Advanced Econometrics: Time Series

Assignment 2

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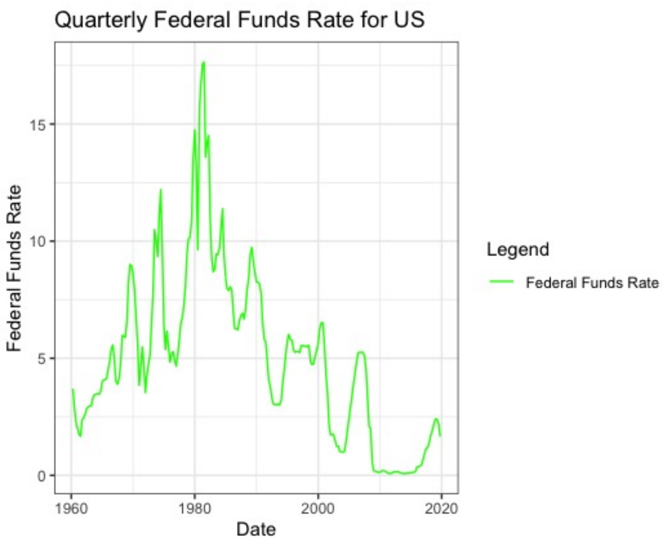
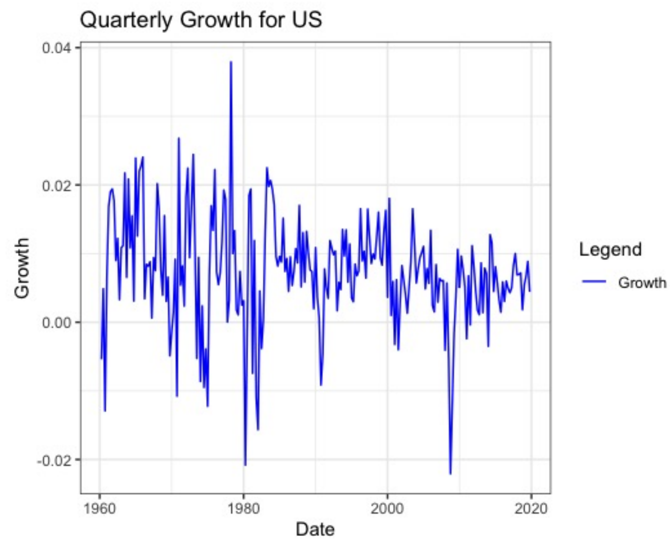
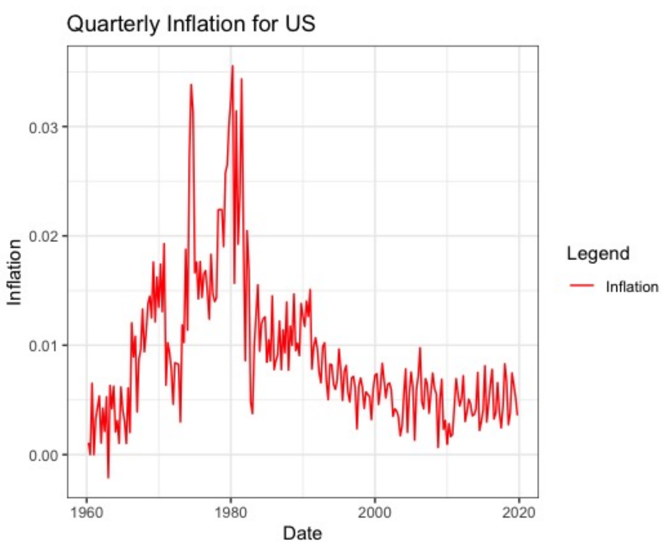
28 April 2023

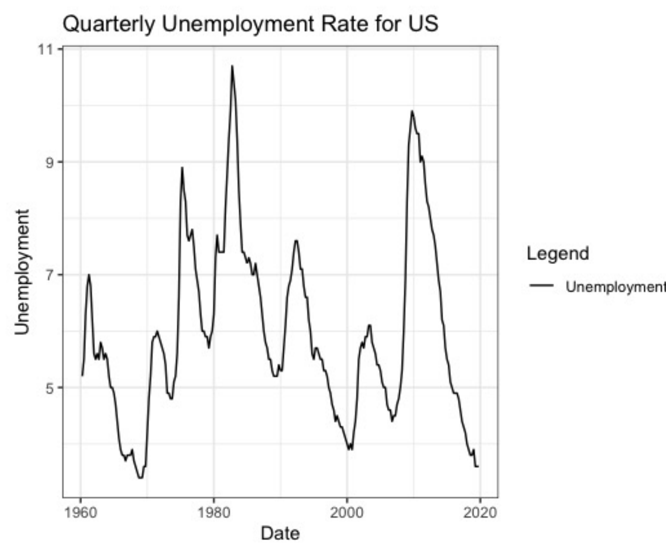
Question 1

In this part, we are required to plot the data:









From the graphs, they don't quite seem dependent on time: they look stationary. But of course, graphics can only infer so far: I thus test this with a Dickey Fuller Test, whereby the null states that a unit root is present (depends on time), whilst the alternative says there is not unit root.

Augmented Dickey Fuller

Variable	Test Statistic	*Critical Values*	*Levels*
Federal Funds	-2.97	*-3.13*	*10%*
Unemployment	-3.31	*-3.43*	*5%*
Growth	-7.61	*-3.99*	*1%*
Inflation	-4.14		

From the above table, I have my results for my Dickey Fuller Test. Note I have used italics to express the critical values and their level of significance. We reject the null of a unit root for growth and inflation (which were first differenced with logarithmic GDP and logarithmic Price levels, respectively) as they are below the critical values, but fail to reject for federal funds rate and unemployment variables because they are above the critical values. However, as this question is dealing with Vector Autoregressions, when we include lags of one or more (of each variable), it takes out the trend. Thus, I keep Unemployment and Federal Funds Rate in levels form.

Question 2

How many lags are required? Results show:

Results from R

	AIC	HQ	SBIC
Lags	10	5	2

We tend to use an AIC when we have a small sample. This is because AIC assigns greater number of lags than the true number of lags. As a result, we avoid omitted variable bias and still yield consistent results.

However, we do not have a small sample: our sample has T greater than 30. I therefore use the SBIC for 2 lags. I COULD use 5 lags as according to the HQ but although I said we have a large sample, including 5 lags is excessive and we lose too many observations from the total 239 [1].

Below is a table of my reduced form VAR:

[1] After cleaning the data.

