Assignment - 10

ECON

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Q.9.2

a) As expected, advertising has ~~is~~ * positive impact on sales. The effect is on current week as well as next two weeks or we can say for this week, there is effect from last two weeks. The maximum impact is in next week after advertising.

total effect =

$1.842 + 3.802 + 2.265 = 7.909$

sustained one million increase in adv. will increase sales by 7.909 million keeping all else constant.

b) 5% 1 10/1.

t_c = t_c =

One tain 5%.	One tail 10%.	two tail 5%.	two tail 10%.
~~1.66~~ 1.66	1.289	1.98	1.66

$H_0: \beta_t = 0$

$H_1: \beta_t \neq 0$

$\frac{1.842}{\sqrt{1.3916}} = 1.559$

Significant at one tail 10%.

H_0: $\beta_{t-1} = 0$ $\quad t = \frac{3.802}{\sqrt{2.1606}} = 2.586$

H_1: $\beta_{t-1} \neq 0$.

Significant at 5 & 10%. ~~bot~~

one & two tail.

H_0: $\beta_{t-2} = 0$ $\quad t = \frac{2.265}{\sqrt{1.4214}} = \frac{2.265}{1.9} = 1.899$

H_1: $\beta_{t-2} \neq 0$

significant at one & two tail 5 & 10%.

c) $t_c = (0.975), 101) = 1.984$

impact

~~one period~~ $= 1.842 \pm 1.984 \times \sqrt{1.3946}$

1.842 ± 2.342

$= -0.5009, 4.184$

one period $= \sqrt{\text{var}(b_0) + \text{var}(b_1) + 2\,\text{cov}(b_0 b_1)}$

$= \sqrt{1.3946 + 2.1606 + 2 \times -1.0406}$

$= 1.2140$

95% Conf int $= b_0 + b_1 \pm 1.984 \times 1.2140$

$= (3.2354, 8.052)$

total impact

$$\sqrt{\text{var } b_0 + \text{var } b_1 + \text{var } b_2 + 2\,\text{cov } b_0 b_1 + 2\,\text{cov } b_0 b_2 + \text{cov } b_1 b_2}$$

$$= \sqrt{1.3946 + 2.1606 + 1.4214 + 2 \times -1.0406 + 2 \times 0.0984 + 2 \times -1.0367}$$

$$= 1.009$$

95% cont interval

$$= 7.909 \pm 1.984 \times 1.009$$

$$= (5.907,\ 9.91)$$

Q.9.4 a)

$$\beta_1 = \frac{0.0979}{1.5436} = 0.0634$$

$$\beta_2 = \frac{0.1008}{1.5436} = 0.0653$$

b) $Z_{critical} = -1.959 \quad +1.959$

$Z S_1 = \sqrt{10} \times 0.0634 = 0.2004$

$H_0: S_1 = 0$
$H_1: S_1 \neq 0$

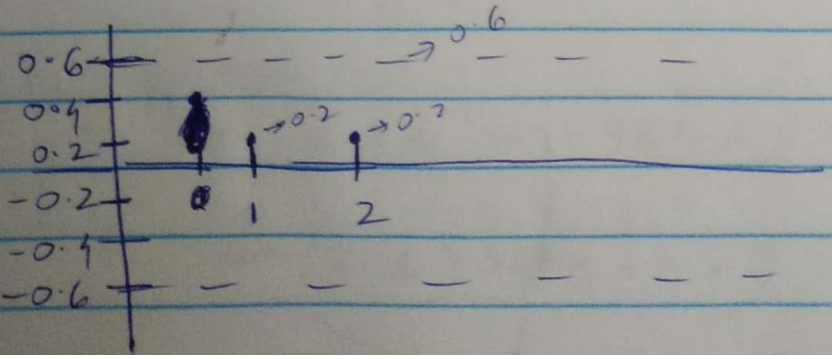
We fail to reject null hyp.
$\therefore S_1$ is not significantly diff from zero

$Z S_2 = \sqrt{10} \times 0.06353 = 0.2064$

$H_0: S_2 = 0$
$H_1: S_2 \neq 0$

We fail to reject the null hypothesis
$\therefore S_2$ is not significantly diff from zero

c) $\sqrt{10} \times x = \pm 1.959 \Rightarrow x = \pm 0.61$



Q. 9.6

a) An increase in interest rate by 1 unit (interest rate in percentage) ~~or change of~~ as compared ~~to~~ that of in previous month, will decrease the sale of houses by 53510 units ~~s~~ as compared ~~to~~ previous month

95% conf = $-53.51 \pm 1.971 \times 16.98$

$= -86.9771 \; -20.042$

∴ the number of household sold will decrea bet^n by 86977 & 20042 as compared ~~to~~ last month.

b) H_0: $\beta_{et-1} = 0$

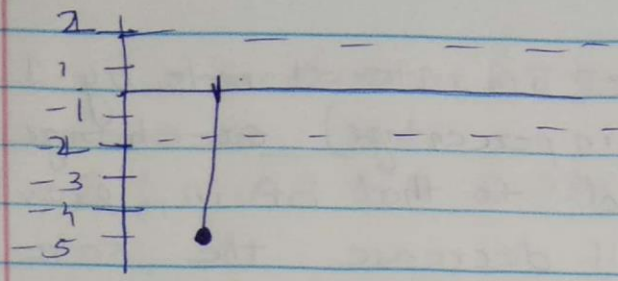
H_1: $\beta_{et-1} \neq 0$.

$t_{critical} = t_{(0.975, 215)} = \pm 1.97$

$t_{stat} = \dfrac{-0.3306}{0.0649} = -5.09$

$t_{stat} > t_{critical}$

∴ we reject the null hypothesis & conclude that there is auto correlation



c) 95% confint

$= -58.61 \pm 1.971 \times 14.10$

$= -86.40 \text{ & } -30.8189$

The lower bound of confidence interval is aprox the same but the upper bound changed significantly.
This shows that ignoring the autocorrelation gives incorrect std. errors & lead to incorrect confidence interval.

