Miguel Alejandro García Navarro

1919323

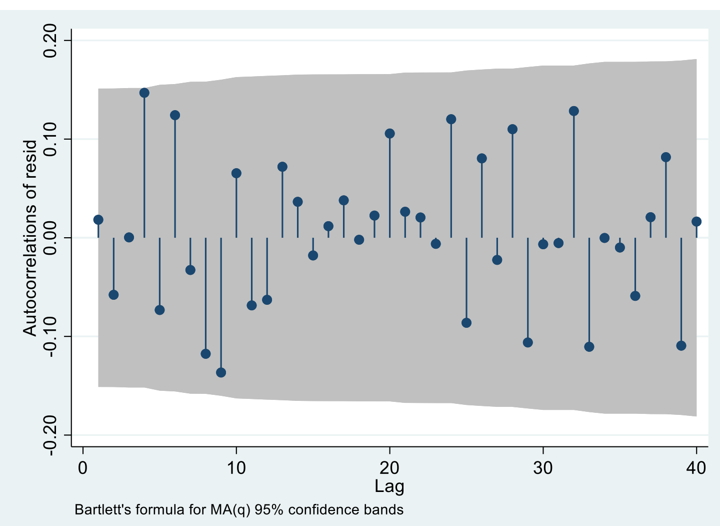
Homework 2

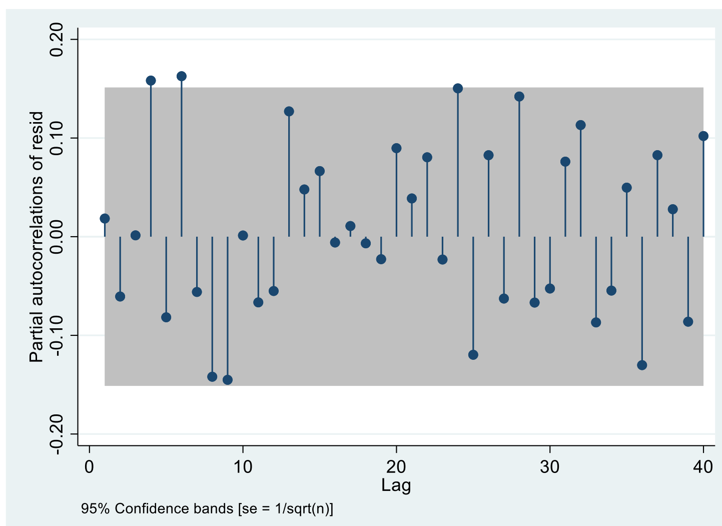
From previous homework, the model ARMA(1,1) was chosen. From the correlogram, no evidence of autocorrelation was found.

```
. corrgram resid, lags(20)

                                          -1       0       1 -1       0       1
 LAG       AC       PAC      Q     Prob>Q  [Autocorrelation]  [Partial autocor]
-------------------------------------------------------------------------------
1        0.0183   0.0184   .05708  0.8112
2       -0.0578  -0.0606   .63213  0.7290
3        0.0004   0.0014   .63215  0.8890
4        0.1469   0.1583   4.3911  0.3557
5       -0.0732  -0.0817   5.3301  0.3769
6        0.1243   0.1627   8.0526  0.2343
7       -0.0327  -0.0560    8.242  0.3117
8       -0.1176  -0.1419   10.711  0.2186
9       -0.1366  -0.1451   14.063  0.1201
10       0.0654   0.0012   14.837  0.1381
11      -0.0686  -0.0666   15.692  0.1530
12      -0.0629  -0.0551   16.416  0.1729
13       0.0720   0.1270   17.371  0.1829
14       0.0364   0.0479   17.617  0.2248
15      -0.0179   0.0665   17.677  0.2800
16       0.0118  -0.0059   17.703  0.3415
17       0.0379   0.0108   17.976  0.3904
18      -0.0020  -0.0067   17.976  0.4572
19       0.0225  -0.0228   18.073  0.5175
20       0.1057   0.0897   20.229  0.4437
```

The AC and the PAC of the residuals also indicate no autocorrelation.