Reduced Form VAR

	Dependent variable:			
	i_t	g_t	π_t	U_t
i_{t-1}	-0.001	0.002^{***}	1.179^{***}	-0.003
	(0.001)	(0.0003)	(0.074)	(0.021)
g_{t-1}	0.161^{**}	-0.040	13.638	-7.259^{***}
	(0.077)	(0.038)	(8.359)	(2.380)
π_{t-1}	-0.058	0.278^{***}	-50.838^{***}	10.472^{**}
	(0.136)	(0.067)	(14.729)	(4.194)
U_{t-1}	-0.004^{*}	-0.002^{**}	-0.584^{**}	1.380^{***}
	(0.002)	(0.001)	(0.247)	(0.070)
i_{t-2}	0.001	-0.001^{***}	-0.228^{***}	0.014
	(0.001)	(0.0003)	(0.073)	(0.021)
g_{t-2}	0.154^{**}	-0.085^{**}	1.933	-7.464^{***}
	(0.071)	(0.035)	(7.663)	(2.182)
π_{t-2}	-0.164	0.416^{***}	71.338^{***}	-5.137
	(0.135)	(0.066)	(14.594)	(4.156)
U_{t-2}	0.005^{**}	0.002^{**}	0.551^{**}	-0.421^{***}
	(0.002)	(0.001)	(0.243)	(0.069)
constant	0.003	0.002^{**}	0.141	0.248^{***}
	(0.002)	(0.001)	(0.234)	(0.067)
Observations	237	237	237	237
R^2	0.197	0.720	0.954	0.981
Adjusted R^2	0.169	0.710	0.953	0.980
Residual Std. Error (df = 228)	0.007	0.004	0.796	0.227
F Statistic (df = 8; 228)	6.991^{***}	73.373^{***}	596.274^{***}	$1{,}469.768^{***}$
Note:				*p<0.1; **p<0.05; ***p<0.01

All the eigenvalues are within the unit circle. Some variables are statistically significant and some are not. For instance, if inflation increased by one percent two quarters ago, we can expect growth to increase this quarter by an average of 0.416 percent, all else being constant. Or if interest rates increased by one unit this quarter, inflation falls by an average of 0.228 percent two quarters later, holding all other variables constant. The aforementioned are both statistically significant at the 1% level.

However, one variable that has struck my attention is the interest rate variable: it does not depend on its own lagged values? Perhaps this is due to first-order stochastic differences, where dependent variables rely on some expectation of some other variable and thus no room for backward looking variables.

Question 3

Formula for Structural Vector Autoregression is:

$$B_0 Z_t = B_1 Z_{t-1} + ... + B_p Z_{t-p} + \omega_t \tag{1}$$

As according to the assignment handout, we have:

$$\begin{align} i_t &= \beta_1 \pi_t + \beta_2 g_t + \omega_t^T \tag{2} \\ g_t &= \alpha_1 i_t + \alpha_2 \pi_t + \omega_t^{AD} \tag{3} \\ \pi_t &= \delta u_t + \omega_t^{PC} \tag{4} \\ g_t &= \mu(u_t - \bar{u}) + \omega_t^O \tag{5} \end{align}$$

We can shift the independent variables to the left hand side. Our vector Z_t is therefore:

$$Z_t = \begin{bmatrix} i_t \\ g_t \\ \pi_t \\ U_t \end{bmatrix} \tag{6}$$

And B_0 matrix is:

$$B_0 = \begin{bmatrix} 1 & -\beta_2 & -\beta_1 & 0 \\ -\alpha_1 & 1 & -\alpha_2 & 0 \\ 0 & 0 & 1 & -\delta \\ 0 & 1 & 0 & -\mu \end{bmatrix} \tag{7}$$

And if we implement the matrix operation, we obtain the same results from equations (2) to (5). As we are interested in interpreting structural and reduced form shocks, our model is:

$$B_0 u_t = \omega_t \tag{8}$$

$$\begin{bmatrix} 1 & -\beta_2 & -\beta_1 & 0 \\ -\alpha_1 & 1 & -\alpha_2 & 0 \\ 0 & 0 & 1 & -\delta \\ 0 & 1 & 0 & -\mu \end{bmatrix} \begin{bmatrix} u_t^T \\ u_t^{AD} \\ u_t^{PC} \\ u_t^O \end{bmatrix} = \begin{bmatrix} \omega_t^T \\ \omega_t^{AD} \\ \omega_t^{PC} \\ \omega_t^O \end{bmatrix} \tag{9}$$

Where u_t and ω_t denote the reduced form shock and structural shocks, respectively. So the above matrices goes a bit like this: some reduced form shocks are effected by their own structural shocks, and may or may not be effected by other structural shocks. The reason for this is because some variables are sluggish: it takes time to have an effect, or some variables according to economic theory, or complete arbitrariness, is irrelevant to certain equations.

Regarding identification, we require $\frac{k(k-1)}{2}$, or 6 in our case since k = 4 for us. For "restrictions", we count the elements that are either 1 or 0. This gives us a total of 10: our model is overidentified. Nevertheless, we can still proceed with our calculations.

Question 4 and 5

Our estimated B_0 matrix is:

$$B_0 = \begin{bmatrix} 1 & 113.98 & -149.55 & 0 \\ -1.27 & 1 & -13.07 & 0 \\ 0 & 0 & 1 & 3.66 \\ 0 & 1 & 0 & -2.61 \end{bmatrix} \tag{10}$$

We are required to shift the non-unit values to the right hand side to explain reduced form shocks as a function of other reduced form shocks and its own exogenous shock: the negatives become positive and the positives become negative. This is demonstrated in the table below as they are estimated results from the SVAR.

All the independent variables in our SVAR are statistically significant at the 1% level, with the exception of growth shock variable in the Taylor Rule equation. The zeros in the table are the constraints applied from the matrices above.

From my output in STATA, it produces my results from the Likelihood Ratio test: null states that overidentification is valid, alternative says it is not. My results rejected the null: overidentification not valid. I nevertheless proceed with my results to continue with the assignment.

SVAR Results

	Dependent variable:			
	u_t^T	u_t^{AD}	u_t^{PC}	u_t^{AD}
u_t^T	0	1.27^{***}	0	0
	(0.000)	(0.06)	(0.000)	(0.000)
u_t^{AD}	-113.98^{***}	0	0	0
	(4.61)	(0.000)	(0.000)	(0.000)
u_t^{PC}	149.55^{***}	13.07^{***}	0	0
	(6.41)	(0.55)	(0.000)	(0.000)
u_t^U	0	0	-3.66^{***}	2.61^{***}
	(0.000)	(0.000)	(0.24)	(0.27)
Observations	238	238	238	238
Note:		*p<0.1; **p<0.05; ***p<0.01		

Question 6

- Taylor Rule Equation: given a positive shock in Aggregate Demand, interest rates fall. Controlling for other variables, given an increase in inflation shocks, interest rates rises. These are statistically significant at the 1% level. The latter makes economic sense: interest rates rise to tame inflation, but the former does not sound realistic, and one of the problems with SVARS: unrealistic results.
- Aggregate Demand Equation: An increase in interest rate shocks increases shock to growth rates, ceterus paribus. This is statistically significant at 1% level.

Again, this does not make sense.

An increase in inflation shock increases growth shocks. This makes sense (of course, up to a certain point): consumers are spending more which increases price levels and also Consumption variable in our $Y = C + I + G$. This is statistically significant at 1% level.

- Phillips Curve: as unemployment witnesses a positive shock [2], inflation falls. Makes sense: more people now do not work and thus have less income, yielding less pressure on price levels. Also statistically significant at 1%.