Q.9.22

a) Plotted using R

b) congwth = 0.973 + 0.449 x incgwth

So says 1% increase in income growth rate will increase consumption growth rate by ~~11 45~~ 0.45%.

$$AIC = \ln\left(\frac{SSE}{N}\right) + \frac{2K}{N} = -0.856$$

$$BIC = \ln\left(\frac{SSE}{N}\right) + \frac{k\left(\ln(N)\right)}{N} = -0.823$$

The correlogram suggests that there is significant correlation in errors at lag 2.

c) Adding lag for congwth

congwth = 0.671 + 0.271 Congwth(t-1) + 0.350 Incgwth$_t$

all significant at 5%.

AIC = -0.81
BIC = -0.76
} both values reduced compared to model 1

which says this is a better model

correlogram says high correlation in lag 1 & 2.

d) Adding cong with t-2

congwth = 0.424 + 0.159 congwth(t-1)
+ 0.2805 congwth(t-2)
+ 0.721 incgwth

θ_2 is significant at 5%.

AIC = -0.910
BIC = -0.84

AIC & BIC further reduced suggesting model 3 is better than 1

f) Adding congwth t-3 & incgwth t-2

congwth = 0.322 + 0.012 congwth(t-1)

+ 0.208 congwth(t-2) + 0.048 congwth$_{t-3}$

+ 0.341 incgwth + 0.22 ingwth$_{t-1}$

− 0.01 incgwth$_{t-2}$

The variables congwth t-3 & incgwth t-2 are not significant

correlogram also same as previous

g) dropping congwth t-1

congwth = 0.340 + 0.214 congwth t-2

+ 0.3554 ingwth + 0.241 incgwt$_{t}$

all significant at 5%

AIC = 1.003 } lowest AIC

BIC = −0.93 } & BIC.

The model is better than model e

~~Correlea~~
correlogram suggests that there is correlation at lag 1.

