Econometrics III
Assignment Part I

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Contents

```
# load packages
if(!require(pacman)){install.packages("pacman")}

p_load(devtools,tidyverse,dplyr,ggplot2,latex2exp,stargazer, fixest,
↪   modelsummary, knitr, readr, tseries, lmtest, forecast)

dfAssign_p1 <- as.data.frame(read_csv("data_assign_p1.csv"))

# Encode quarters
dfAssign_p1 <-
↪   cbind(dfAssign_p1,c(seq(1,nrow(dfAssign_p1),length.out=nrow(dfAssign_p1))))
colnames(dfAssign_p1) <- c("obs", "GDP_QGR", "ind")
```
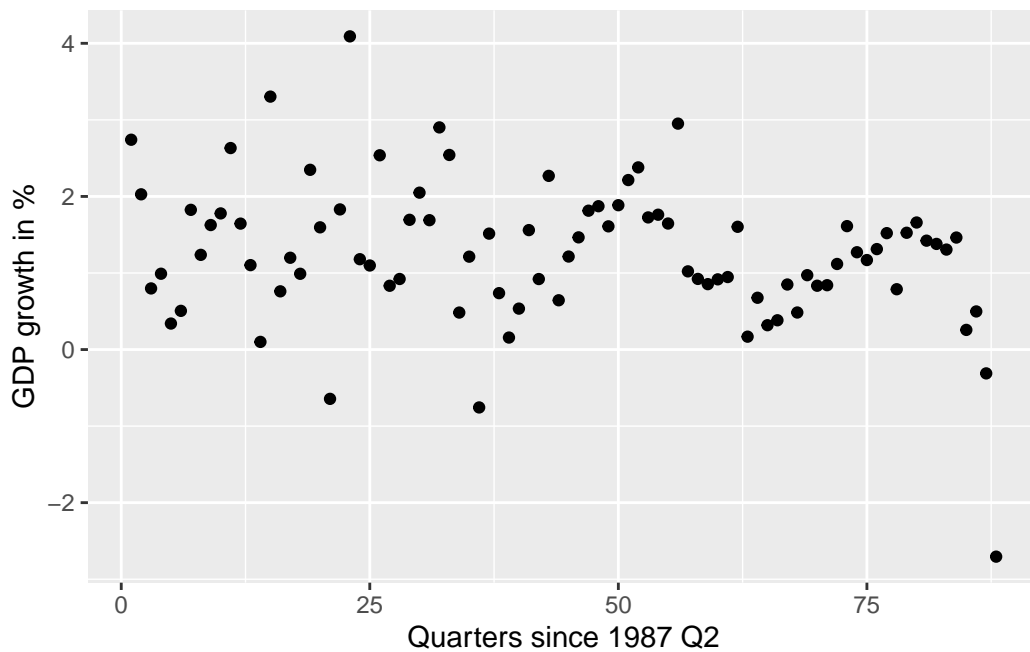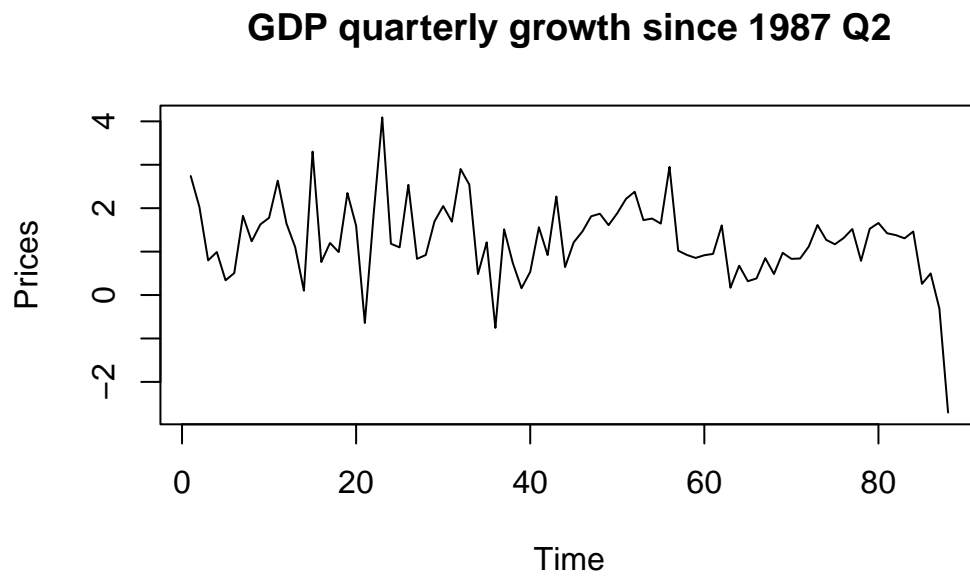
1 Question 1

```
ggplot(dfAssign_p1, aes(x = ind, y = GDP_QGR)) + geom_point() +
↪   ylab("GDP growth in %") + xlab("Quarters since 1987 Q2")
```

```
plot.ts(dfAssign_p1$GDP_QGR, main="GDP quarterly growth since 1987 Q2",
↪  ylab="Prices")
```
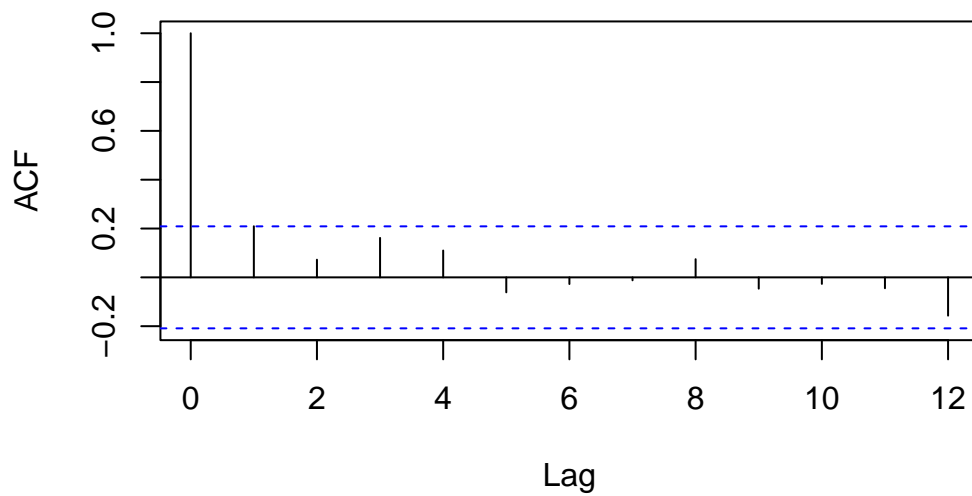
GDP quarterly growth since 1987 Q2


```
acf(dfAssign_p1$GDP_QGR,12,pl=F)
```

```
Autocorrelations of series 'dfAssign_p1$GDP_QGR', by lag

     0      1      2      3      4      5      6      7      8      9     10
 1.000  0.209  0.072  0.162  0.110 -0.061 -0.027 -0.012  0.075 -0.046 -0.027
    11     12
-0.045 -0.157
```

```
acf(dfAssign_p1$GDP_QGR,12,pl=T)
```