- Okun's Law: Okun's law argues that information on unemployment is the main driver of output. We see here that as we witness a positive unemployment shock, growth increases. This makes does not sense and is significant at 1% level.

To summarize this subsection, the SVAR does not work great, as there are some variables that doesn't sound quite realistic, but that is the nature of SVARs.

Question 7

- Test impact of higher interest rates on output is negative.

$$H_0 : \alpha_1 \geq 0 \quad H_1 : \alpha_1 < 0 \tag{11}$$

$$Z = \frac{\alpha_1}{SE(\alpha_1)} = \frac{1.27}{0.06} = 21.16 > -1.96 \tag{12}$$

As this is a one tailed test, I only reject the null if my t-statistic is less than my critical value of -1.96 at the 1% level. Thus, I fail to reject null higher interest rates on output is negative.

Let's consider some theories. In open economy, interest rates increase yield higher demand for domestic bond, driving domestic currency power up. This yields to higher consumption and subsequently output. Another possibility is rational agents: they

[2] I always get unemployment a bit mixed up. So here it says that something happened that caused unemployment to rise.

expect interest rates to rise (given some other shock) and thus invest this period to avoid future high interest rates.

- Test impact of higher inflation rates on interest rates is positive.

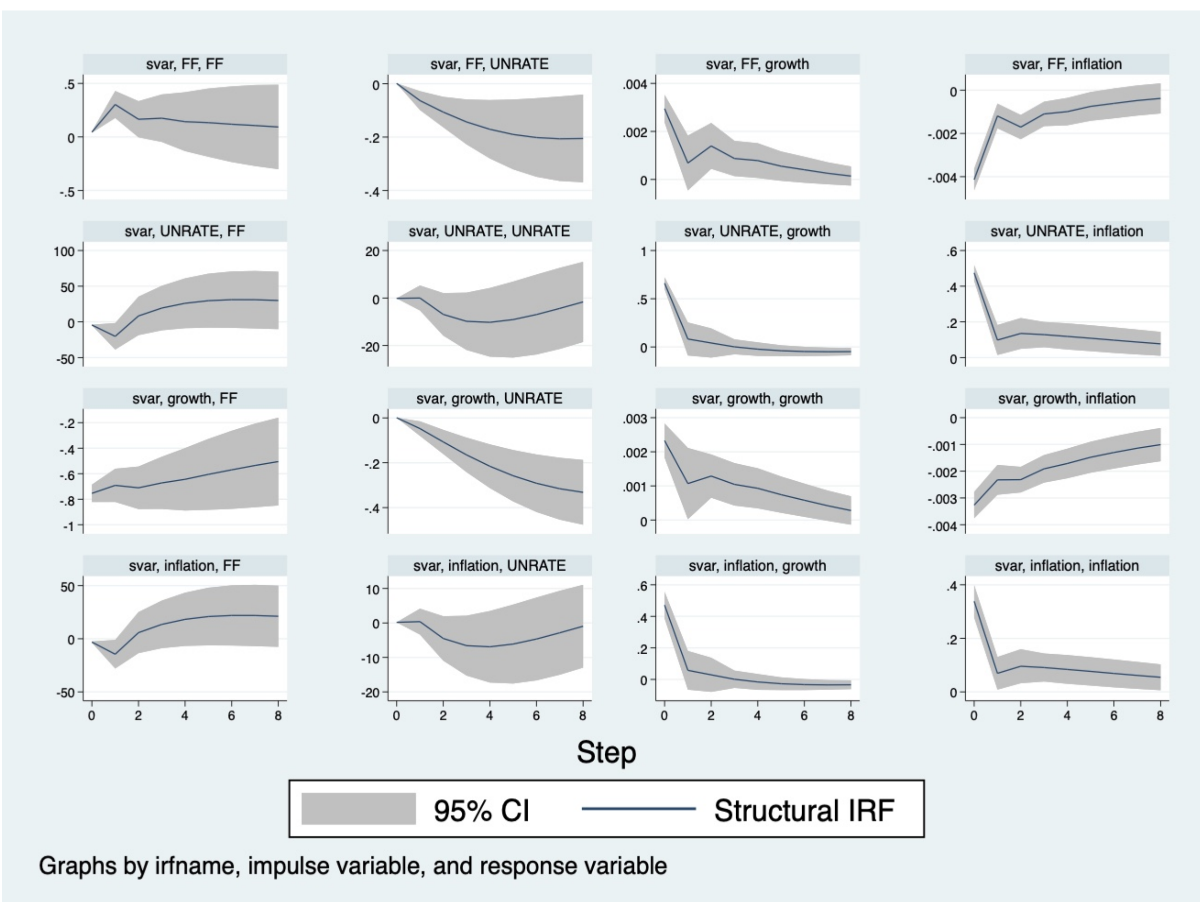
$$H_0 : \beta_1 \leq 0 \quad H_1 : \beta_1 > 0 \tag{13}$$

$$Z = \frac{\beta_2}{SE(\alpha_1)} = \frac{149.55}{6.41} = 23.33 > 1.96 \tag{14}$$

We reject the null that the effect of a positive inflation shock on interest rate is zero and conclude that the effect of inflation on interest rates is positive.

Question 8

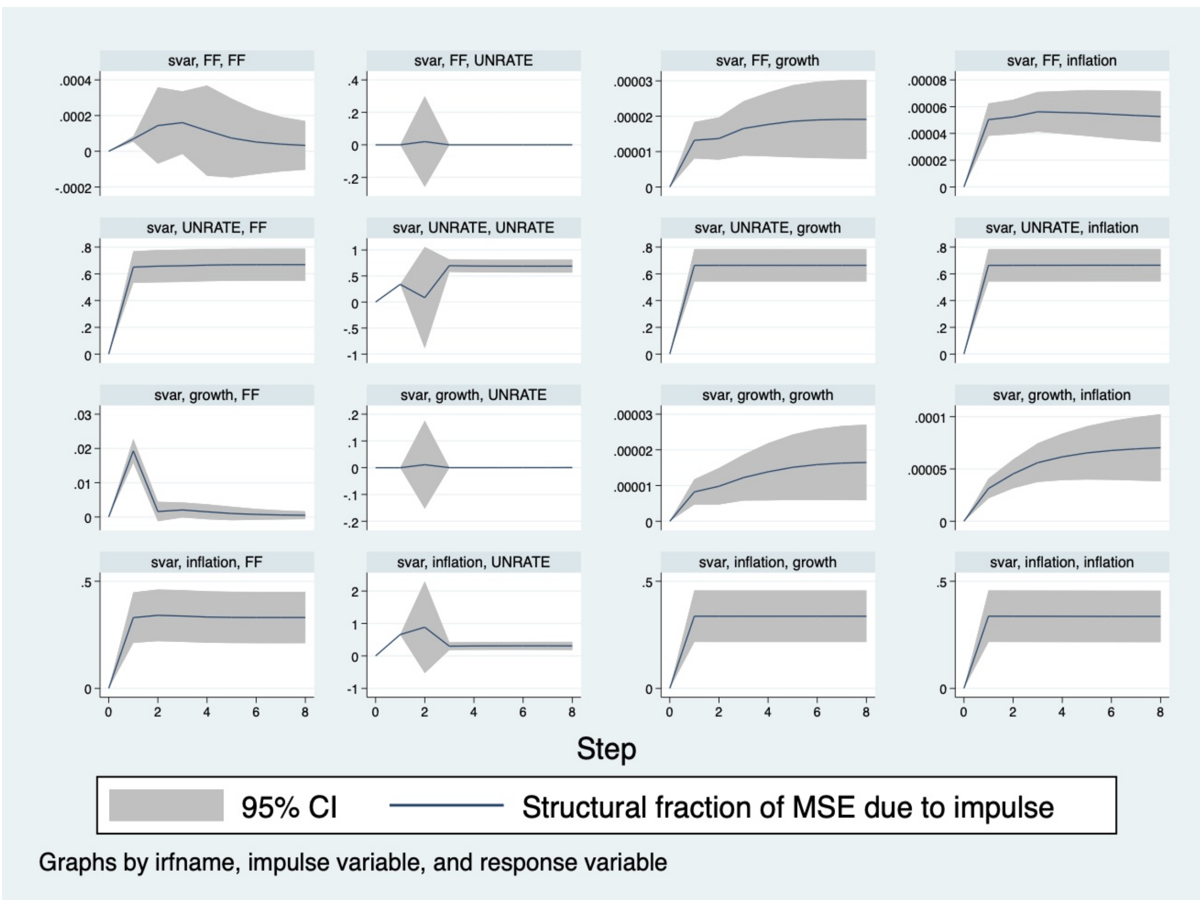
Plotting the Impulse Response Functions:



To interpret the significance of the shocks, if the confidence interval includes the integer 0, then it is statistically insignificant, else it is significant. For instance, given a shock in growth, holding all else constant, inflation increases up to about 8 quarters. This is statistically significant.

Though there are some strange results: a positive shock to interest rates increases inflation? Most of the shocks where interest rate is the response variables do not have a long effect: it usually lasts about two quarters max. This is excluding growth shock where it increases interest rates, which make sense in order to tame aggregate demand. Nevertheless, the vast majority seem to be quite logical.

Moving on to Forecast Error Variance Decomposition (FEVD):



The purpose of FEVD is to analyse how much of a structural shock is impacted by another (or its own) structural shock. The maximum our Y axis takes is 1, because we are interested in the percentage of structural shocks that explains one variable i.e. the ratio of structural shocks. Best to provide some examples.

Unemployment rate shocks represent about 70% of deviations of growth. Another example is a positive structural shock to growth has little effect on federal funds rate.

Though the strange results are the ones where unemployment is the response variable: it has a geometric shape in the second period, and all of them at this period are statistically insignificant. The remaining periods however, make sense: unemployment shocks represent about 70% of the deviations in unemployment, whilst inflation shocks amount for approximately the remaining 30%. Note that the latter graph (4th row, 2nd column) has a y axis to 2. This is because my confidence interval goes above 2.

Question 9

Asked monetary shocks (ω_t^T) on output: Our impulse is federal funds rate shocks and our response is growth. According to our structural form IRF graph, this shock has a negative effect on growth. This makes economic sense as the propensity to borrow and therefore invest falls due to higher costs. The confidence bands do not seem to contain a zero (with exception of second quarter only): this is therefore statistically significant.

FEVD graph says a positive structural shock in interest rates represent a small amount of growth rates: inflation and unemployment shocks represent most of the effects. This was hinted at in our IRF graph as our Y axis contained minuscule numbers.

Question 10

- Main source of shock on growth?
- Main source of shock on unemployment?

For growth, it seems that unemployment rate shocks effect it the most, representing approximately 70% from the FEVD graph. We also see from the IRF Graph that a positive shock in the unemployment rate (unemployment increases), growth falls. This makes sense as less people work, and therefore consumer spending and investment falls. It is also statistically significant.

Unemployment shocks explain about 70% of the deviations in unemployment according to the FEVD. However, from the IRF Graph, this is statistically insignificant as the confidence interval contains a 0. This is a strange result as we expect its own shocks to have an effect.

1 Appendix

1.1 STATA Code

use "/Users/wilsontai/Downloads/assignment2.dta", clear //Importing Data

matrix A=[1, . , ., 0 ., 1, ., 0 0, 0, 1, . 0, 1, 0, .] //Setting SVAR Matrix B0

matrix list A

egen t = seq() //Setting Time Series

tsset t

drop if USACPICORMINMEI == .

// creating new variables called growth and inflation

gen growth = d.GDPC1

gen inflation = d.USACPICORMINMEI

Running SVAR

svar FF growth inflation UNRATE,aeq(A) lags(1 2) nocnsreport nolog

esttab svar

//Plotting IRF and FEVD

irf create svar, set(SVAR,replace) replace

irf graph sirf, byopts(yrescale)

irf graph sfevd, byopts(yrescale)

1.2 R Code

Time Series

Wilson Tai

```r
##loading libraries
library(haven)
library(lubridate)
library(tidyverse)
library(tsibble)
library(urca)
library(ggplot2)
library(forecast)
library(stargazer)
library(vars)
library(cowplot)
library(gridExtra)

##importing and cleaning data
FRED <- read_dta("/Users/wilsontai/Downloads/assignment2.dta")
FRED  <- FRED %>%
  mutate(date=ymd(datestr)) %>%
  as_tsibble(index=date)

FRED <- FRED %>%
  mutate(growth = difference(log(GDPC1)), inflation = difference(log(USACPICORMINMEI)))

FRED <- FRED %>%
  drop_na()
attach(FRED)

###Question 1
##checking unit roots first
summary(ur.df(FRED$FF, type = "trend"))
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.4842 -0.2290 -0.0237  0.2976  7.0426
```

```
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.4703808  0.1796825   2.618 0.009428 **
## z.lag.1     -0.0518282  0.0174488  -2.970 0.003286 **
## tt          -0.0017841  0.0009242  -1.931 0.054758 .
## z.diff.lag   0.2443066  0.0631345   3.870 0.000142 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8566 on 233 degrees of freedom
## Multiple R-squared:  0.08546,    Adjusted R-squared:  0.07368
## F-statistic: 7.257 on 3 and 233 DF,  p-value: 0.0001126
##
##
## Value of test-statistic is: -2.9703 3.0601 4.5875
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47
```

```r
##null: unit root: fail to reject. Solution is to first difference
summary(ur.df(log(FRED$UNRATE), type = "trend"))
```

```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.105991 -0.024570 -0.004914  0.022722  0.140731
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  4.997e-02  1.754e-02   2.849  0.00478 **
## z.lag.1     -2.821e-02  9.699e-03  -2.908  0.00399 **
## tt          -1.069e-05  3.707e-05  -0.288  0.77336
## z.diff.lag   6.503e-01  5.023e-02  12.946  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03885 on 233 degrees of freedom
## Multiple R-squared:  0.4236, Adjusted R-squared:  0.4162
## F-statistic: 57.09 on 3 and 233 DF,  p-value: < 2.2e-16
##
##
```

```
## Value of test-statistic is: -2.9083 2.9197 4.3285
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47
```

```r
##null: unit root: fail to reject. Solution is to first difference

summary(ur.df(FRED$growth, type = "trend")) ##reject null of unit root.
```