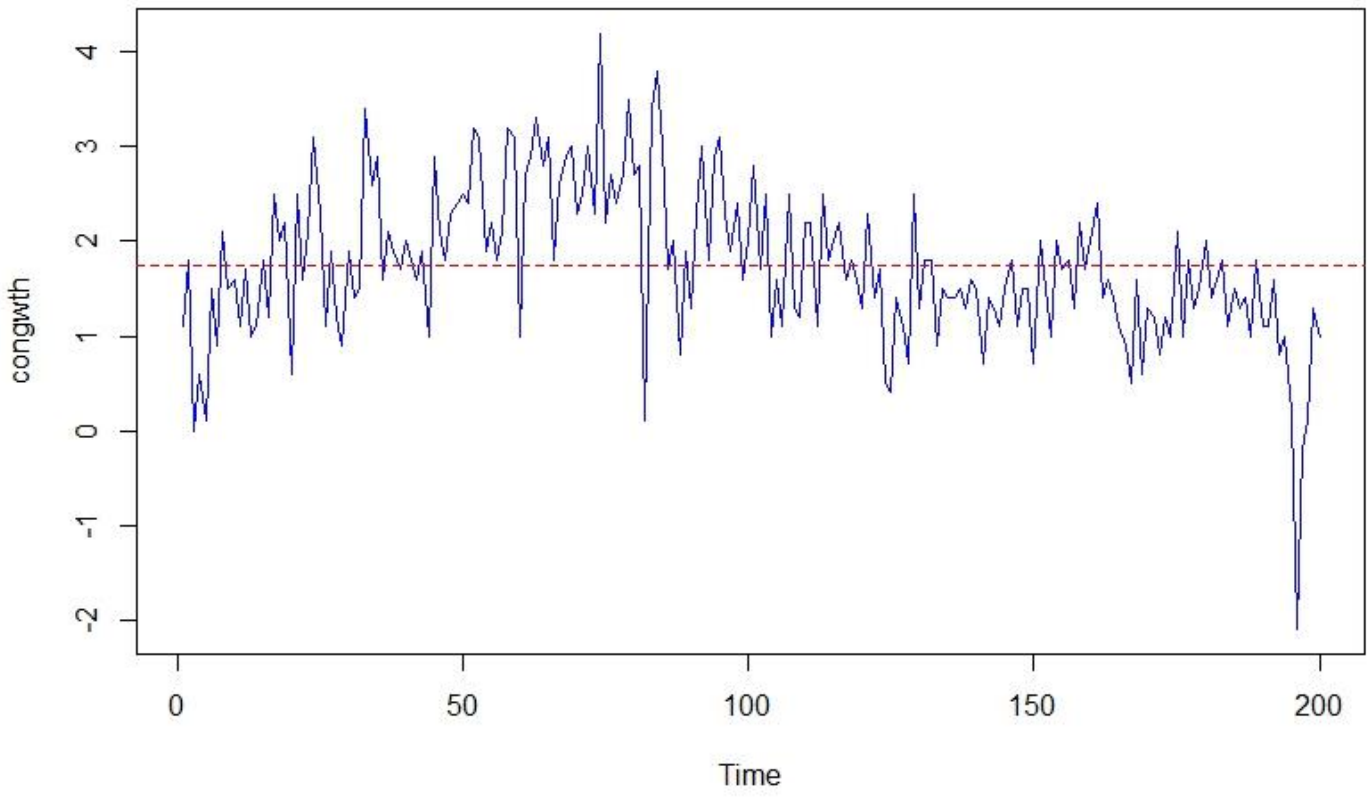
e) Adding incgwth t-1

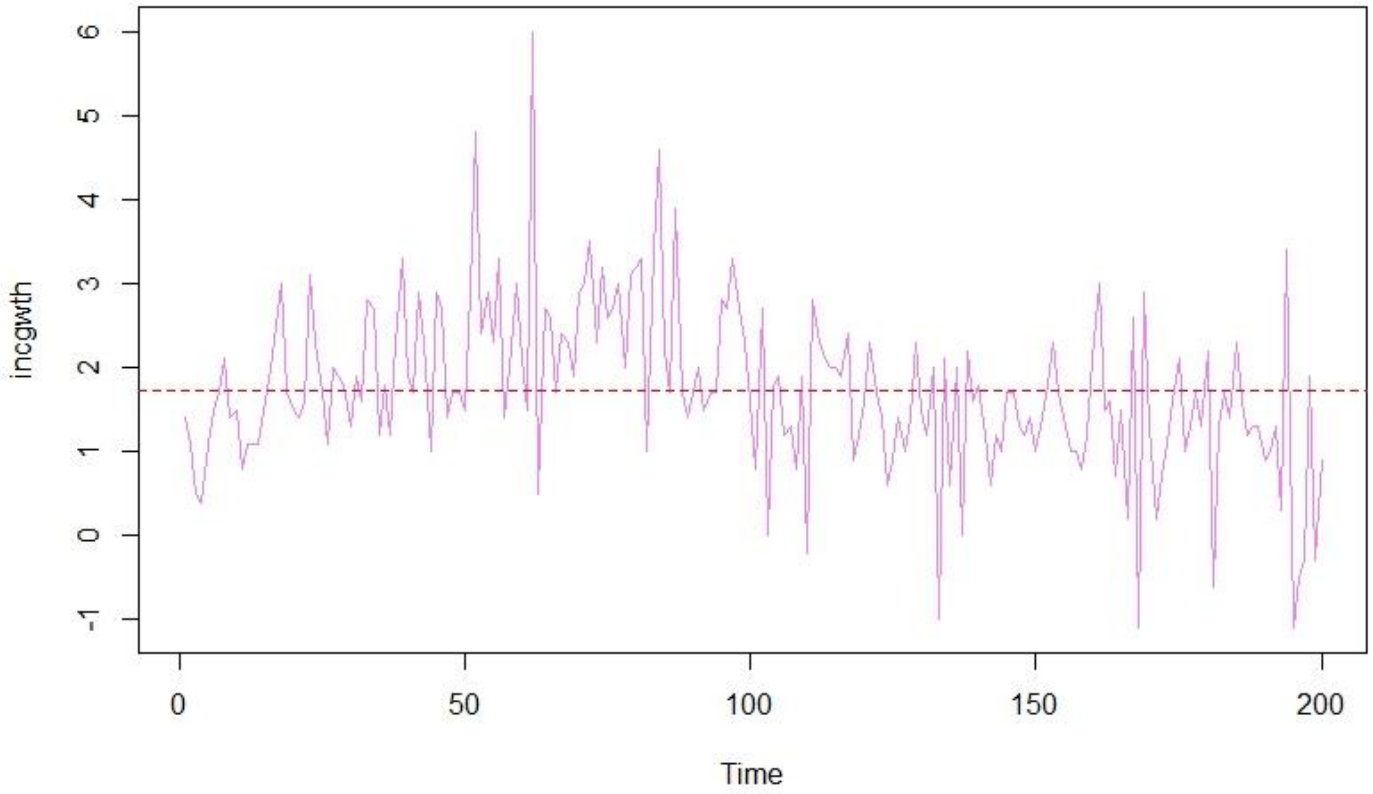
congwth = 0.3319 + 0.023 congwth t-1
+ 0.2101 congwth t-2
+ 0.349 incgwth + 0.233 incgwth t-1

all significant except congwth t-1 at 5%.
~~congwth t-1 → d, not.~~
d, significant.

AIC → -0.993
BIC → ~~-0.81~~ -0.91 ~~As~~ AIC & BIC reduced further. Better model
correlogram sohows significant correlating at lag 4

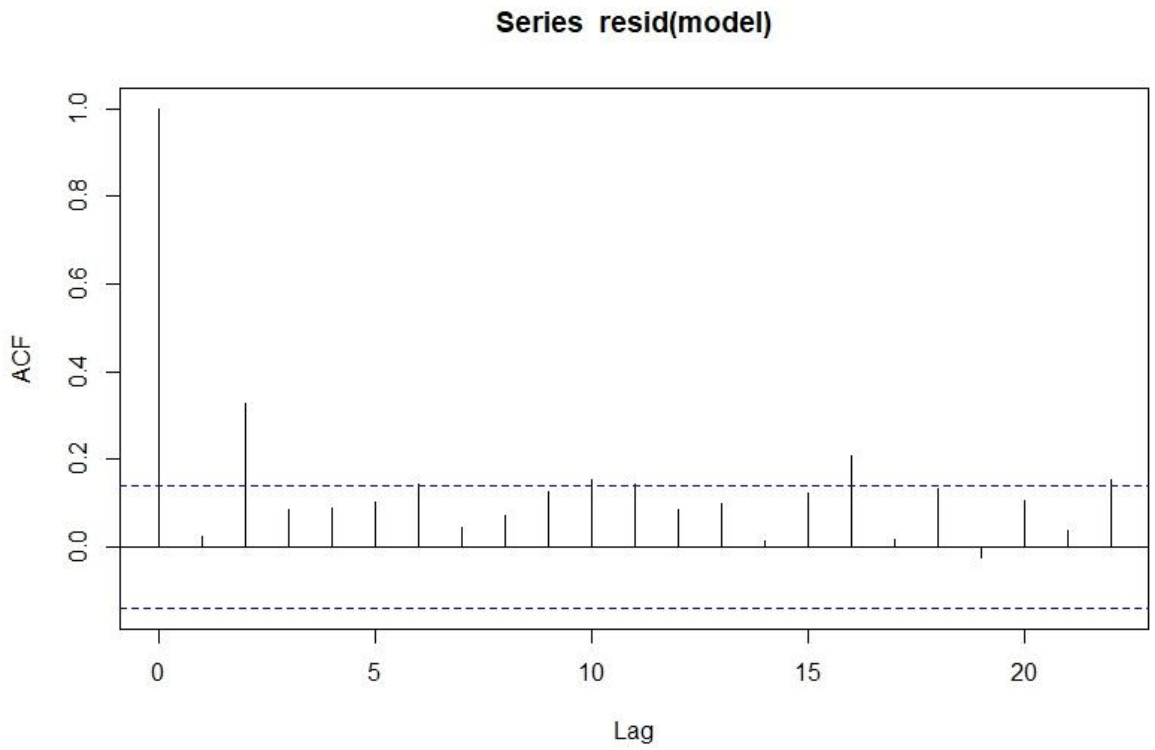
The correlogram shows very little correlation at lag 4.