The square residuals are generated, and they're correlogram suggests that the null hypothesis of no autocorrelation is rejected, evidence of heteroscedasticity is found.

```
. gen sqres=resid*resid
(1 missing value generated)

. corrgram sqres, lags(20)

                                          -1       0       1 -1       0       1
 LAG       AC       PAC      Q     Prob>Q  [Autocorrelation]  [Partial autocor]
-------------------------------------------------------------------------------
1        0.1547   0.1547   4.0948  0.0430          |-                 |-
2        0.3244   0.3131   22.202  0.0000          |--                |--
3        0.1252   0.0562   24.917  0.0000          |-                 |
4        0.3619   0.2970   47.731  0.0000          |--                |--
5        0.0382  -0.0832   47.987  0.0000          |                  |
6        0.0997  -0.1025    49.74  0.0000          |                  |
7       -0.0333  -0.1116   49.936  0.0000          |                  |
8        0.1201   0.0269   52.509  0.0000          |                  |
9       -0.0587  -0.0291   53.129  0.0000          |                  |
10      -0.0242  -0.0473   53.235  0.0000          |                  |
11      -0.0790  -0.0121   54.369  0.0000          |                  |
12      -0.0086  -0.0082   54.383  0.0000          |                  |
13      -0.0552   0.0268   54.944  0.0000          |                  |
14      -0.0286   0.0186   55.096  0.0000          |                  |
15      -0.0519  -0.0052   55.599  0.0000          |                  |
16       0.0160   0.0233   55.647  0.0000          |                  |
17      -0.0224   0.0065   55.742  0.0000          |                  |
18      -0.0130  -0.0193   55.774  0.0000          |                  |
19      -0.0566  -0.0650   56.387  0.0000          |                  |
20       0.0473   0.0493   56.819  0.0000          |                  |
```

Before running an ARCH regression on the square of the residuals, it needs to be known how many lags must be used. An AR(8) regression on the square residuals is run.

```
. test l5.ar l6.ar l7.ar l8.ar

 ( 1)  [ARMA]L5.ar = 0
 ( 2)  [ARMA]L6.ar = 0
 ( 3)  [ARMA]L7.ar = 0
 ( 4)  [ARMA]L8.ar = 0

           chi2(  4) =    4.71
         Prob > chi2 =    0.3188
```

The last eight lags are tested, and the null hypothesis of them being equal to 0 is not rejected.

An AR(4) regression is run, and when testing the four lags, the null hypothesis of being equal to 0 is rejected.

```
. test l1.ar l2.ar l3.ar l4.ar

 ( 1)  [ARMA]L.ar = 0
 ( 2)  [ARMA]L2.ar = 0
 ( 3)  [ARMA]L3.ar = 0
 ( 4)  [ARMA]L4.ar = 0

           chi2(  4) =  129.55
         Prob > chi2 =    0.0000
```

Now an ARMA(1,1), with and ARCH(4) regression on the square residuals is run.

```
ARCH family regression -- ARMA disturbances

Sample: 1960q2 thru 2002q1                      Number of obs     =        168
                                                Wald chi2(2)      =     184.58
Log likelihood = 544.3289                       Prob > chi2       =     0.0000
```

inflation	Coefficient	OPG std. err.	z	P>|z|	[95% conf.	interval]
inflation						
_cons	.0035375	.0023527	1.50	0.133	-.0010736	.0081487
ARMA						
ar						
L1.	.8057974	.0740961	10.88	0.000	.6605718	.9510231
ma						
L1.	-.4127088	.1231003	-3.35	0.001	-.653981	-.1714366
ARCH						
arch						
L1.	.1847635	.1000118	1.85	0.065	-.011256	.3807831
L2.	.1100382	.0756079	1.46	0.146	-.0381506	.258227
L3.	.0396241	.0802092	0.49	0.621	-.117583	.1968312
L4.	.3981576	.1129958	3.52	0.000	.1766899	.6196252
_cons	.0000381	9.92e-06	3.84	0.000	.0000187	.0000575

The sum of the ARCH lags is less than 1, so this process is stationary.

