why it makes sense or not, from an economic perspective, that this particular linear combination(s) is (are) stationary.

Eigenvectors, normalised to first column: (These are the cointegration relations)

Table 4:

	l1.broadm	l1.ffr	l1.lgdp	l1.r10y	const
l1.broadm	1	1	1	1	1
l1.ffr	0.14	0.02	-0.05	0.01	0.01
l1.lgdp	0.07	-0.25	-0.57	-1.2	-1.08
l1.r10y	-0.13	-0.01	0.09	0.02	-0.01
const	-0.61	0.96	1.61	4.12	3.89

Thus, the cointegration vector are the columns of the of the matrix labeled "Eigenvector, normalized to first column. The cointegration vectors are determined only up to multiplication by a nonzero scalar and so can be normalized so that their first element is 1. So the linear combinations of the vectors that would be stationary, can be written as follows:
(1) BROADM + 0.14*FFR +0.07*LGDP -0.13*R10Y - 0.61
(2) BROADM + 0.02*FFR -0.25*LGDP -0.01*R10Y + 0.96
(3) BROADM -0.05*FFR -0.57*LGDP +0.09*R10Y + 1.61

Question 1.e

e)Estimate a VEC model with 3 lags and one cointegrating relationship. Look at the adjustment coefficients and explain whether the stationary linear combination would substantially improve the short-term forecasts of any of the four variables in your model

$$
\begin{aligned}
\begin{pmatrix} \Delta X_t^1 \\ \Delta X_t^2 \\ \Delta X_t^3 \\ \Delta X_t^4 \end{pmatrix} = {} &
\begin{pmatrix} 0.0059^{***} \\ (0.0015) \\ -0.7112 \\ (0.4931) \\ -0.0039^{**} \\ (0.0014) \\ -0.4122^{*} \\ (0.2024) \end{pmatrix} ECT_{-1}
\begin{pmatrix} 0.0014^{*} \\ (0.0006) \\ -0.5419^{**} \\ (0.1866) \\ 0.0015^{**} \\ (0.0005) \\ -0.0865 \\ (0.0766) \end{pmatrix} +
\begin{pmatrix}
0.5141^{***} & -0.0002 & -0.1038 & -0.0020^{**} \\
(0.0695) & (0.0003) & (0.0784) & (0.0006) \\
3.5603 & -0.2174^{**} & 84.7541^{***} & 0.4065^{*} \\
(22.3323) & (0.0828) & (25.1591) & (0.2032) \\
0.0224 & 0.0003 & 0.2179^{**} & -2.4\text{e-}05 \\
(0.0634) & (0.0002) & (0.0715) & (0.0006) \\
2.8344 & 0.0258 & 9.7813 & 0.2511^{**} \\
(9.1663) & (0.0340) & (10.3265) & (0.0834)
\end{pmatrix}
\begin{pmatrix} \Delta X_{t-1}^1 \\ \Delta X_{t-1}^2 \\ \Delta X_{t-1}^3 \\ \Delta X_{t-1}^4 \end{pmatrix} \\
& + \begin{pmatrix}
0.0363 & -0.0004 & 0.0590 & 0.0018^{**} \\
(0.0775) & (0.0003) & (0.0786) & (0.0007) \\
14.3544 & -0.1367 & 34.1022 & -0.5489^{*} \\
(24.8824) & (0.0840) & (25.2476) & (0.2139) \\
0.0119 & -0.0007^{**} & 0.2268^{**} & -0.0005 \\
(0.0707) & (0.0002) & (0.0717) & (0.0006) \\
7.3426 & -0.0236 & -4.8352 & -0.0739 \\
(10.2130) & (0.0345) & (10.3628) & (0.0878)
\end{pmatrix}
\begin{pmatrix} \Delta X_{t-2}^1 \\ \Delta X_{t-2}^2 \\ \Delta X_{t-2}^3 \\ \Delta X_{t-2}^4 \end{pmatrix} +
\begin{pmatrix}
0.1430^{*} & -0.0004 & 0.2009^{**} & -0.0006 \\
(0.0666) & (0.0003) & (0.0757) & (0.0006) \\
12.3071 & 0.1910^{*} & -12.5464 & 0.4652^{*} \\
(21.3899) & (0.0816) & (24.3066) & (0.2082) \\
0.0185 & -0.0003 & 0.0029 & 0.0002 \\
(0.0607) & (0.0002) & (0.0690) & (0.0006) \\
3.8456 & 0.0597^{\cdot} & -5.0759 & 0.1106 \\
(8.7795) & (0.0335) & (9.9766) & (0.0854)
\end{pmatrix}
\begin{pmatrix} \Delta X_{t-3}^1 \\ \Delta X_{t-3}^2 \\ \Delta X_{t-3}^3 \\ \Delta X_{t-3}^4 \end{pmatrix}
\end{aligned} \tag{1}
$$