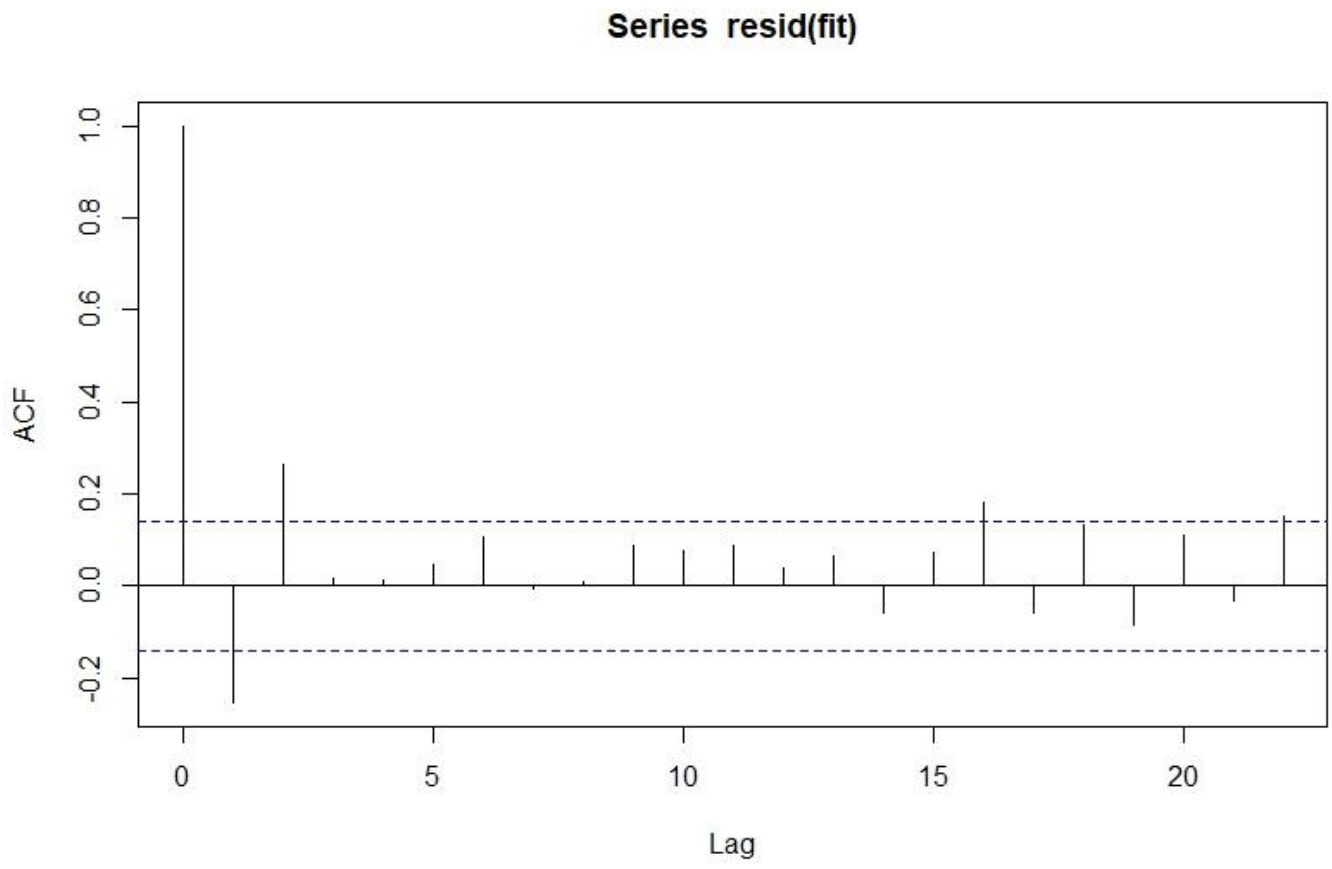


Both Time series appear to be fluctuating around their mean.