Next step is predicting the residuals, and the variance. After that, the standardized residuals are generated as the residuals over the square root of the variance. Lastly, the square standardized residuals are generated; and the correlogram of the residuals and the square standardized residuals is checked to make sure there is no heteroscedasticity is left.

```
. predict resid1, r
(1 missing value generated)

. predict var, v

. gen sr1=resid1/sqrt(var)
(1 missing value generated)

. gen sqres1=sr1*sr1
(1 missing value generated)
```

From the correlogram of the residuals, the null hypothesis of no autocorrelation is not rejected.

```
. corrgram resid1, lags(20)

                                          -1       0       1 -1       0       1
 LAG       AC       PAC      Q     Prob>Q  [Autocorrelation]  [Partial autocor]
-------------------------------------------------------------------------------
1        0.0503   0.0506   .4334  0.5103
2       -0.0139  -0.0177  .46664  0.7919
3        0.0392   0.0425  .73247  0.8655
4        0.1735   0.1885  5.9744  0.2011          |-                 |-
5       -0.0433  -0.0580  6.3028  0.2779
6        0.1470   0.1774   10.11  0.1201          |-                 |-
7       -0.0071  -0.0437   10.12  0.1819
8       -0.0905  -0.1301   11.58  0.1709                            -|
9       -0.1101  -0.1258  13.757  0.1312                            -|
10       0.0815   0.0250  14.958  0.1336
11      -0.0504  -0.0400  15.419  0.1641
12      -0.0443  -0.0265  15.779  0.2016
13       0.0850   0.1515  17.109  0.1943                             |-
14       0.0484   0.0661  17.543  0.2284
15      -0.0040   0.0783  17.546  0.2873
16       0.0251   0.0012  17.664  0.3439
17       0.0498   0.0191  18.133  0.3805
18       0.0108   0.0005  18.155  0.4455
19       0.0342  -0.0166   18.38  0.4972
20       0.1138   0.0953  20.879  0.4043
```

From the correlogram of the square standardized residuals, the null hypothesis of no autocorrelation is not rejected.

```
. corrgram sqres1, lags(20)

                                          -1       0       1 -1       0       1
 LAG       AC       PAC      Q     Prob>Q  [Autocorrelation]  [Partial autocor]
-------------------------------------------------------------------------------
1       0.0285   0.0285   .13898  0.7093           |                  |
2      -0.0335  -0.0346   .33215  0.8470           |                  |
3       0.0068   0.0087   .34007  0.9523           |                  |
4      -0.0135  -0.0167    .3717  0.9847           |                  |
5       0.0594   0.0667   .99058  0.9633           |                  |
6       0.0438   0.0452   1.3283  0.9701           |                  |
7      -0.0688  -0.0715   2.1681  0.9500           |                  |
8       0.1155   0.1316   4.5511  0.8043           |                  |-
9      -0.0613  -0.0804    5.226  0.8142           |                  |
10     -0.0394  -0.0317   5.5068  0.8549           |                  |
11     -0.0730  -0.1017   6.4754  0.8398           |                  |
12      0.0382   0.0588   6.7421  0.8742           |                  |
13     -0.0097  -0.0267   6.7596  0.9141           |                  |
14     -0.0525  -0.0603   7.2708  0.9238           |                  |
15     -0.0602  -0.0402   7.9465  0.9259           |                  |
16      0.0742   0.0878    8.982  0.9142           |                  |
17      0.0165   0.0399   9.0334  0.9392           |                  |
18      0.0623   0.0923   9.7733  0.9391           |                  |
19     -0.0546  -0.0568   10.346  0.9439           |                  |
20      0.0884   0.1198   11.852  0.9211           |                  |
```