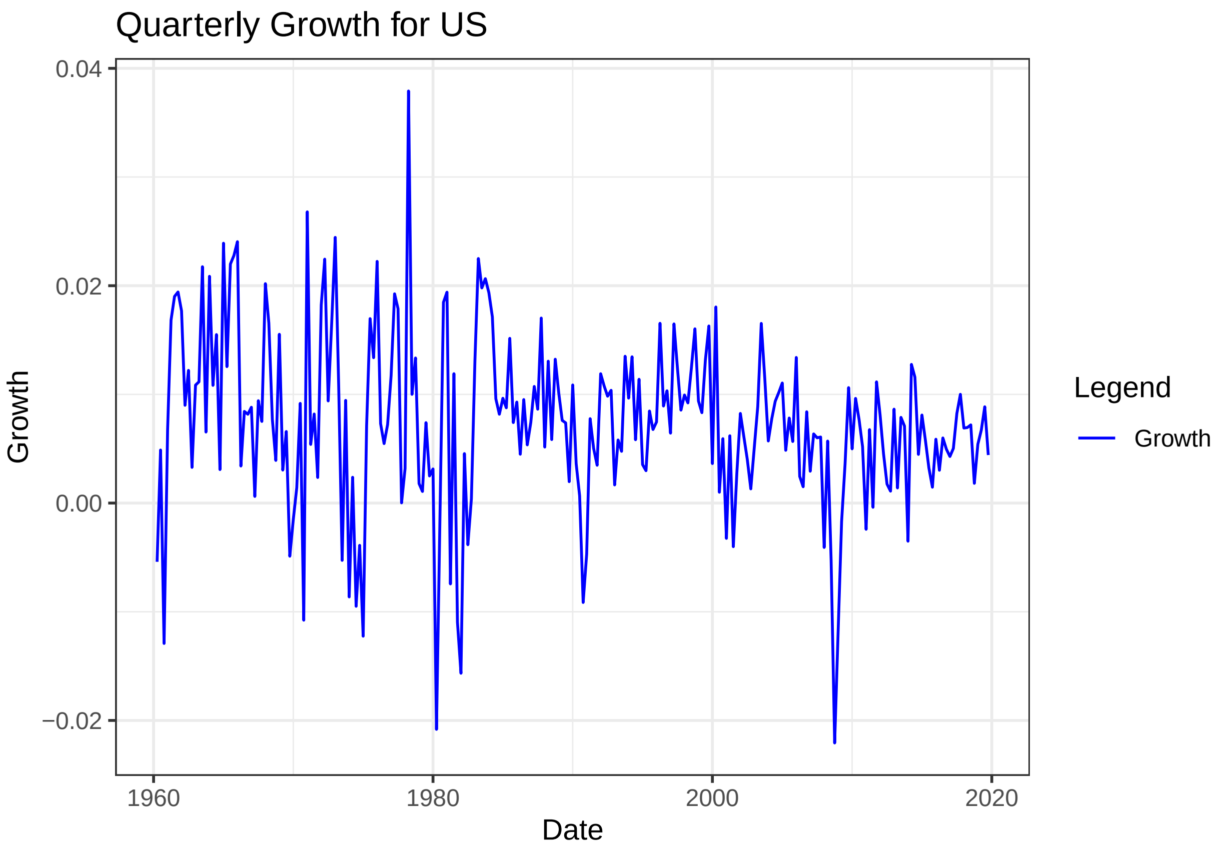
```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.026961 -0.003804  0.000318  0.003896  0.032085
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.130e-03  1.253e-03   4.891 1.87e-06 ***
## z.lag.1     -5.805e-01  7.606e-02  -7.632 5.89e-13 ***
## tt          -1.489e-05  7.318e-06  -2.035  0.04300 *
## z.diff.lag  -1.785e-01  6.396e-02  -2.791  0.00569 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.007471 on 233 degrees of freedom
## Multiple R-squared:  0.3742, Adjusted R-squared:  0.3661
## F-statistic: 46.43 on 3 and 233 DF,  p-value: < 2.2e-16
##
##
## Value of test-statistic is: -7.6321 19.4263 29.138
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47
```

```r
summary(ur.df(FRED$inflation, type = "trend")) ##reject null of unit root.
```

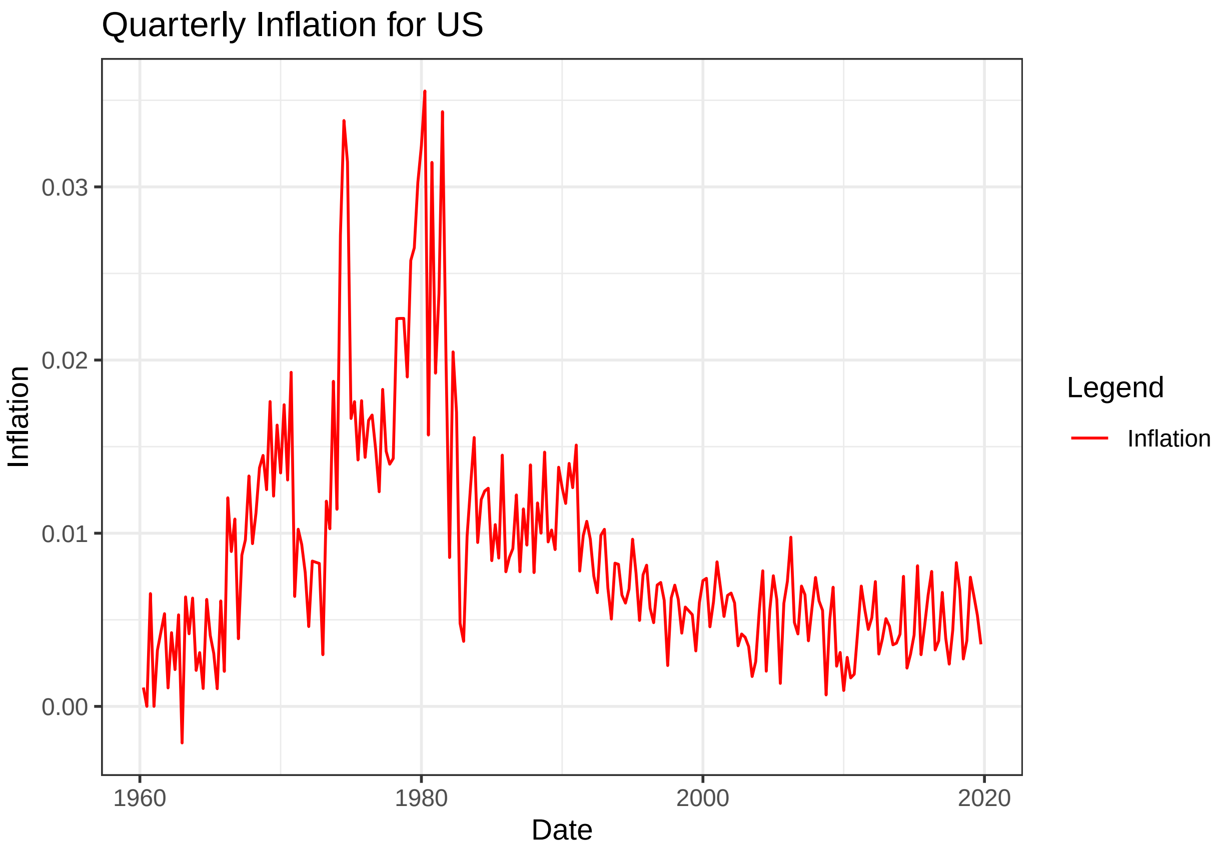
```
##
## ###############################################
## # Augmented Dickey-Fuller Test Unit Root Test #
## ###############################################
```

```
##
## Test regression trend
##
##
## Call:
## lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -0.0146022 -0.0022156 -0.0000437  0.0020895  0.0146748
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.622e-03  7.658e-04   3.424 0.000729 ***
## z.lag.1     -1.781e-01  4.318e-02  -4.124 5.18e-05 ***
## tt          -8.178e-06  3.990e-06  -2.049 0.041543 *
## z.diff.lag  -3.387e-01  6.096e-02  -5.556 7.53e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.003905 on 233 degrees of freedom
## Multiple R-squared:  0.2367, Adjusted R-squared:  0.2269
## F-statistic: 24.09 on 3 and 233 DF,  p-value: 1.294e-13
##
##
## Value of test-statistic is: -4.1242 5.779 8.6645
##
## Critical values for test statistics:
##       1pct  5pct 10pct
## tau3 -3.99 -3.43 -3.13
## phi2  6.22  4.75  4.07
## phi3  8.43  6.49  5.47
```