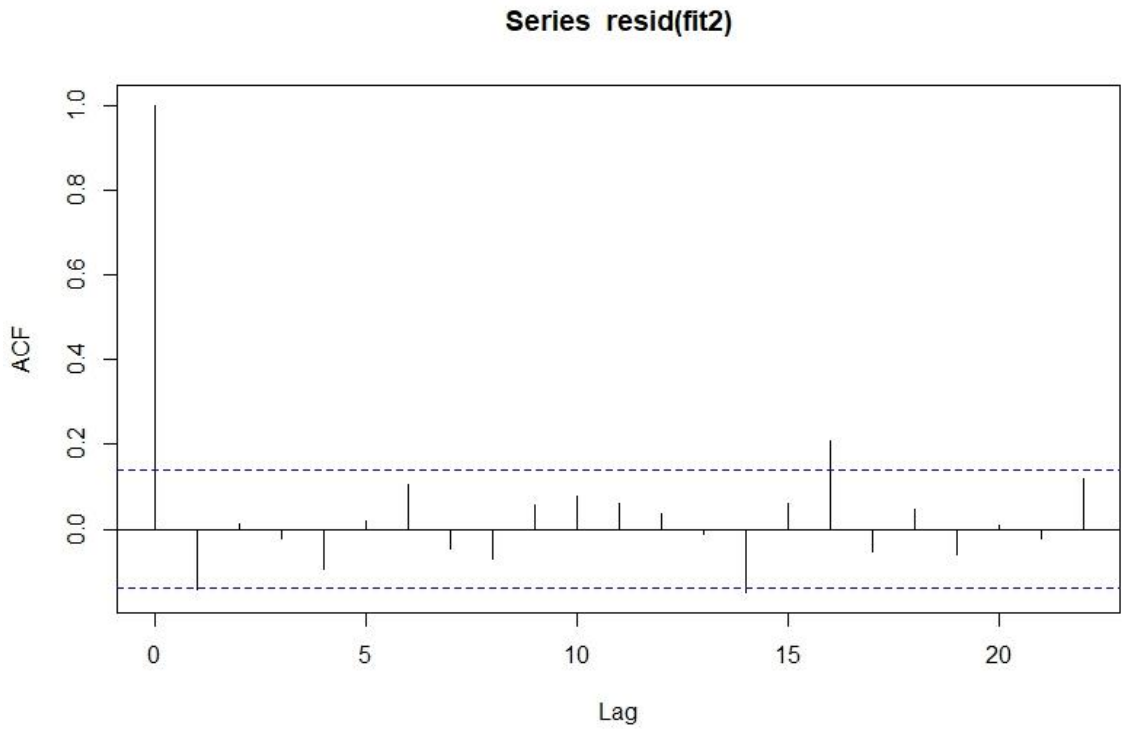
Correlogram part b



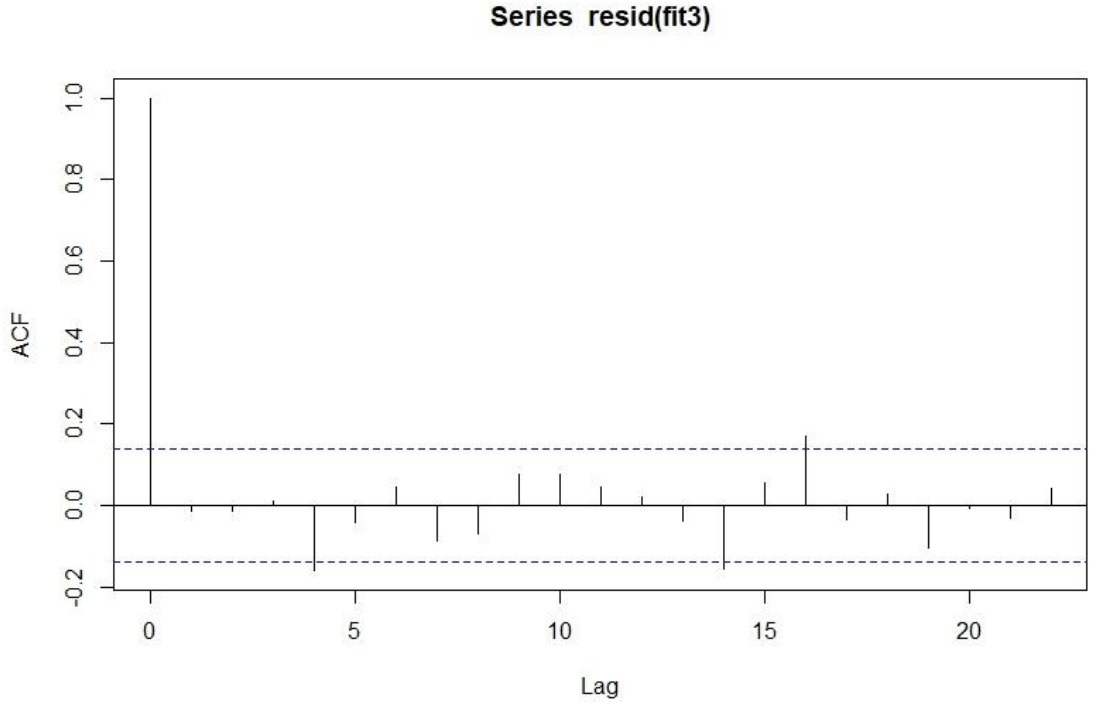
Correlogram part c



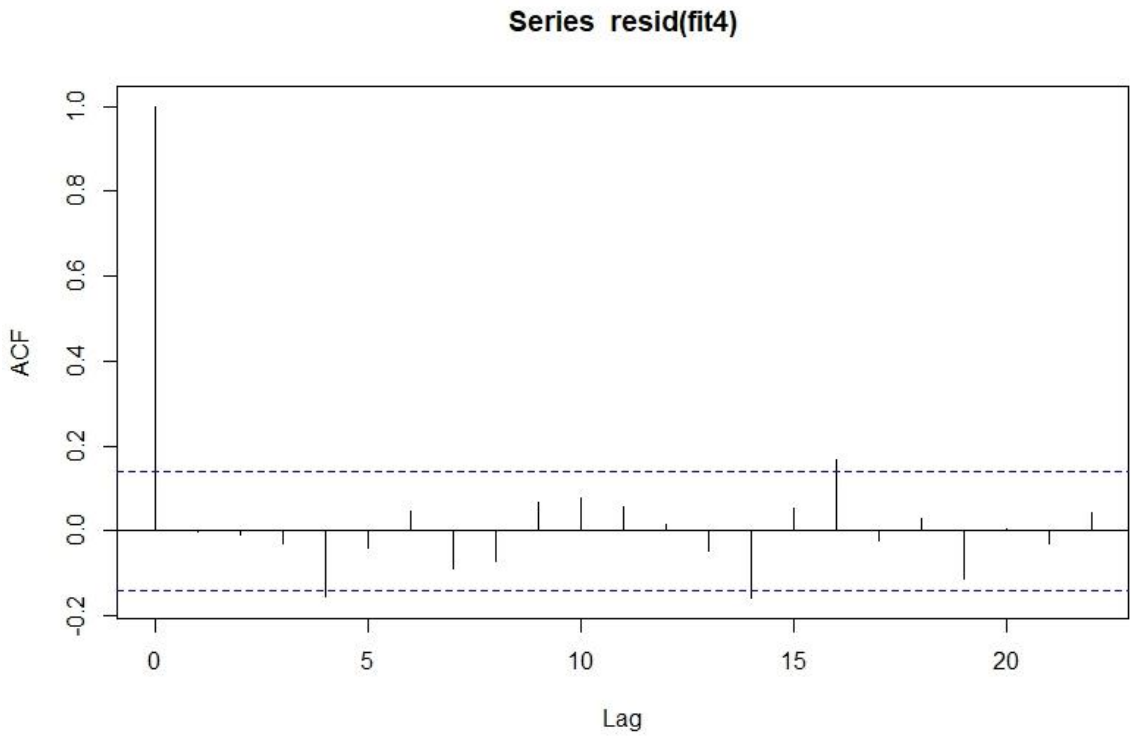
Correlogram part d



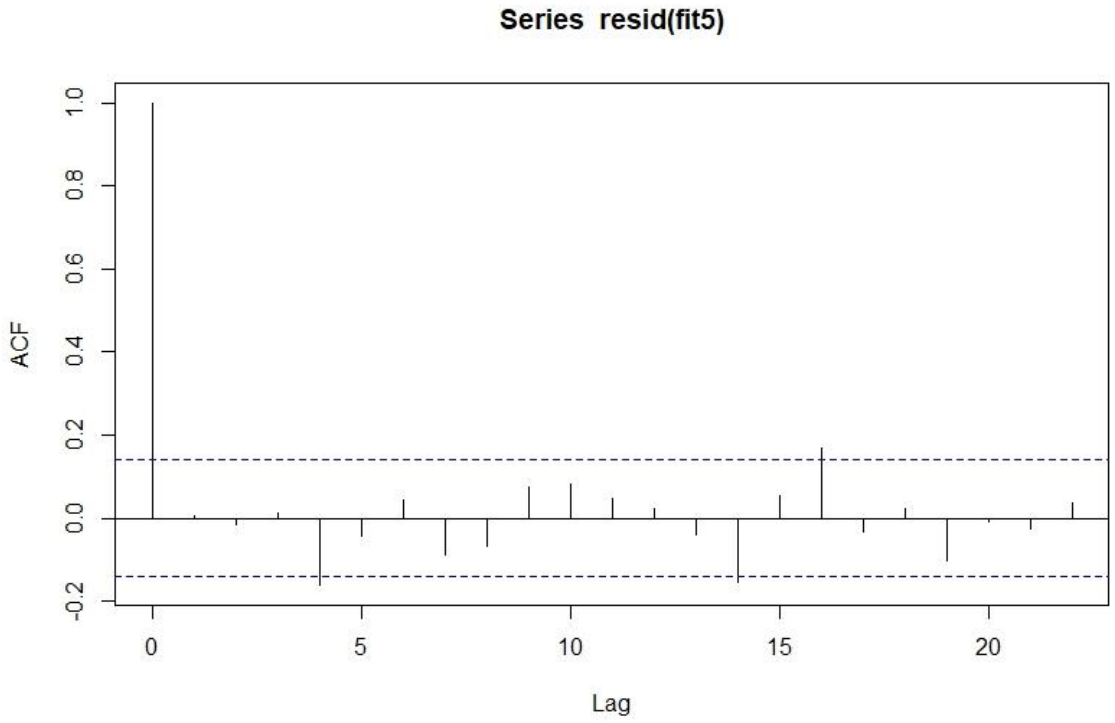
Correlogram part e



Correlogram Part f



Correlogram Part g



R Code:

```
> # ----------------------------
> #-------- Q 9.2 ---------------
> #----------------------------
> qt(0.975,101)
[1] 1.983731
> qt(0.95,101)
[1] 1.660081
> qt(0.90,101)
[1] 1.28999
>
> sqrt(1.3946+2.1606-(2*1.0406))
[1] 1.214084
>
> 5.644-(1.984*1.2140)
[1] 3.235424
> sqrt(1.3946+2.1606+1.4214-(2*1.0406)+(2*.0984)-(2*1.0367))
[1] 1.009356
> 7.909-(1.984*1.009)
[1] 5.907144
>
> # ******************
> # ***** Q 9.4 *******
> # ******************
>
> (-.31*.28)+(.09*.31)-(.03*.09)-(.37*.03)+(.17*.37)+(.39*.17)+(.03*.39)-(.03*.03)+(1.02*.03)
[1] 0.0979
>
> c <- c(0.28, -0.31,-0.09, 0.03, -0.37, -0.17, -0.39, -0.03, 0.03, 1.02)
> View(c)
> d <- c^2
> View(d)
```

```
> sum(d)
[1] 1.5436
> 0.0979/1.5436
[1] 0.06342317
>
> (-.09*.28)-(.03*.31)+(.37*.09)-(.17*.03)+(.39*.37)+(.03*.17)-(.03*.39)-(1.02*.03)
[1] 0.1008
>
> .1008/1.5436
[1] 0.06530189
>
> qnorm(.025)
[1] -1.959964
> qnorm(1-.025)
[1] 1.959964
>
> sqrt(10)*0.0653
[1] 0.2064967
>
> 1.959/sqrt(10)
[1] 0.6194902
>
> # ***************************
> # ********* Q 9.6*************
> #***************************
>
> qt(.975, 216)
[1] 1.971007
> qt(.975,215)
[1] 1.971059
>
> -53.51 - (1.971*16.98)
```

```
[1] -86.97758
> .3306/.0649
[1] 5.093991
>
> -58.61 - (1.971*14.10)
[1] -86.4011
> ts.plot(congwth, col = "blue")
> abline(h = mean(congwth), col = "red", lty = 2)
>
> ts.plot(incgwth, col = "violet")
> abline(h = mean(incgwth), col = "red", lty = 2)
> lag1congwth <- lag(congwth, -1)
> lag1incgwth <- lag(incgwth, -1)
> lag2congwth <- lag(congwth, -2)
> lag2incgwth <- lag(incgwth, -2)
> data <- cbind(consumptionts, lag1congwth, lag2congwth, lag1incgwth, lag2congwth)
> View(data)
>
> data2 <- data[-c(1,2,3), ]
>
> data3 <- as.data.frame(data2)
>
> consumption2 <- consumptn[-c(1,2,3), ]
> incgwth2<- ts((consumption2$incgwth))
>
> congwth2 <- ts((consumption2$congwth))
>
> consumptionTS2 <- cbind(congwth2, incgwth2)
> # ************************************
> # ** Model 1 **********************
> #************************************
> model1 <- lm(congwth2 ~ incgwth2)
```

```
> summary(model1)

Call:
lm(formula = congwth2 ~ incgwth2)

Residuals:
    Min      1Q  Median      3Q     Max
-2.84905 -0.41333 -0.01333  0.37659  2.10138

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.97384    0.09961   9.776   <2e-16 ***
incgwth2     0.44958    0.04967   9.052   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6878 on 195 degrees of freedom
Multiple R-squared:  0.2959,      Adjusted R-squared:  0.2923
F-statistic: 81.94 on 1 and 195 DF,  p-value: < 2.2e-16

> acf(resid(model))
> anova(model1)