Series dfAssign_p1$GDP_QGR


```
pacf(dfAssign_p1$GDP_QGR,12,pl=F)
```
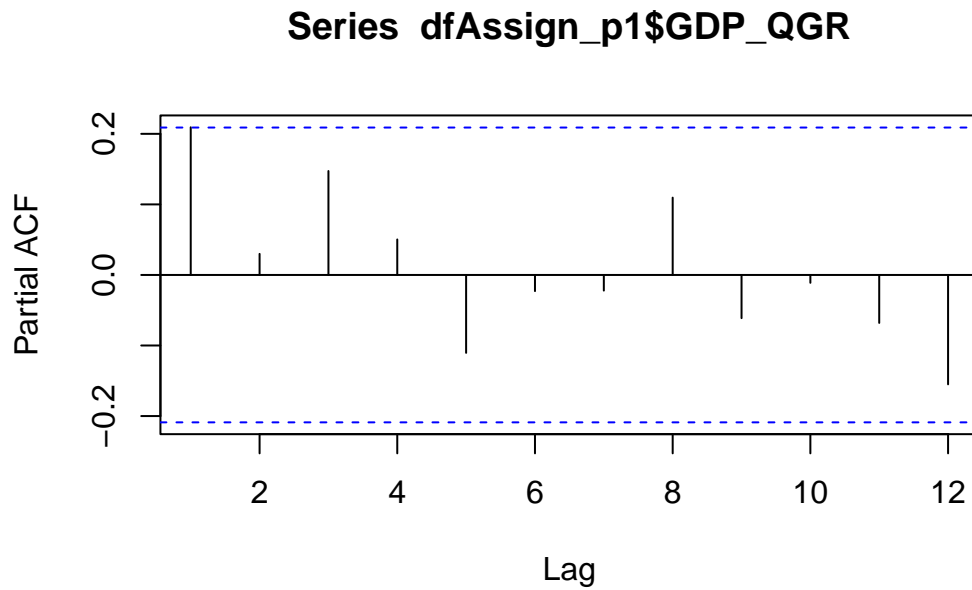
Partial autocorrelations of series 'dfAssign_p1$GDP_QGR', by lag

```
     1       2       3       4       5       6       7       8       9      10      11
 0.209   0.030   0.147   0.050  -0.110  -0.023  -0.022   0.110  -0.061  -0.011  -0.068
    12
-0.155
```

```
pacf(dfAssign_p1$GDP_QGR,12,pl=T)
```