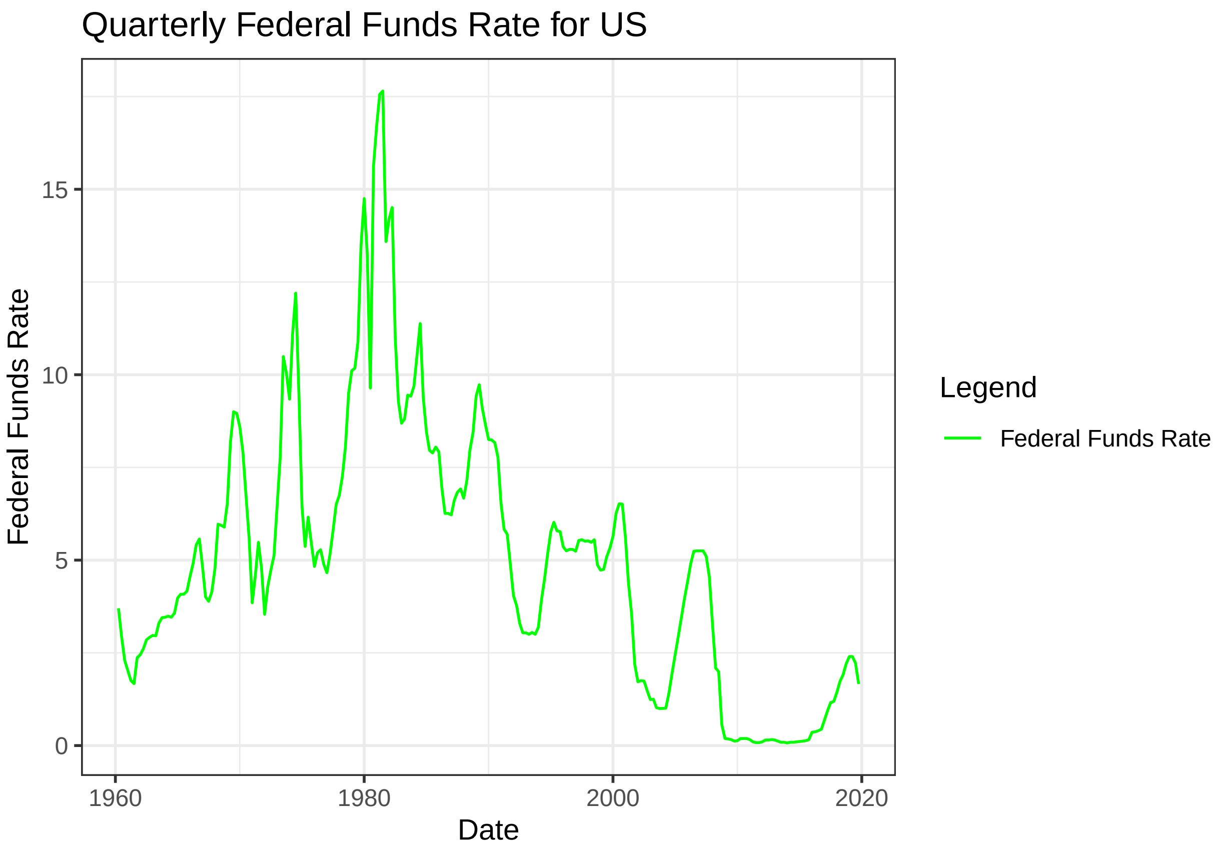
```r
##Plots
cols <- c("Growth" = "blue")
ggplot(data=FRED, aes(x=date)) +
  theme_bw() +
  geom_line(aes(y= growth, color = "Growth")) +
  scale_colour_manual(name="Legend",values=cols) +
  labs(x = "Date", y = "Growth", title = "Quarterly Growth for US")
```