Analysis of Variance Table

Response: congwth2
            Df Sum Sq Mean Sq F value    Pr(>F)
incgwth2     1 38.764  38.764  81.939 < 2.2e-16 ***
Residuals 195 92.253   0.473
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> log(81.94/197) + (4/197)
[1] -0.8569119
```

```
>
> log(81.94/197) + 2*(log(197)/197)
[1] -0.8235799
> # ************************************************
> # ********* Adding Lag 1 gor congwth *****************
> # ************************************************
> fit <- lm(consumptionts.congwth ~ lag1congwth + consumptionts.incgwth, data = data3)
> summary(fit)

Call:
lm(formula = consumptionts.congwth ~ lag1congwth + consumptionts.incgwth,
    data = data3)

Residuals:
     Min       1Q   Median       3Q      Max
-2.65079 -0.45241 -0.00952  0.40190  1.78389

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)         0.67158    0.11883   5.652 5.61e-08 ***
lag1congwth         0.27137    0.06351   4.273 3.02e-05 ***
consumptionts.incgwth  0.35012    0.05299   6.607 3.68e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6593 on 194 degrees of freedom
  (2 observations deleted due to missingness)
Multiple R-squared:  0.3564,      Adjusted R-squared:  0.3498
F-statistic: 53.73 on 2 and 194 DF,  p-value: < 2.2e-16

> anova(fit)
Analysis of Variance Table
```

```
Response: consumptionts.congwth
                    Df Sum Sq Mean Sq F value    Pr(>F)
lag1congwth          1 27.726 27.7258  63.793 1.196e-13 ***
consumptionts.incgwth   1 18.975 18.9747  43.658 3.677e-10 ***
Residuals          194 84.316  0.4346
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
> log(84.316/197) +(6/197)
[1] -0.8181752
>
> log(84.316/197) + (3 * log(197)/ 197)
[1] -0.7681772
>
> acf(resid(fit))
>
>
> # ************************************************
> # ********* Adding Lag 1 and lag 2 for congwth *****************
> # ************************************************
>
> fit2 <- lm(consumptionts.congwth ~ lag1congwth + lag2congwth  +  consumptionts.incgwth, data = data3)
> summary(fit2)

Call:
lm(formula = consumptionts.congwth ~ lag1congwth + lag2congwth +
   consumptionts.incgwth, data = data3)

Residuals:
    Min      1Q  Median      3Q     Max
-2.67655 -0.34503 -0.02734  0.33613  1.53752
```

```
Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)          0.42490    0.12541   3.388 0.000853 ***
lag1congwth          0.15940    0.06527   2.442 0.015498 *
lag2congwth          0.28059    0.06146   4.565 8.87e-06 ***
consumptionts.incgwth  0.32162    0.05086   6.324 1.73e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6279 on 193 degrees of freedom
  (2 observations deleted due to missingness)
Multiple R-squared:  0.4192,	Adjusted R-squared:  0.4101
F-statistic: 46.43 on 3 and 193 DF,  p-value: < 2.2e-16

> anova(fit2)
Analysis of Variance Table

Response: consumptionts.congwth
                     Df Sum Sq Mean Sq F value    Pr(>F)