Series dfAssign_p1$GDP_QGR

2 Question 2

```r
ar4 <- arima(dfAssign_p1$GDP_QGR, order=c(4,0,0))
#coeftest(ar4)

ar3 <- arima(dfAssign_p1$GDP_QGR, order=c(3,0,0))
#coeftest(ar3)

ar2 <- arima(dfAssign_p1$GDP_QGR, order=c(2,0,0))
#coeftest(ar2)

ar1 <- arima(dfAssign_p1$GDP_QGR, order=c(1,0,0))
#coeftest(ar1)
```

```r
stargazer::stargazer(ar4,ar3,ar2,ar1, title="Estimating the AR(4) to
↪  AR(1) models on GDP data",  align=TRUE, label = "tab_ar4",
↪  table.placement="H", out = "tab_ar4.tex")
```

Table 1: Estimating the AR(4) to AR(1) models on GDP data

	Dependent variable:			
	(1)	(2)	(3)	(4)
ar1	0.242**	0.256**	0.263**	0.272**
	(0.118)	(0.117)	(0.119)	(0.118)
ar2	0.030	0.030	0.058	
	(0.120)	(0.120)	(0.121)	
ar3	0.189	0.200*		
	(0.119)	(0.119)		
ar4	0.086			
	(0.120)			
intercept	1.214***	1.228***	1.249***	1.253***
	(0.204)	(0.180)	(0.140)	(0.130)
Observations	88	88	88	88
Log Likelihood	-113.211	-113.468	-114.849	-114.963
σ^2	0.765	0.770	0.796	0.798
Akaike Inf. Crit.	238.421	236.936	237.698	235.925

Note: *p<0.1; **p<0.05; ***p<0.01

3 Question 3
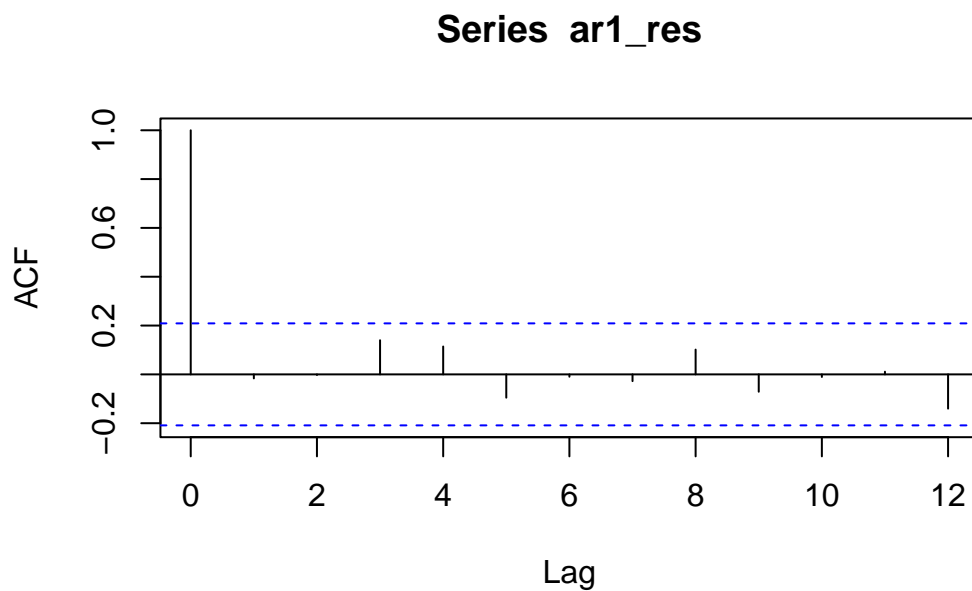
```r
ar1_res <- as.numeric(ar1[["residuals"]])
acf(ar1_res,12,pl=F)
```