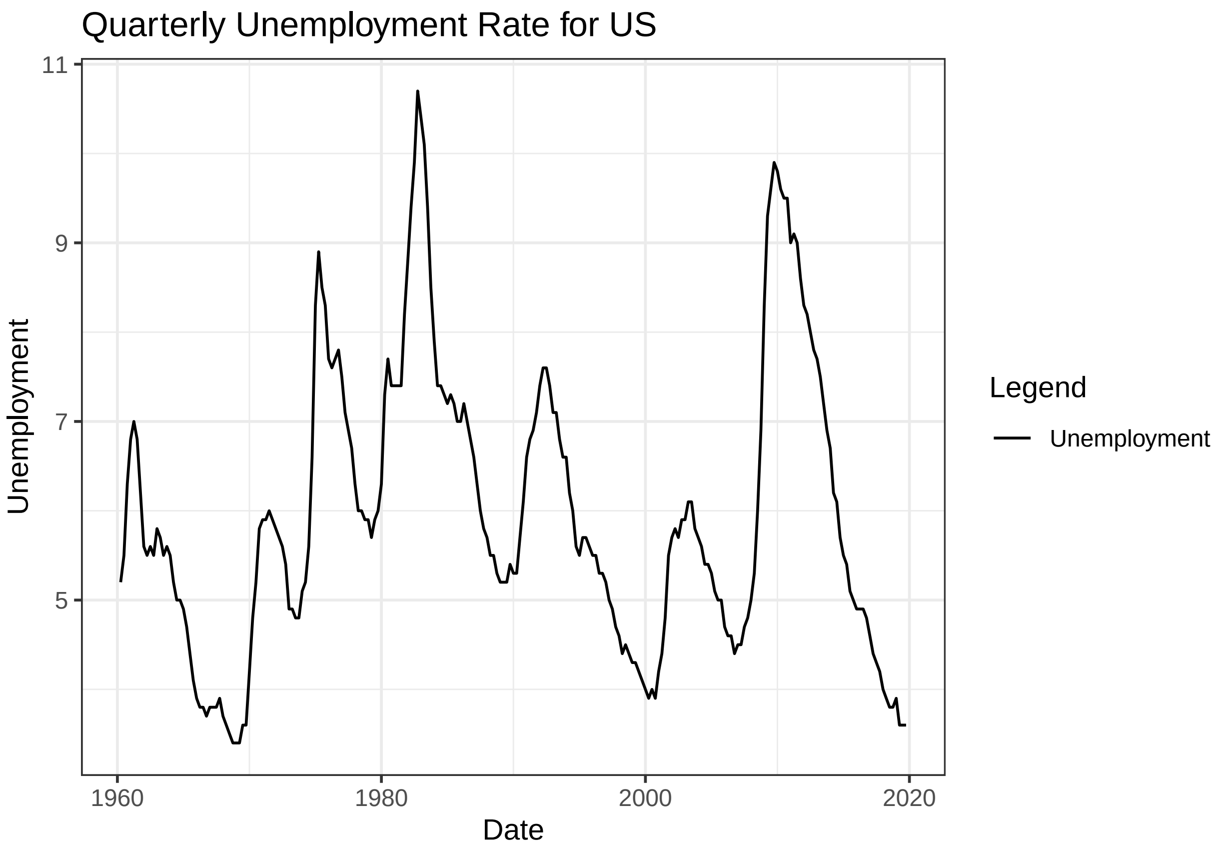

```
cols <- c("Inflation" = "red")
ggplot(data=FRED, aes(x=date)) +
  theme_bw() +
  geom_line(aes(y= inflation, color = "Inflation")) +
  scale_colour_manual(name="Legend",values=cols) +
  labs(x = "Date", y = "Inflation", title = "Quarterly Inflation for US")
```




```r
cols <- c("Federal Funds Rate" = "green")
ggplot(data=FRED, aes(x=date)) +
  theme_bw() +
  geom_line(aes(y= FF , color = "Federal Funds Rate")) +
  scale_colour_manual(name="Legend",values=cols) +
  labs(x = "Date", y = "Federal Funds Rate", title = "Quarterly Federal Funds Rate for US")
```




```
cols <- c("Unemployment" = "black")
ggplot(data=FRED, aes(x=date)) +
  theme_bw() +
  geom_line(aes(y= UNRATE, color = "Unemployment")) +
  scale_colour_manual(name="Legend",values=cols) +
  labs(x = "Date", y = "Unemployment", title = "Quarterly Unemployment Rate for US")
```




```r
##Question 2
##Vector Autoregression in Reduced Form
VARDATA <- ts(cbind(FRED$FF,FRED$growth, FRED$inflation, FRED$UNRATE),
              names = c("FF_rate","growth", "inflation", "unemp"))
print(VARselect(VARDATA,type="const", lag.max = 10))
```

```
## $selection
## AIC(n)  HQ(n)  SC(n) FPE(n)
##     10      5      2     10
##
## $criteria
##                    1             2             3             4             5
## AIC(n) -2.447140e+01 -2.492755e+01 -2.503557e+01 -2.514266e+01 -2.527477e+01
## HQ(n)  -2.435041e+01 -2.470979e+01 -2.472102e+01 -2.473132e+01 -2.476664e+01
## SC(n)  -2.417151e+01 -2.438775e+01 -2.425586e+01 -2.412304e+01 -2.401524e+01
## FPE(n)  2.356243e-11  1.493384e-11  1.340916e-11  1.205477e-11  1.057319e-11
##                    6             7             8             9            10
## AIC(n) -2.535900e+01 -2.533957e+01 -2.529242e+01 -2.537232e+01 -2.544364e+01
## HQ(n)  -2.475408e+01 -2.463787e+01 -2.449394e+01 -2.447705e+01 -2.445158e+01
## SC(n)  -2.385955e+01 -2.360021e+01 -2.331316e+01 -2.315314e+01 -2.298455e+01
## FPE(n)  9.732970e-12  9.943543e-12  1.045084e-11  9.680663e-12  9.052042e-12
```

```r
#go for 2 lag: we have large data and SIC good for this


var1 <- VAR(VARDATA ,p=2 , type="const")
print(summary(var1))
```

```
##
## VAR Estimation Results:
## =========================
## Endogenous variables: FF_rate, growth, inflation, unemp
## Deterministic variables: const
## Sample size: 237
## Log Likelihood: 1644.968
## Roots of the characteristic polynomial:
## 0.9679 0.8319 0.8319 0.8178 0.3769 0.1263 0.1219 0.1219
## Call:
## VAR(y = VARDATA, p = 2, type = "const")
##
##
## Estimation results for equation FF_rate:
## ========================================
## FF_rate = FF_rate.l1 + growth.l1 + inflation.l1 + unemp.l1 + FF_rate.l2 + growth.l2 + inflation.l2 +
##
##               Estimate Std. Error t value Pr(>|t|)
## FF_rate.l1     1.17865    0.07367  15.999  < 2e-16 ***
## growth.l1     13.63832    8.35946   1.631 0.104169
## inflation.l1 -50.83769   14.72859  -3.452 0.000664 ***
## unemp.l1      -0.58447    0.24729  -2.364 0.018942 *
## FF_rate.l2    -0.22785    0.07349  -3.100 0.002177 **
## growth.l2      1.93328    7.66257   0.252 0.801035
## inflation.l2  71.33841   14.59430   4.888 1.92e-06 ***
## unemp.l2       0.55058    0.24307   2.265 0.024448 *
## const          0.14060    0.23366   0.602 0.547957
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.7958 on 228 degrees of freedom
## Multiple R-Squared: 0.9544,  Adjusted R-squared: 0.9528
## F-statistic: 596.3 on 8 and 228 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation growth:
## =======================================
## growth = FF_rate.l1 + growth.l1 + inflation.l1 + unemp.l1 + FF_rate.l2 + growth.l2 + inflation.l2 + u
##
##                Estimate Std. Error t value Pr(>|t|)
## FF_rate.l1   -0.0006702  0.0006819  -0.983   0.3267
## growth.l1     0.1614790  0.0773713   2.087   0.0380 *
## inflation.l1 -0.0583661  0.1363211  -0.428   0.6689
## unemp.l1     -0.0038901  0.0022888  -1.700   0.0906 .
## FF_rate.l2    0.0007554  0.0006802   1.111   0.2679
## growth.l2     0.1544833  0.0709213   2.178   0.0304 *
## inflation.l2 -0.1641604  0.1350782  -1.215   0.2255
## unemp.l2      0.0045175  0.0022498   2.008   0.0458 *
## const         0.0029206  0.0021626   1.351   0.1782
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
```

```