lag1congwth           1 27.726 27.7258  70.318 1.045e-14 ***
lag2congwth           1 11.422 11.4224  28.969 2.118e-07 ***
consumptionts.incgwth   1 15.770 15.7705  39.997 1.730e-09 ***
Residuals           193 76.098  0.3943
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
>
> log(76.098/197) +(8/197)
[1] -0.9105726
>
> log(76.098/197) + (4 * log(197)/ 197)
[1] -0.8439086
```

```
>
> acf(resid(fit2))
>
>
> # ************************************************
> # Adding Lag 1 and lag 2 for congwth  and lag 1 for inc gwth
> #************************************************
>
> fit3 <- lm(consumptionts.congwth ~ lag1congwth + lag2congwth  + consumptionts.incgwth + lag1incgwth, data =
data3)
> summary(fit3)


Call:
lm(formula = consumptionts.congwth ~ lag1congwth + lag2congwth +
    consumptionts.incgwth + lag1incgwth, data = data3)


Residuals:
     Min       1Q   Median       3Q      Max
-2.21541 -0.34194 -0.02908  0.33843  1.52952


Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)         0.33195    0.12193   2.723 0.007075 **
lag1congwth         0.02332    0.06993   0.334 0.739093
lag2congwth         0.21013    0.06103   3.443 0.000706 ***
consumptionts.incgwth  0.34931    0.04909   7.116 2.15e-11 ***
lag1incgwth         0.23335    0.05392   4.328 2.42e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.6009 on 192 degrees of freedom
  (2 observations deleted due to missingness)
```

```
Multiple R-squared:  0.4708,      Adjusted R-squared:  0.4598
F-statistic:  42.7 on 4 and 192 DF,  p-value: < 2.2e-16


> anova(fit3)
Analysis of Variance Table


Response: consumptionts.congwth
                   Df Sum Sq Mean Sq F value    Pr(>F)
lag1congwth         1 27.726 27.7258  76.778 1.003e-15 ***
lag2congwth         1 11.422 11.4224  31.631 6.511e-08 ***
consumptionts.incgwth   1 15.770 15.7705  43.672 3.731e-10 ***
lag1incgwth         1  6.764  6.7641  18.731 2.420e-05 ***
Residuals         192 69.334  0.3611
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
> log(69.334/197) +(10/197)
[1] -0.9935069
>
> log(69.334/197) + (5 * log(197)/ 197)
[1] -0.9101769
> sum((residuals(fit3)^2))
[1] 69.33421
>
> acf(resid(fit3))
>
> # **********************************
> # Adding t-3 and t-2 ***************
> # **********************************
>
> lag3congwth <- lag(congwth, -3)
>
```

```
> data5 <- cbind(consumptionts, lag1congwth, lag2congwth, lag3congwth, lag1incgwth, lag2incgwth)
> View(data5)
>
> data5 <- data5[-c(1,2,3,4), ]
>
> data5 <- as.data.frame(data5)
> data5 <- data5[-c(197,198,199),]
>
> fit4 <- lm(consumptionts.congwth ~ lag1congwth + lag2congwth + lag3congwth +
+            consumptionts.incgwth + lag1incgwth + lag2incgwth, data = data5)
> summary(fit4)

Call:
lm(formula = consumptionts.congwth ~ lag1congwth + lag2congwth +
    lag3congwth + consumptionts.incgwth + lag1incgwth + lag2incgwth,
    data = data5)

Residuals:
     Min       1Q   Median       3Q      Max