Autocorrelations of series 'ar1_res', by lag

```
    0      1      2      3      4      5      6      7      8      9     10
1.000 -0.017 -0.003  0.140  0.114 -0.096 -0.010 -0.028  0.102 -0.071 -0.011
   11     12
0.011 -0.140
```

```
acf(ar1_res,12,pl=T)
```

Series ar1_res

4 Question 4

```
forecast8 <- forecast(ar1, 8, level = c(95))
predlbl <- c("2009Q2", "2009Q3", "2009Q4", "2010Q1", "2010Q2", "2010Q3",
↪  "2010Q4", "2011Q1")
forecast_q4 <- cbind(predlbl, as.data.frame(forecast8))

kable(forecast_q4[,1:2], caption="The predicted quarterly GDP growth
↪  rates using ARIMA(1,0,0)", col.names = c("Quarter", "Predicted
↪  growth %"), digits = 3, row.names = F)
```

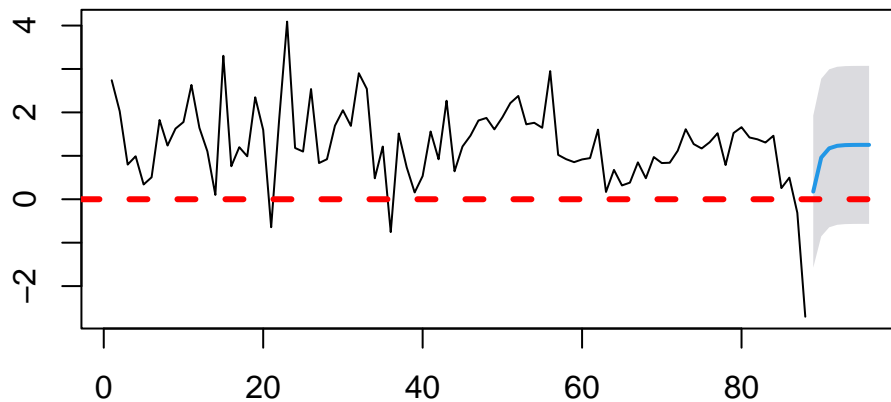Table 2: The predicted quarterly GDP growth rates using ARIMA(1,0,0)

Quarter	Predicted growth %
2009Q2	0.177
2009Q3	0.960

7

Quarter	Predicted growth %
2009Q4	1.173
2010Q1	1.231
2010Q2	1.247
2010Q3	1.251
2010Q4	1.252
2011Q1	1.253

5 Question 5

```
plot(forecast8) %>%
abline(h=0, col="red", lwd=3, lty=2)
```
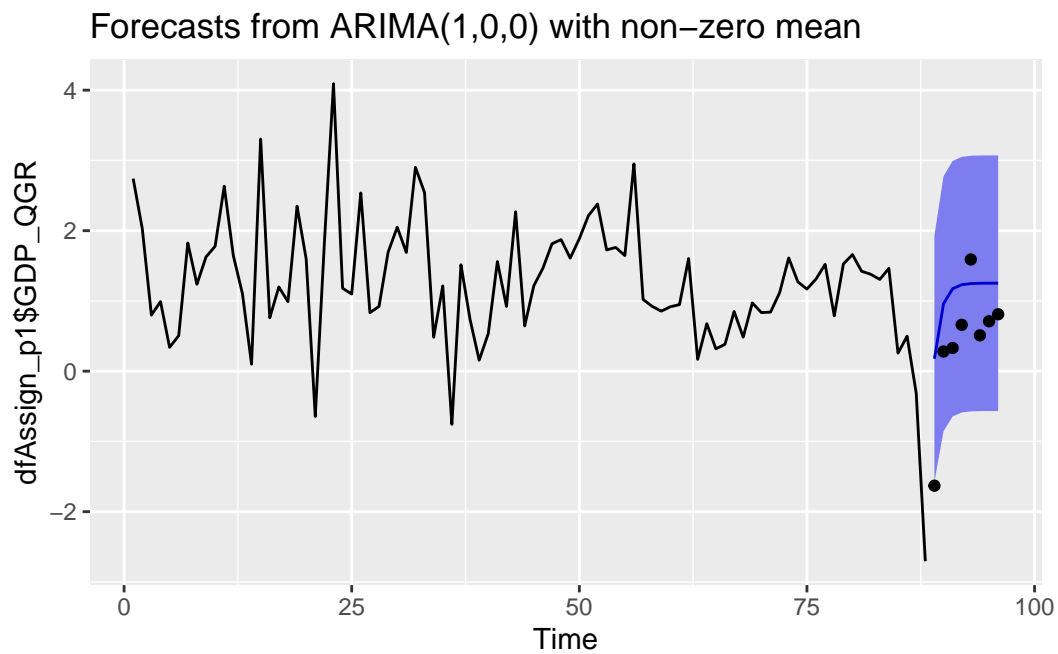
Forecasts from ARIMA(1,0,0) with non−zero mean