## Residual standard error: 0.007365 on 228 degrees of freedom
## Multiple R-Squared: 0.197,   Adjusted R-squared: 0.1688
## F-statistic: 6.991 on 8 and 228 DF,  p-value: 3.049e-08
##
##
## Estimation results for equation inflation:
## ==========================================
## inflation = FF_rate.l1 + growth.l1 + inflation.l1 + unemp.l1 + FF_rate.l2 + growth.l2 + inflation.l2
##
##                Estimate Std. Error t value Pr(>|t|)
## FF_rate.l1    0.0017505  0.0003332   5.254 3.41e-07 ***
## growth.l1    -0.0399616  0.0378054  -1.057   0.2916
## inflation.l1  0.2780240  0.0666097   4.174 4.26e-05 ***
## unemp.l1     -0.0024253  0.0011184  -2.169   0.0311 *
## FF_rate.l2   -0.0013572  0.0003324  -4.083 6.14e-05 ***
## growth.l2    -0.0853961  0.0346538  -2.464   0.0145 *
## inflation.l2  0.4161667  0.0660023   6.305 1.47e-09 ***
## unemp.l2      0.0023554  0.0010993   2.143   0.0332 *
## const         0.0021706  0.0010567   2.054   0.0411 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.003599 on 228 degrees of freedom
## Multiple R-Squared: 0.7202,  Adjusted R-squared: 0.7104
## F-statistic: 73.37 on 8 and 228 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation unemp:
## ======================================
## unemp = FF_rate.l1 + growth.l1 + inflation.l1 + unemp.l1 + FF_rate.l2 + growth.l2 + inflation.l2 + un
##
##               Estimate Std. Error t value Pr(>|t|)
## FF_rate.l1   -0.002893   0.020977  -0.138 0.890435
## growth.l1    -7.259181   2.380229  -3.050 0.002561 **
## inflation.l1 10.471607   4.193744   2.497 0.013233 *
## unemp.l1      1.379726   0.070412  19.595  < 2e-16 ***
## FF_rate.l2    0.013733   0.020926   0.656 0.512314
## growth.l2    -7.464199   2.181802  -3.421 0.000739 ***
## inflation.l2 -5.136652   4.155506  -1.236 0.217691
## unemp.l2     -0.420976   0.069212  -6.082 4.95e-09 ***
## const         0.247864   0.066530   3.726 0.000246 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.2266 on 228 degrees of freedom
## Multiple R-Squared: 0.981,   Adjusted R-squared: 0.9803
## F-statistic:  1470 on 8 and 228 DF,  p-value: < 2.2e-16
##
##
##
## Covariance matrix of residuals:
##             FF_rate     growth  inflation      unemp
```

```
## FF_rate    0.6332820  1.418e-03  9.623e-04 -5.872e-02
## growth     0.0014179  5.425e-05 -3.155e-07 -8.796e-04
## inflation  0.0009623 -3.155e-07  1.295e-05 -3.765e-05
## unemp     -0.0587236 -8.796e-04 -3.765e-05  5.134e-02
##
## Correlation matrix of residuals:
##           FF_rate  growth inflation    unemp
## FF_rate    1.0000  0.2419   0.33600 -0.32567
## growth     0.2419  1.0000  -0.01190 -0.52703
## inflation  0.3360 -0.0119   1.00000 -0.04617
## unemp     -0.3257 -0.5270  -0.04617  1.00000
```

```
stargazer::stargazer(var1$varresult$growth, var1$varresult$inflation,
                     var1$varresult$FF_rate, var1$varresult$unemp)
```

```
##
## % Table created by stargazer v.5.2.2 by Marek Hlavac, Harvard University. E-mail: hlavac at fas.harva
## % Date and time: Mon, Apr 17, 2023 - 16:42:14
## \begin{table}[!htbp] \centering
##   \caption{}
##   \label{}
## \begin{tabular}{@{\extracolsep{5pt}}lcccc}
## \\[-1.8ex]\hline
## \hline \\[-1.8ex]
##  & \multicolumn{4}{c}{\textit{Dependent variable:}} \\
## \cline{2-5}
## \\[-1.8ex] & \multicolumn{4}{c}{y} \\
## \\[-1.8ex] & (1) & (2) & (3) & (4)\\
## \hline \\[-1.8ex]
##  FF\_rate.l1 & $-$0.001 & 0.002$^{***}$ & 1.179$^{***}$ & $-$0.003 \\
##   & (0.001) & (0.0003) & (0.074) & (0.021) \\
##   & & & & \\
##  growth.l1 & 0.161$^{**}$ & $-$0.040 & 13.638 & $-$7.259$^{***}$ \\
##   & (0.077) & (0.038) & (8.359) & (2.380) \\
##   & & & & \\
##  inflation.l1 & $-$0.058 & 0.278$^{***}$ & $-$50.838$^{***}$ & 10.472$^{**}$ \\
##   & (0.136) & (0.067) & (14.729) & (4.194) \\
##   & & & & \\
##  unemp.l1 & $-$0.004$^{*}$ & $-$0.002$^{**}$ & $-$0.584$^{**}$ & 1.380$^{***}$ \\
##   & (0.002) & (0.001) & (0.247) & (0.070) \\
##   & & & & \\
##  FF\_rate.l2 & 0.001 & $-$0.001$^{***}$ & $-$0.228$^{***}$ & 0.014 \\
##   & (0.001) & (0.0003) & (0.073) & (0.021) \\
##   & & & & \\
##  growth.l2 & 0.154$^{**}$ & $-$0.085$^{**}$ & 1.933 & $-$7.464$^{***}$ \\
##   & (0.071) & (0.035) & (7.663) & (2.182) \\
##   & & & & \\
##  inflation.l2 & $-$0.164 & 0.416$^{***}$ & 71.338$^{***}$ & $-$5.137 \\
##   & (0.135) & (0.066) & (14.594) & (4.156) \\
##   & & & & \\
##  unemp.l2 & 0.005$^{**}$ & 0.002$^{**}$ & 0.551$^{**}$ & $-$0.421$^{***}$ \\
##   & (0.002) & (0.001) & (0.243) & (0.069) \\
##   & & & & \\
##  const & 0.003 & 0.002$^{**}$ & 0.141 & 0.248$^{***}$ \\
##   & (0.002) & (0.001) & (0.234) & (0.067) \\
```

```
##   & & & & \\
## \hline \\[-1.8ex]
## Observations & 237 & 237 & 237 & 237 \\
## R$^{2}$ & 0.197 & 0.720 & 0.954 & 0.981 \\
## Adjusted R$^{2}$ & 0.169 & 0.710 & 0.953 & 0.980 \\
## Residual Std. Error (df = 228) & 0.007 & 0.004 & 0.796 & 0.227 \\
## F Statistic (df = 8; 228) & 6.991$^{***}$ & 73.373$^{***}$ & 596.274$^{***}$ & 1,469.768$^{***}$ \\
## \hline
## \hline \\[-1.8ex]
## \textit{Note:}  & \multicolumn{4}{r}{$^{*}$p$<$0.1; $^{**}$p$<$0.05; $^{***}$p$<$0.01} \\
## \end{tabular}
## \end{table}
```

```
##Question 3
##by hand


##Question 4 - 8 were implemented in STATA
##Question 4 and 5
##Question 6
##Question 7
##Question 8
```