-2.20805 -0.35351 -0.01537  0.35356  1.53709

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)         0.32262    0.12920   2.497  0.01337 *
lag1congwth         0.01221    0.07566   0.161  0.87195
lag2congwth         0.20848    0.07079   2.945  0.00364 **
lag3congwth         0.04094    0.06508   0.629  0.53013
consumptionts.incgwth  0.34136    0.05068   6.735 1.91e-10 ***
lag1incgwth         0.22960    0.05600   4.100 6.13e-05 ***
lag2incgwth        -0.01029    0.05736  -0.179  0.85775
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 0.6044 on 189 degrees of freedom
Multiple R-squared:  0.4675,      Adjusted R-squared:  0.4506
F-statistic: 27.66 on 6 and 189 DF,  p-value: < 2.2e-16

> acf(resid(fit4))
> anova(fit4)
Analysis of Variance Table

Response: consumptionts.congwth
                   Df Sum Sq Mean Sq F value    Pr(>F)
lag1congwth         1 26.509 26.5091 72.5622 5.019e-15 ***
lag2congwth         1 11.706 11.7064 32.0436 5.527e-08 ***
lag3congwth         1  1.517  1.5172  4.1530   0.04295 *
consumptionts.incgwth   1 14.194 14.1935 38.8514 2.913e-09 ***
lag1incgwth         1  6.682  6.6819 18.2900 3.008e-05 ***
lag2incgwth         1  0.012  0.0118  0.0322   0.85775
Residuals         189 69.047  0.3653
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
> # ************************************************
> # Droppping  Lag 1  for congwth  and lag 1 for inc gwth
> #************************************************
>
> fit5 <- lm(consumptionts.congwth ~ lag2congwth  + consumptionts.incgwth + lag1incgwth, data = data3)
> summary(fit5)

Call:
lm(formula = consumptionts.congwth ~ lag2congwth + consumptionts.incgwth +
    lag1incgwth, data = data3)
```

```
Residuals:
    Min      1Q  Median      3Q     Max
-2.21171 -0.34415 -0.01992  0.34549  1.52367

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)          0.34074    0.11877   2.869 0.004577 **
lag2congwth          0.21428    0.05961   3.594 0.000413 ***
consumptionts.incgwth  0.35545    0.04539   7.831 3.14e-13 ***
lag1incgwth          0.24144    0.04805   5.025 1.15e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.5995 on 193 degrees of freedom
  (2 observations deleted due to missingness)
Multiple R-squared:  0.4705,      Adjusted R-squared:  0.4623
F-statistic: 57.16 on 3 and 193 DF,  p-value: < 2.2e-16

> anova(fit5)
Analysis of Variance Table

Response: consumptionts.congwth
                  Df Sum Sq Mean Sq F value    Pr(>F)
lag2congwth          1 29.136 29.1363  81.057 < 2.2e-16 ***
consumptionts.incgwth   1 23.431 23.4307  65.184 7.181e-14 ***
lag1incgwth          1  9.076  9.0756  25.248 1.145e-06 ***
Residuals          193 69.374  0.3595
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
> log(69.374/197) +(8/197)
[1] -1.003082
```

```
>
> log(69.334/197) + (4 * log(197)/ 197)
[1] -0.9369952
> sum((residuals(fit3)^2))
[1] 69.33421
>
> acf(resid(fit5))
```