In the coefficient of the error-correction term (ECT) we see that the for the broad money index, ECT has a positive sign and is significant at 1% level of significance. α_1 is significant at 1% but α_2 is not significant at any level of significance. Adjustment parameters α_1 and α_2 determine the speed of return to long run equilibrium. For long run relationship to be stable, we need $\alpha_1 \leq 0$ and $\alpha_2 \geq 0$ and at least one of them can not be equal 0. In this result, $\alpha_1 > 0$ and $\alpha_2 > 0$ and not significant, so it does not satisfy the condition for long run stable relationship. However, for the variable lgdp the adjustment coefficient is negative and significant at 10% level of significance. It means that there is stability in the system and this series converge to equilibrium path in case of any disturbance in the system. Finally, when we include the cointegrating vector in the model in the short-term forecasts of the variables broadm (broad money index) and lgdp (log of GDP) improves.

	ECT	Intercept	broadm -1	ffr -1
Equation broadm	0.0059(0.0015)***	0.0014(0.0006)*	0.5141(0.0695)***	-0.0002(0.0003)
Equation ffr	-0.7112(0.4931)	-0.5419(0.1866)**	3.5603(22.3323)	-0.2174(0.0828)**
Equation lgdp	-0.0039(0.0014)**	0.0015(0.0005)**	0.0224(0.0634)	0.0003(0.0002)
Equation r10y	-0.4122(0.2024)*	-0.0865(0.0766)	2.8344(9.1663)	0.0258(0.0340)
	lgdp -1	r10y -1	broadm -2	ffr -2
Equation broadm	-0.1038(0.0784)	-0.0020(0.0006)**	0.0363(0.0775)	-0.0004(0.0003)
Equation ffr	84.7541(25.1591)***	0.4065(0.2032)*	14.3544(24.8824)	-0.1367(0.0840)
Equation lgdp	0.2179(0.0715)**	-2.4e-05(0.0006)	0.0119(0.0707)	-0.0007(0.0002)**
Equation r10y	9.7813(10.3265)	0.2511(0.0834)**	7.3426(10.2130)	-0.0236(0.0345)
	lgdp -2	r10y -2	broadm -3	ffr -3
Equation broadm	0.0590(0.0786)	0.0018(0.0007)**	0.1430(0.0666)*	-0.0004(0.0003)
Equation ffr	34.1022(25.2476)	-0.5489(0.2139)*	12.3071(21.3899)	0.1910(0.0816)*
Equation lgdp	0.2268(0.0717)**	-0.0005(0.0006)	0.0185(0.0607)	-0.0003(0.0002)
Equation r10y	-4.8352(10.3628)	-0.0739(0.0878)	3.8456(8.7795)	0.0597(0.0335).
	lgdp -3	r10y -3		
Equation broadm	0.2009(0.0757)**	-0.0006(0.0006)		
Equation ffr	-12.5464(24.3066)	0.4652(0.2082)*		
Equation lgdp	0.0029(0.0690)	0.0002(0.0006)		
Equation r10y	-5.0759(9.9766)	0.1106(0.0854)		

Question 2

Question 2.a

Explain the term 'error correction' in the vector error correction model (VECM).

A vector error correction (VEC) model is a restricted VAR designed for use with nonstationary series that are known to be cointegrated. The VEC has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is known as the "error correction term" since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. In other words, in case two variables are not stationary but the linear combination of the two variables is stationary then we can include the error correction term in the model using the co-integrating parameters and taking the first difference of all the variables to make all the variables stationary.

Question 2.b

What is a dynamic causal effect of the fed funds rate on GDP, and the main assumption needed for estimating a dynamic causal effect of the fed funds rate on GDP?

We assume that the fed fund rates affect the GDP but GDP has no contemporaneous feedback on the fed funds rate effect if controlling for a lot of other factors. If we set $\gamma_2 = 0$ in the structural model then GDP has no contemporaneous impact of fed funds rates and also another assumption that needs to hold is that $\mathrm{E}(\epsilon_t | m_t, m_{t1}, ..., y_{t1}, y_{t2}, ...) = 0$.

$$\mathrm{GDP}_t = \gamma_1 FFR_t + B11(L)GDP_{t-1} + B12(L)FFR_{t-2} + \epsilon_{GDP}$$

$$\text{FFR}_t = \gamma_2 GDP_t + M11(L)GDP_{t-1} + M12(L)FFR_{t-2} + \epsilon_{FFR}$$

(2)

if $\gamma_2 = 0$, this implies that exogeneity assumption is satistified.
Then the equation can be rewritten as:

$$\text{GDP}_t = \gamma FFR_t + B11(L)GDP_t + B(12)FFR_{t1} + B(12)FFR_{t2} + ... + B(p)(12)FFR_{tp} + \epsilon_t$$