6 Question 6

7 Question 7

```
dfActuals <- data.frame(x=c(89, 90, 91, 92, 93, 94, 95, 96),
          y=c(-1.63, 0.28, 0.33, 0.66, 1.59, 0.51, 0.71, 0.81))

autoplot(forecast8, showgap = F) + geom_point(data = dfActuals, aes(x=x,
↪   y=y))
```

Forecasts from ARIMA(1,0,0) with non−zero mean

8 Question 8

```
ar4_10 <- arima(dfAssign_p1$GDP_QGR, order=c(4,0,0))
coeftest(ar4_10)
```

z test of coefficients:

```
          Estimate Std. Error z value  Pr(>|z|)
ar1       0.241960   0.117749  2.0549   0.03989 *
ar2       0.029955   0.119538  0.2506   0.80213
ar3       0.189023   0.119463  1.5823   0.11359
ar4       0.086413   0.120151  0.7192   0.47201
intercept 1.214421   0.203636  5.9637 2.466e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
ar3_10 <- arima(dfAssign_p1$GDP_QGR, order=c(3,0,0))
coeftest(ar3_10)
```

```
z test of coefficients:

          Estimate Std. Error z value  Pr(>|z|)
ar1       0.255536   0.116737  2.1890   0.02860 *
ar2       0.029868   0.120377  0.2481   0.80404
ar3       0.200007   0.119049  1.6800   0.09295 .
intercept 1.228330   0.179893  6.8281 8.605e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
forecast_10 <- forecast(ar3_10, 8, level = c(90))
forecast_10db <- cbind(predlbl, as.data.frame(forecast_10))

kable(forecast_10db[,1:2], caption="The predicted quarterly GDP growth
  ↪  rates using ARIMA(1,0,0) and 90% CI", col.names = c("Quarter",
  ↪  "Predicted growth %"), digits = 3, row.names = F)
```
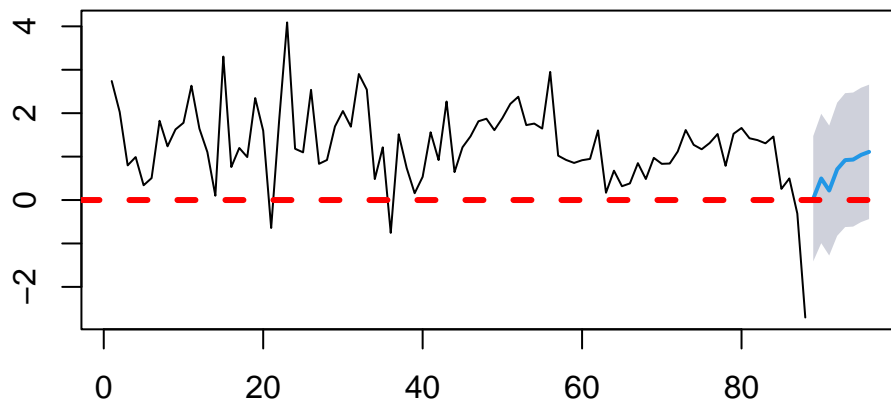
Table 3: The predicted quarterly GDP growth rates using ARIMA(1,0,0) and 90% CI

Quarter	Predicted growth %
2009Q2	0.031
2009Q3	0.497
2009Q4	0.219
2010Q1	0.709
2010Q2	0.919
2010Q3	0.932
2010Q4	1.040

Quarter	Predicted growth %
2011Q1	1.109

```
plot(forecast_10) %>%
abline(h=0, col="red", lwd=3, lty=2)
```

Forecasts from ARIMA(3,0,0) with non−zero mean


```
autoplot(forecast_10, showgap = F) + geom_point(data = dfActuals,
↪  aes(x=x, y=y))
```

Forecasts from ARIMA(3,0,0) with non−zero mean