In purpose of not using so many ARCH lags, another model to be tried is a GARCH(1,1).

```
ARCH family regression -- ARMA disturbances

Sample: 1960q2 thru 2002q1                      Number of obs     =        168
                                                Wald chi2(2)      =     307.39
Log likelihood = 538.5763                       Prob > chi2       =     0.0000
```

inflation	Coefficient	OPG std. err.	z	P>|z|	[95% conf.	interval]
inflation						
_cons	.0049261	.0028999	1.70	0.089	-.0007576	.0106099
ARMA						
ar						
L1.	.8567799	.0594179	14.42	0.000	.740323	.9732369
ma						
L1.	-.4730103	.1256903	-3.76	0.000	-.7193588	-.2266617
ARCH						
arch						
L1.	.2288776	.101372	2.26	0.024	.030192	.4275631
garch						
L1.	.6026424	.1939788	3.11	0.002	.2224509	.9828339
_cons	.00002	.0000135	1.48	0.140	-6.54e-06	.0000465

The coefficients of the GARCH process sum less then 1, so this process is also stationary.

Once run, the residuals and the square standardized residuals are obtained to check for any left heteroscedasticity.

```
. predict resid2, r
(1 missing value generated)

. predict var2, v

. gen sr2=resid2/sqrt(var2)
(1 missing value generated)

. gen sqres2=sr2*sr2
(1 missing value generated)
```

The correlogram for the residuals suggest there is no statistical evidence of autocorrelation.

```
. corrgram resid2, lags(20)
```

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial autocor]
1	0.0516	0.0519	.455	0.5000		
2	-0.0338	-0.0387	.65163	0.7219		
3	0.0164	0.0201	.6982	0.8736		
4	0.1522	0.1651	4.7304	0.3161		
5	-0.0601	-0.0769	5.3633	0.3732		
6	0.1263	0.1629	8.175	0.2256		
7	-0.0283	-0.0622	8.3168	0.3055		
8	-0.1151	-0.1436	10.682	0.2204		
9	-0.1327	-0.1366	13.845	0.1279		
10	0.0614	0.0110	14.526	0.1503		
11	-0.0661	-0.0575	15.321	0.1683		
12	-0.0586	-0.0408	15.95	0.1936		
13	0.0734	0.1380	16.943	0.2019		
14	0.0397	0.0524	17.235	0.2439		
15	-0.0127	0.0675	17.265	0.3033		
16	0.0157	-0.0067	17.311	0.3657		
17	0.0417	0.0130	17.641	0.4118		
18	0.0039	-0.0042	17.644	0.4794		
19	0.0289	-0.0175	17.804	0.5356		
20	0.1097	0.0948	20.126	0.4501		

With 5 percent of significance, it can be said that the correlogram suggests there is no autocorrelation. However, with 10 percent significance, autocorrelation cannot be rejected in the fourth, fifth, eighth and ninth lags.

```
. corrgram sqres2, lags(20)
```

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial autocor]
1	0.0072	0.0072	.00891	0.9248		
2	-0.0224	-0.0225	.09513	0.9535		
3	-0.0134	-0.0133	.12639	0.9885		
4	0.2310	0.2516	9.4168	0.0515		
5	-0.0211	-0.0242	9.4944	0.0909		
6	0.0333	0.0499	9.6903	0.1383		
7	-0.0745	-0.0866	10.676	0.1534		
8	0.1474	0.1076	14.552	0.0685		
9	-0.0535	-0.0612	15.066	0.0891		
10	-0.0546	-0.0797	15.605	0.1115		
11	-0.0745	-0.0471	16.614	0.1198		
12	0.0086	-0.0570	16.628	0.1641		
13	-0.0341	0.0040	16.841	0.2067		
14	-0.0606	-0.0607	17.523	0.2294		
15	-0.0723	-0.0295	18.499	0.2373		
16	0.1041	0.1210	20.534	0.1971		
17	-0.0215	0.0027	20.622	0.2437		
18	0.0243	0.0889	20.734	0.2931		
19	-0.0733	-0.0677	21.763	0.2962		
20	0.1049	0.0820	23.888	0.2473		