(3)

Here, γ, B(12) , B(12), ..., B(p)(12) are the dynamic multipliers. Finally the effect of FFR on GDP is equal to: $\frac{\partial GDP_t}{\partial FFR_{Rt-n}} = B^n(12)$

Question 2.c

In a q-variate VAR, the sequential Johansen testing procedure (trace or max. eig.) selects q cointegrating relationships. At the same time, individual Phillips-Perron unit root tests indicate that all q series have a unit root. How can this happen? First, the Johansen's Cointegration Tests use a sequential procedure. First it estimates H(0) vs. H(1). If cannot reject, stop, conclude no cointegration relationship. If reject, we have at least one conintegration relationship and we continue. Then, estimates test H(1) vs. H(2). If cannot reject, stop, conclude we have 1 cointegration relationship. If reject, we have at least 2 cointegration relationship. It continue until we can no longer reject. If all tests up to q 1 reject, we conclude that the VAR(p) is stationary.
Therefore, in a q-variate VAR, if we observe that Phillips-Perron indicates that all series have unit root and at the same time the Johansen testing selects q-cointegrating relationships then it is something wrong with the test because it is not posible that all shocks are unit rood and at the same time have q cointegrating relationships. As we saw already, Johanen test can have maximum of q-1 cointegrating relationships. Thus we can say that exist a spurious cointegration. It can happen in situation when the test do not perfome so well like for example if the data has breaks or when the variables have long memory and are not a part of I(1) process.

Question 2.d

What is the main purpose of estimating a structural VAR?
A structural VAR (SVAR) uses additional identifying restrictions and estimation of structural matrices to transform VAR errors into uncorrelated structural shocks. Obtaining structural shocks is central to a wide range of VAR analysis, including impulse response, forecast variance decomposition, historical decomposition, and other forms of analysis.

Question 2.e

Explain clearly (an example would also work) why a structural VAR is not identified without further restrictions.

Because we have identification problem because in the VAR model we have eight parameters to estimate (γ_1, α_{11},$\alpha 12$, γ_2, α_{21}, α_{22}, σ_1 and σ_2) but in the empirical model (the reduce form), we can estimate only seven estimates and hence there is underidentification problem in the model. The solution for this problem implies to find a instrumental variable or make another restriction. But IV are hard to find and very unlikely to be truely exogenous. Exist others ways to make another restriction such as 1) The short-run restrictions, 2) The long-run restrictions, 3) The informal identification and 4) The sign restrictions to use the theory to make restrictions about the behaviour we expect of our model.

Appendix

```
setwd("C:/Users/lgome/OneDrive/Documents/Master of Econometrics and Mathematical Economics/
    Econometrics 3")
library(readxl)
DATAAssignment4 <- read_excel("C:/Users/lgome/OneDrive/Documents/Master of Econometrics and
    Mathematical Economics/Econometrics 3/DATAAssignment4.xlsx")
View(DATAAssignment4)
Data2 = na.omit(DATAAssignment4)
broadm = ts(Data2[,2], start = c(1959,1), frequency = 4)
ffr = ts(Data2[,3], start = c(1959,1), frequency = 4)
lgdp = ts(Data2[,4], start = c(1959,1), frequency = 4)
r10y = ts(Data2[,5], start = c(1959,1), frequency = 4)
y = ts(Data2[,c(2,3,4,5)], start = c(1959,1), frequency = 4)
newdata2 = Data2[-c( 193:220),]

install.packages("vars")
library(vars)
install.packages("zoo")
library(zoo)
install.packages("lmtest")
library(lmtest)
install.packages("forecast")
library(forecast)
install.packages("tseries")
library(tseries)
install.packages("dplyr")
library(dplyr)
install.packages("sandwich")
library(sandwich)
install.packages("vars")
library(vars)
install.packages("urca")
library(urca)
install.packages("tsDyn")
library(tsDyn)
library(haven)
# Solution 1(a)
# Testing for Unit Root using Phillips and Perron test

pp.test(newdata2$broadm)
pp.test(newdata2$ffr)
pp.test(newdata2$lgdp)
pp.test(newdata2$r10y)

# Solution 1(b)
Johansentrace= ca.jo(newdata2[,c(2,3,4,5)], type = "trace", ecdet = "const", K = 3, spec = "
    transitory")
summary(Johansentrace)

# Solution 1(c)
# Testing for Conintegration using Johansen's eigen test
```

```
Johanseneigen = ca.jo(newdata2[,c(2,3,4,5)], type = "eigen", ecdet = "const",  K = 3, spec =
     "transitory")
summary(Johanseneigen)

# Solution 1(d)


# Solution 1(e)

install.packages("tsDyn")
library(tsDyn)

VECM_1= VECM(y, lag = 3, r = 1, include = "const")
summary(VECM_1)
toLatex(summary(VECM_1))
```